DEPARTMENT OF
ECOLOGY
State of Washington

Northwest Region Report

Optimizing the Commingled Residential Curbside Recycling Systems in Northwest Washington

October 2016
Publication no. 16-07-028

Publication and Contact Information

This report is available on the Department of Ecology's website at:

https://fortress.wa.gov/ecy/publications/SummaryPages/1607028.html

For more information contact:

Waste 2 Resources
Program P.O. Box 47600
Olympia, WA
98504-7600 Phone:
360-407-6900

Washington State Department of Ecology - www.ecy.wa.gov

- Headquarters, Olympia 360-407-6000
- Northwest Regional Office, Bellevue 425-649-7000
- Southwest Regional Office, Olympia 360-407-6300
- Central Regional Office, Yakima 509-575-2490
- Eastern Regional Office, Spokane 509-329-3400

To ask about the availability of this document in a format for the visually impaired, call the Waste 2 Resources at 360-407-6900. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Northwest Region Report

Optimizing the Commingled Residential Curbside Recycling Systems In Northwest Washington

Waste 2 Resources Program
Washington State Department of Ecology
Olympia, Washington

This page is purposely left blank

TABLE OF CONTENTS

Contents

Executive Summary 1
Summary of Findings 1
Commodity Issues and Recommendations 2
Commingled Recycling System Issues 5
Introduction 7
Goals of the Report 7
Scope of Work 7
Background 9
Methodology 10
The Basic Recycling System – How Does It Work? 11
Commodity Overview 17
Corrugated Cardboard 19
Glass Containers 25
Metals – Aluminum and Steel 35
Mixed Paper 43
Newspaper 51
Plastic 59
Key Issues & Recommendations 79
Problematic Materials in Commingled* Curbside Systems 79
Commingled Recycling System Issues 84
Cited Resources 91
Glossary 97

List of Tables

Table 1. Recyclable Materials Collected in Residential Commingled Curbside Recycling Programs 2
Table 2. Recyclable Materials Collected in Residential Commingled Curbside Recycling Programs 12
Table 3. Carton Recycling Options 50
Table 4. Commingled Contaminants and Operating Impacts at NORPAC's Paper Mill 55
Table 5. Plastic by Resin Type and Code 59

List of Figures

Figure 1. Who is Involved in Commingled Recycling Programs? 11
Figure 2. Commingled Collection and the Rise of Contamination of Fiber at NORPAC Paper Mill – Deinking Facility, Longview, WA 54
Figure 3. Two Sided Tip Card and Retail Poster 72
Figure 4. Messaging from Waste Management's Recycle Often, Recycle Right Campaign 76

List of Appendices

Appendix A. Methodology A-1
Appendix B. NW Region Residential Curbside Recycle Material List B-1
Appendix C. Snohomish County Recycling Facilities and Districts Map C-1
Island, San Juan, Skagit, Whatcom Counties Recycling Facilities and Districts Map C-2
King County Recycling Facilities and Districts Map C-3
Appendix D. Commodity Specifications D-1
Appendix E. Energy Savings from Recycling Glass E-1
Appendix F. NORPAC Study on Effects of Glass at Paper Mill (2009) F-1

ACKNOWLEDGEMENTS

Many people contributed much time and effort. Thanks to all!

Northwest Region Workgroup Participants

Abby Hart	Republic Services	Collector/MRF
Alli Kingfisher	Department of Ecology	Government
Candy Castellanos	Waste Management	Collector/MRF
Chris Piercy	Kitsap County	Government
Diana Wadley	Department of Ecology	Government
Dick Lilly	Seattle Public Utilities	Government
Erwin L. Swetnam III	San Juan County	Government
Evelyn Nicholson	Sound Disposal, Inc	Collector
Gene Clark	Island County	Government
Gerty Coville	King County	Government
Jeff Epstein	Carton Council	Industry Association
Jenna Higgins	City of Kirkland	Government
Jim Frey	Resource Recycling Systems	Consultant
Joan Nelson	City of Auburn	Government
John Caputo	Republic Services	Collector/MRF
John Drucker	SP Recycling	MRF
John MacGillivray	City of Kirkland	Government
Shannon McClelland	Department of Ecology	Government
Kelly Ferron	Recology CleanScapes	Collector/MRF
Kim Ducote	Resource Stewards	Consultant
Laura Kelly	City of Everett	Government
Lisa Sepanski	King County	Government
Matt Stern	Waste Management	Collector/MRF
Michelle Metzler	Waste Management	Collector/MRF
Norman Nicholson	Sound Disposal, Inc	Collector
Pat Campbell	Kitsap County	Government
Polagaya McLaughlin	Snohomish County	Government
Quinn Apuzzo	Recology CleanScapes	Collector/MRF
Rob Van Orsow	City of Federal Way	Government
Rodd Pemble	Sanitary Service Company, Inc.	Collector
Sabrina Combs	City of Bothell	Government
Sego Jackson	Seattle Public Utilities	Government
Sheila Hosner	Department of Ecology	Government
Stephanie Schwenger	City of Bellevue	Government
Suellen Mele	Zero Waste Washington	NGO/Environmental
Susan Robinson	Waste Management	Collector/MRF
Tracy Durnell	City of Kirkland	Government

Guest Speakers* and Other Stakeholders

Jeromy Adams*	Nucor Steel Seattle	Manufacturer - Steel
Jetta Antonakos	City of Tacoma	Government
Jan Cleiland*	KapStone Container Corporation	Manufacturer - Cardboard
Jeff Epstein	Carton Council	Industry Association
Katie Flight*	Verallia	Manufacturer - Glass
Jim Frey*	Resource Recycling Systems	Consultant for Carton Council
Dennis Hinson*	Strategic Materials	Processor – Glass
Marty Kuljis	Northwest Recycling	MRF/Processor
Andy McKee*	Novelis	Manufacturer – Aluminum
Patty Moore*	Moore Recycling Associates, Inc.	Consultant – Plastics
Carl D. Quinto	Strategic Materials	Processor – Glass
Jay Simmons	NORPAC	Manufacturer –Paper
Ed Tolan*	Nippon Paper Industries	Manufacturer - Paper
Juli Tuson*	Simpson Tacoma Kraft Company, LLC	Manufacturer – Cardboard

EXECUTIVE SUMMARY

Commingled recycling programs require that residents place all recyclables into one bin at the curb. The materials picked up by the recycling company go to a "material recovery facility (MRF)". The MRF sorts the material into individual commodity streams such as glass, paper, plastics, and metals.

Sorted materials become bales and sell to markets. The markets use the bales as a feedstock for manufacturing new products. This report provides specific recommendations for improving commingled collection systems.

The recommendations outlined in this report will optimize residential commingled curbside recycling programs in the following areas:

- Provide customer, environmental, social, and economic benefits;
- Result in quality materials for return to commerce;
- Ensure public confidence in the recycling system; and
- Provide ease of use by residents.

Washington State Department of Ecology identifies the Northwest Region as Island, King, Kitsap, Snohomish, San Juan, Skagit, and Whatcom counties. A workgroup came together comprised of government recycling staff, solid waste and recycling service providers and recyclable materials processors.

The workgroup met monthly, starting in November 2012. Participants provided their perspectives on the issues they face with each material. Guest presenters provided data on the final use of each material. An identical set of questions used for each material allowed the group to obtain data.

Summary of Findings

Evaluation of the most common materials collected in residential commingled curbside recycling bins broke down into seven categories: cardboard, newspaper, mixed paper, steel, aluminum, plastic, and glass.

Table 1: Recyclable Materials Collected in Residential Commingled Curbside Recycling Programs

Materials Collected All Programs (100%)	Most (85%-99%)	Many (50%-84%)	Some (7%-49%)	None (0%)
Office paper	Fiber milk and juice cartons	Gift wrap (non-foil)	Shredded paper (bagged)	Waxed boxes[1]
Corrugated cardboard	Glass bottles & jars	Aseptic cartons (milk, soy, soup, juice)	Egg cartons	Paper plates, towels, napkins, tissues[2]
Boxboard	Small scrap metal	Paper cups	Small appliances	Food soiled paper[3]
Phone books/ paperback books	Metal pots & pans	Aluminum foil & trays	Aerosol cans (non-toxic contents)	Foil gift wrap
Mail/envelops	Plastic tubs	Plastic plant pots	Metal lids & caps	Non-bottle/jar glass
Magazines/catalogs	Polycoated food boxes	Plastic cups	Plastic lids & caps	Large scrap metal
Paper bags			Plastic 5-gallon buckets	Hangers
Newspaper & inserts			Plastic bags & stretch wrap (bagged)	Ammunition
Aluminum & steel cans			Plastic trays & clamshells	Flexible pouches (food and juice packaging)
PET/HDPE bottles & jugs			PVC pipe	
			Rigid plastic (lawn furniture, laundry baskets)	

The table summarizes the array of materials residential commingled curbside recycling programs accept. It also includes the percentage of communities that collect them in their commingled systems.

Commodity Issues and Recommendations

The following commodities presented specific problems in the commingled collection systems. Each material's issues and preliminary recommendations follow.

A. Plastic bags and film: Plastic bags and film tangle in sorting equipment at MRFs. This negatively affects the sorting of other commodities. Recommendations include:

- Do not collect bags/film from curbside in commingled collection bins.
- Promote taking these items to participating retailers; build on national efforts when feasible (i.e. Re-Trac's WRAP; www.plasticfilmrecycling.org).

[1] Some food and yard waste composting programs collect waxed boxes.
[2] Paper plates, towels, napkins, tissues are collected in some food and yard waste composting programs.
[3] Food soiled paper are collected in some food and yard waste composting programs.

- Explore bag ban legislation.

B. Plastic caps: Plastic caps are recyclable, but end up as residual waste at the MRF. A way to avoid this is to put them back onto the container. Recommendations include:

- Require residents to put caps back onto empty plastic bottles for recycling.

C. Compostable and degradable plastics: Compostable plastics are not commercially recycled locally. Compostable and degradable plastics can contaminate plastics bales. This is more of an issue with degradable plastics.

Degradable plastics have the same light wavelength signature as their base resin (PET or HDPE) when passing under a near infrared (NIR) optical sorter. Optical sortation sorts compostable plastic such as PLA from other plastics. Recommendations include:

- Require the use of simple and accurate labeling on compostable and degradable plastic packaging.

D. Glass: Glass in commingled collection bins breaks into fine pieces. Broken glass contaminates other materials, damages equipment, and is a safety hazard for MRF workers. Glass is particularly affected. Recommendations include:

- Collect glass separately if possible. Communities that do not take glass in their commingled programs should continue to keep it separate. Jurisdictions changing to collect glass as a non-comingled item will need to build in time for the adjustment. Residents will not change their habits when a commodity collected in the curbside cart for a long period. In this case, glass will remain in the feedstock as a contaminant.

- Explore alternative methods of collecting glass. Other methods include redemption programs, producer financed programs, and partnerships with local glass manufacturers.

- Conduct further research on the costs and benefits of collecting glass curbside now that commingled systems have been in place for several years. Compile an analysis of the existing types of systems including commingled systems with "glass in", curbside collection with "glass on the side" or separation from fiber and collection depots. This will help jurisdictions make the business case for whether or not they collect glass.

- Examine the impacts of secondary glass processing facility Strategic Materials on the market in the Northwest Region. Analyze the roles and relationships between the MRFs, Strategic Materials, and final glass markets as they work. Reviewing the roles of operation will allow possibilities to present themselves to decrease contamination and optimize glass recycling.

E. Shredded paper: MRFs cannot sort shredded paper. Shredded paper is too small for the sorting machinery at MRFs. Shredded paper contaminates other commodities. The majority sent for material recovery ends up not being recycled. Recommendations include:

- Do not collect shredded paper in commingled recycling systems. Once residents are accustomed to collecting material it is difficult to change behavior.
- Request customers to tear off and shred only sensitive information. Promote use of shred events. Shred events collect and recycle the material in bulk.

F. Food-contaminated paper: Food-contaminated paper cannot be recycled. Food contaminated paper is not accepted in any system. However, it continues to be a common contaminant. Recommendations include:

- Do not add food contaminated paper to list of accepted recyclables.
- Educate residents to place food-contaminated papers in their garbage cans and not the recycling bin.
- An education program will decrease contamination.

G. Poly-coated paper (milk cartons, juice boxes, cups, and frozen food boxes): MRFs cannot sort poly-coated paper easily. Local paper mills cannot process poly-coated paper. Recommendations include:

- Engage the Carton Council to address issues. The workgroup and Carton Council will work together to provide analysis, and assistance in implementing improvements. This may include improving the collection and sorting of poly-coated paper.

  Determine system costs and per ton costs for various approaches to collecting and processing poly-coated packaging materials. Other areas to consider are researching end markets and best practices for attaining high yield bales.
- Identify funding sources for pilots/system improvements.
- Explore whether handling cups and other non-carton items should be separate or combined with cartons in specific (Grade #52 poly-coated) bales. Engage the manufacturers that use and make poly-coated items in the stakeholder discussions.

H. Metal lids: The MRF loses loose metal lids smaller than 3 inches in diameter to residual. These lids are often disposed of. Recommendations include:

- Leave metal lids from metal containers attached or crimped inside the can.
- Do not put metal lids less than 3 inches in diameter in the recycle bin.

I. Aluminum foil, trays, and pans: Aluminum non-beverage containers have low recoverability at smelters. The containers are food contaminated, and are difficult to sort. Recommendations include:

- Do not collect aluminum foil, trays, and pie pans in curbside commingled systems.

Commingled Recycling System Issues

The workgroup identified several systemic issues with the commingled curbside collection systems. Preliminary recommendations provide possible solutions for each issue.

A. Commingled curbside recycling programs accept marginally recyclable. Many of the materials accepted are disruptive to the regional recycling system. Recommendations include:

- Prioritize the collection of recyclables to meet the following three categories: have viable markets, MRFS can sort recyclables effectively, and generate revenue.
- Conduct research to determine the effects of including additional materials in the commingled bin. Determine actual costs to the collectors/MRF of removing or adding new materials. Materials evaluation should occur before adding or removing items from the commingled bins.
- Prorate charges to curbside programs rates for sorting at the MRF. The charges will vary based on the quality and type of materials included in the curbside program.
- Explore how companies that use materials can help to finance the processing required for recycling. In particular, secure financing for those recyclables that are costly to process or have large impacts on the MRF/processor.

B. Commingled curbside recycling programs vary across the Northwest Region. This leads to confusion by the public about what can be recycled. Recommendations include:

- Create a workgroup of jurisdictions within the Northwest Region. The workgroup will develop a standardized list of recyclable materials for commingled curbside recycling programs. Communicate this approach to the local government officials.
- Develop language for RFPs for use in recycling service contracts. The language will standardize the recyclable materials accepted by curbside recycling programs.
- Create coordinated education program and messaging. The messages will emphasize commodities that hold their value. It would also de-emphasize materials that do not hold their value in markets. This effort will provide tactics to all communities for their use in education outreach.

C. There is a lack of assurance that materials collected in curbside programs process at high recovery rates, and the materials achieve their highest value at MRFs. Information about the fate of recyclable materials from curbside collection programs is lacking. Recommendations include:

- Create a Toolkit for cities that develops RFPs for recycling service contracts. The toolkit should include a mechanism to assess performance of the MRFs. The assessment would verify that the materials accepted in the curbside program are being recycled.
- Consider developing regional or statewide MRF performance standards.
- Improve the methodology used to calculate the state recycling rate using stakeholder feedback.

D. Recyclability does not drive new and existing packaging and products design. Recommendations include:

- Encourage dialogue between MRF operators and product manufacturers at the product development stage. Explain sorting and processing limitations at MRF's and processing facilities. The goal being that manufacturers consider recyclability in all steps of processing, packaging and product design.
- Participate in existing national packaging design efforts. Share information with packaging designers and manufacturers about our local recycling infrastructure.
- Explore additional options such as attaching a fee to products containing problematic components (i.e. disruptor fee).
- Explore opportunities for obtaining funding from manufacturers/packaging producers for alternative recycling systems. Both for packaging and for products that is incompatible with current curbside/MRF systems.

E. Messaging and symbols on packaging can create confusion. Messaging needs to improve recycling. Recommendations include:

- Understand how the Federal Trade Commission calculates "recycling rate" and recyclability claims on packaging. Decide how to use this information. Clarify the steps for filing complaints against packaging with false recyclability claims.
- Use the Sustainable Packaging Coalition's How2Recycle Label Program to improve the labeling systems.
- Support national efforts to remove "chasing arrows" symbol from resin code on plastics.

F. The mix of plastic resins and containers is becoming more complex. Explore potential for siting Regional Plastics Recycling Facility (PRF). Recommendation includes:

- Explore the possibility for funding and siting a PRF in the Northwest region. A PRF located in the Seattle area would allow for collection and processing of existing "curbside" plastics. It would also allow the ability to collect and process plastics from a greater range of sources.

INTRODUCTION

The report identifies ways to optimize the commingled residential curbside recycling systems. It focuses on the systems in place within the Northwest Region of Washington State. The report identifies key problems and issues. It also gives a list of recommendations for correcting problems. The suggested solutions address both the quality and amount of recyclable materials.

The Department of Ecology considers the Northwest Region to include Island, King, Kitsap, San Juan, Skagit, Snohomish, and Whatcom Counties. The majority of counties in the Northwest Region offer "commingled" curbside recycling programs to their residents. The only exceptions are Whatcom County, parts of two cities in Snohomish County and areas outside of Oak Harbor, Coupeville, and Camano Island in Island County.

Commingled recycling programs require that customers place all of their recyclable materials into one recycling bin. The materials go to a "material recovery facility (MRF)". The materials are sorted into individual commodity streams such as glass, paper and plastics by type of resin. . This report focuses on the commingled model. The report also references the three-bin collection system as appropriate.

Goals of the Report

One goal of this report is to identify ways to optimize residential commingled curbside recycling programs. Another is to support effective processing systems for recyclable paper, packaging, and other materials. The two separate goals entailed ensuring recommendations incorporated the following:

- Providing customer, environmental, social, and economic benefits;
- Result in quality materials for return to commerce;
- Ensuring public confidence in the recycling system; and
- Easy use by residents.

Scope of Work

Included in this scope of this report are:

- Jurisdictions within the Department of Ecology's Northwest Region that have single family commingled curbside recycling programs;
- Materials accepted in single-family commingled curbside recycling carts such as cardboard, newspaper, mixed paper, steel, aluminum, glass containers, and plastic containers and bags;

- MRFs that accept materials from Northwest Region single family commingled curbside collection programs;
- Current and potential processors and end markets that do or could accept materials from MRFs in the Northwest Region.

Outside of the scope of this study are:

- Organics – yard and food waste
- Multi-family and commercial sector – including public spaces
- Drop off collection systems and sites

This report provides an evaluation of each material stream commonly accepted in commingled curbside residential programs. The report includes the scope of material accepted in the stream. It also has an overview of the current performance of each recyclable material. The workgroup defined standard recyclable materials as cardboard, newspaper, mixed paper, metal, plastic, and glass:

The workgroup collected the following information on the standard recyclable materials:

- Weight of material as a percentage of the recycling stream. Both in the cart and at the MRFs
- Instructions for how the public should prepare the materials for placement in the cart
- Collection issues
- Processing issues
- Markets for the recyclable materials
- Issues with the material as a recyclable feedstock
- Environmental benefits and reduction of greenhouse gases from recycling these materials
- Impacts of the material on the value of the other commodities
- Final products resulting from each of the materials

Based on the information above, we were able to identify key problem areas. These areas affect the quality and quantity of the materials destined for recycling. The data collected allowed us to provide recommendations for improvement.

Disclaimer: This report represents the best efforts of the agencies and businesses in the Northwest Region Commingled Workgroup. Broad consensus led to the report and recommendations herein. Participation in the workgroup does not connote endorsement of the recommendations by every participating organization. This is a dynamic subject matter. The recommendations reflect the best available information and thinking at the time of publication.

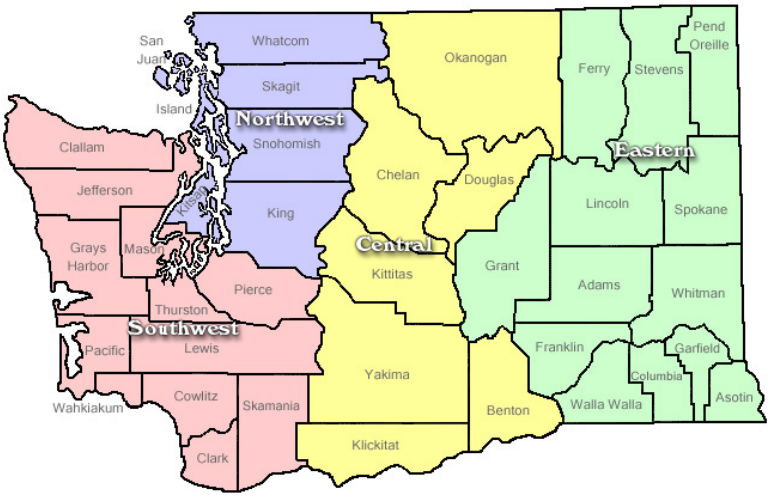
BACKGROUND

In July 2007, the Environmental Protection Agency (EPA) Region 10 began an initiative called the *Contamination in Commingled Recycling Systems Standards & Guidelines Initiative*. The purpose of the Initiative is to develop standards and guidelines for commingled recycling systems. This development will reduce contamination of recycled materials; and increase the quality and quantity of materials recycled. The standards and guidelines will also capture the highest percentage of materials intended to be recycled. In September 2008, EPA Region 10 handed off the deliverables of the Initiative to Oregon and Washington. The deliverables included common terminology, guidelines, goals, evaluation protocols, and marketing tools. The expectation was that the states would pursue their own individual implementation processes.

The Washington State Department of Ecology (Ecology) followed up the original Initiative with a *Washington Commingled Recycling Improvements Project* meeting in March 2009. The meeting purpose was for local government stakeholders to discuss contamination issues associated with commingled recycling. This discussion included the process and outcomes of the EPA Region 10 Initiative project. It also allowed Ecology to ask if local governments had interest in working further on this issue. Ecology focused its attention on local government for two reasons. Local municipalities were largely absent during EPA's Region 10 Initiative project. Moreover, local governments are critical decision-makers for residential recycling programs in Washington.

The result of the meeting was that participants agreed to address reducing contamination. Three workgroups formed based on Ecology's regional divisions of the state – Northwest, Southwest, and a combined Central/Eastern/Idaho border group. Each agreed to involve all stakeholders including local governments, MRFs, haulers, and end-users. The Southwest Region Workgroup completed the bulk of its work between 2009 and 2010. Members still meet annually to check in with each other. The Central/Eastern/Idaho group has, to date, only met a few times.

This report is the result of the work of the Northwest Region Workgroup (NRW), which includes King, Kitsap, Snohomish, Island, San Juan, Skagit, and Whatcom counties. The NRW began in November 2012 and met monthly for three years to explore curbside commingled recycling systems in the region from collection to end-user.



This report intends to inform readers of basic issues and fates of

curbside commingled residential recyclables. Most counties in the region have commingled curbside residential recycling in at least part of their county. The only exception is Whatcom County, which utilizes a stacking, three-bin system.

Methodology

The NRW tracked commingled systems collection of seven material categories. The material categories include cardboard, glass containers, aluminum, steel, mixed paper, newspaper, and plastics. At meetings, stakeholders shared their perspectives on the recycling process for each material. Guest speakers representing end-users[4] presented data. The data included the processing and final use of materials at meetings. Several processing facilities held tours.

Each materials evaluation came from an identical set of questions. The group also used available existing data and anecdotal information. The information allows understanding of the 'story' of each material throughout differing stages. The stages included from the curb, to the MRFs, and to its eventual final end-use. Detailed information on the methodology is available in Appendix A.

[4] An end-user is the company that first uses recycled material to manufacture a product (See Glossary).

The Basic Recycling System – How Does It Work?

Figure 1. Who is Involved in Commingled Recycling Programs?

Many hands determine the outcome of recyclables on their journey from the resident to becoming new products. The above diagram provides a basic overview of the curbside recycling system.

Items Collected in Commingled Recycling Programs

This report focuses on the evaluation of standard recyclable materials collected in residential commingled curbside recycling bins. Standard recyclable materials include cardboard, newspaper, mixed paper, steel, and aluminum, plastic, and glass containers. The table below shows some other materials that are accepted in residential commingled curbside recycling programs.

Table 2. Recyclable Materials Collected in Residential Commingled Curbside Recycling Programs

Materials Collected All Programs (100%)	Most (85%-99%)	Many (50%-84%)	Some (7%-49%)	None (0%)
Office paper	Fiber milk and juice cartons	Gift wrap (non-foil)	Shredded paper (bagged)	Waxed boxes
Corrugated cardboard	Glass bottles & jars	Aseptic cartons (milk, soy, soup, juice)	Egg cartons	Paper plates, towels, napkins, tissues
Boxboard	Small scrap metal	Paper cups	Small appliances	Food soiled paper
Phone books/ paperback books	Metal pots & pans	Aluminum foil & trays	Aerosol cans (non-toxic contents)	Foil gift wrap
Mail/envelops	Plastic tubs	Plastic plant pots	Metal lids & caps	Non-bottle/jar glass
Magazines/catalogs	Polycoated food boxes	Plastic cups	Plastic lids & caps	Large scrap metal
Paper bags			Plastic 5-gallon buckets	Hangers
Newspaper & inserts			Plastic bags & stretch wrap (bagged)	Ammunition
Aluminum & steel cans			Plastic trays & clamshells	Flexible pouches (food and juice packaging)
PET/HDPE bottles & jugs			PVC pipe	
			Rigid plastic (lawn furniture, laundry baskets)	

Collection of Commingled Recyclable Materials

In the majority of the Northwest Region, local governments and solid waste management companies provide a single cart. All recyclables go into one cart and curbside collectors require no sorting for residents. Usually, an automated arm attached to the recycling truck lifts the cart. Photo 2 shows an automated recycling truck emptying the recycling cart into the truck.

Photo 1: Recycling cart for commingled curbside collection.

The single cart method has a formal name known as commingled recycling. It is the system used primarily in King, Kitsap, Snohomish, and Skagit counties. Island and San Juan counties use commingled collection, where curbside collection occurs.

Most jurisdictions opt for the commingled method of collection. because it requires less labor. to put all recyclable materials into one large bin versus having to

Photo 2: Recycling truck with automated arm for lifting the commingled recycling cart.

separate by material type into different recycling bins. The premise is that more materials will get recycled. Commingled collection programs also allow the recycling trucks to use automated systems to lift the bins. Automated systems can save time and reduces worker injuries. This report focuses on the commingled model, with occasional references to the source-separated two/three-bin model.

Source-separated Collection of Recyclable Materials

In Whatcom County, residents have three hand-carried bins. Residents can only sort their recyclables into the following: 1) mixed paper and cardboard, 2) newspaper, and 3) plastic containers, metal cans, and glass. The recycling employees manually lift each bin into the appropriate compartment of the truck. The employees screen for materials that are contaminants and can provide immediate feedback to the customer.

On Vashon Island in King County, residential curbside collection utilizes a four-bin system. The four bins are as follows: 1) plastics, 2) aluminum and metal cans, 3) mixed paper and cardboard, and 4) glass. Vashon Island plans to move towards commingled collection in the near future.

In Snohomish County, residential two-bin curbside recycling occurs in sections of the City of Everett and the City of Mukilteo. Residents can only sort their recyclables into the following: 1) mixed paper and cardboard and 2) plastic, metal and glass containers.

Processing Commingled Recyclable Materials

All materials collected for recycling from residents, regardless of collection process, go to a Materials Recovery Facility (MRF). The MRF is a facility that accepts, sorts, processes, and bales different types of recyclables. The MRF bales recyclables for shipment and sale to a secondary processor or end-user.

The primary MRFs that accept commingled recyclables from the Northwest Region residential curbside programs include:

Republic Services 3rd and Lander Recycling Facility, 2733 3rd Ave S/200 S Hanford St, Seattle, WA 98134

Waste Management Cascade Recycling Facility, 14020 NE 190th St, Woodinville, WA 98072

Waste Management JMK Fibers, 1440 Port of Tacoma Road, Tacoma, WA 98421

Recology CleanScapes Material Recovery Facility, 7 S Idaho St, Seattle WA 98134

Pioneer Recycling, 4109 192nd St E, Tacoma, WA 98446

Northwest Recycling, Bellingham, 1419 C Street, Bellingham, WA 98225

How Does a MRF Work?

The diagram below shows how a MRF accepts materials from a commingled collection system. It clarifies how materials separate into recyclable commodities and non-recyclable residuals.

The MRF has a different method of processing recyclable materials for Whatcom County due to collection differences.

Northwest Recycling runs the main MRF in Whatcom County. Northwest Recycling has separate bays for the three categories of materials where the compartmentalized truck directly dumps. A photo of Sanitary Service Company, dumping its plastic/metal/glass compartment at Northwest Recycling.

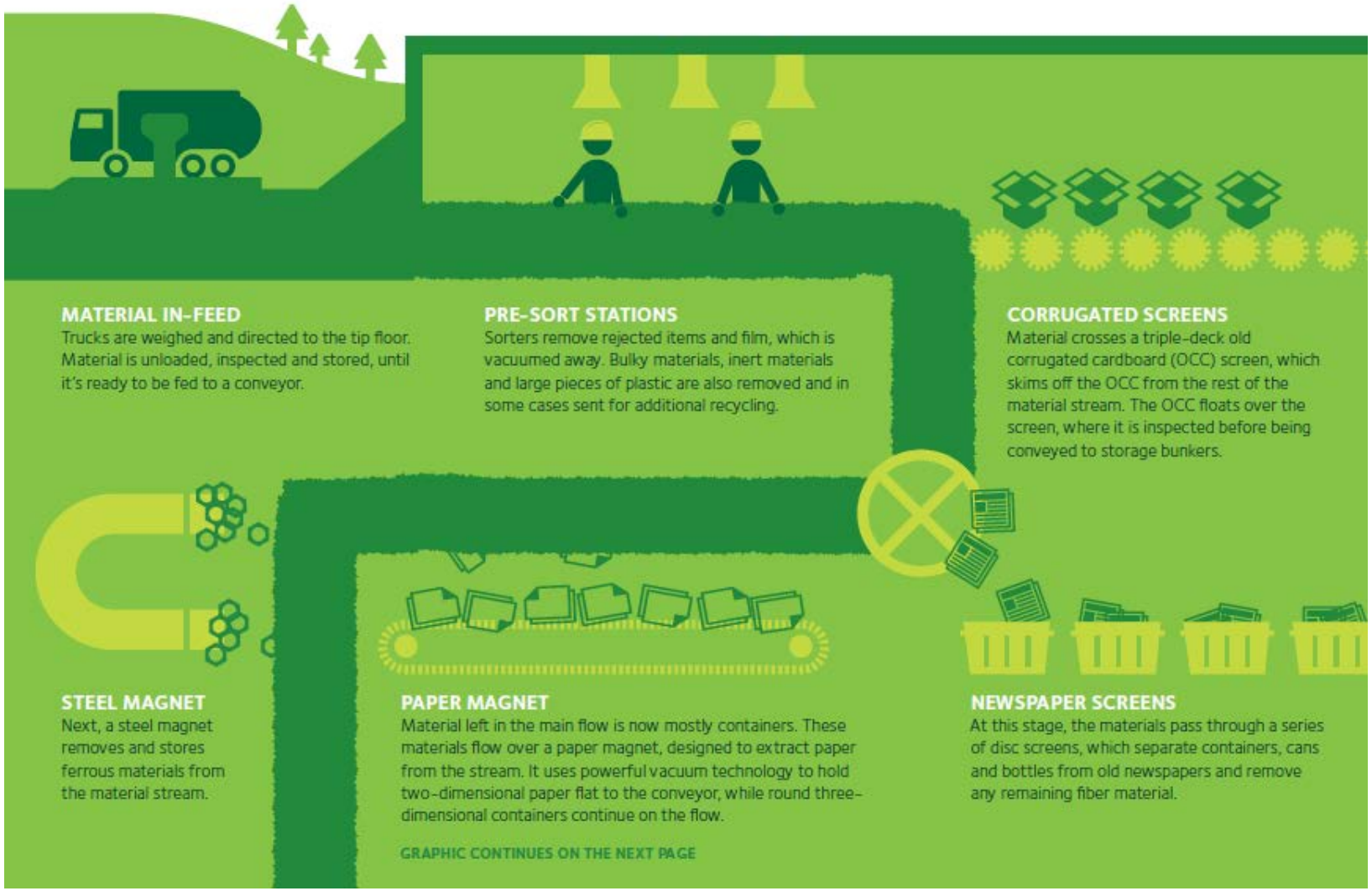
Photo 3: Compartmentalized recycling truck.

Rubatino Refuse Removal processes the Everett and Mukilteo two-bin sort system of mixed paper and cardboard. They bale and market the recycled material.

Separation of certain materials into specific bins reduces cross-contamination of recyclables. Reducing contamination increases the market price for most commodities.

See for yourself how a MRF works! http://www.youtube.com/watch?v=7CFE5tD1CCI

A TYPICAL SINGLE STREAM RECYCLING FACILITY



MATERIAL IN-FEED
Trucks are weighed and directed to the tip floor. Material is unloaded, inspected and stored, until it's ready to be fed to a conveyor.

PRE-SORT STATIONS
Sorters remove rejected items and film, which is vacuumed away. Bulky materials, inert materials and large pieces of plastic are also removed and in some cases sent for additional recycling.

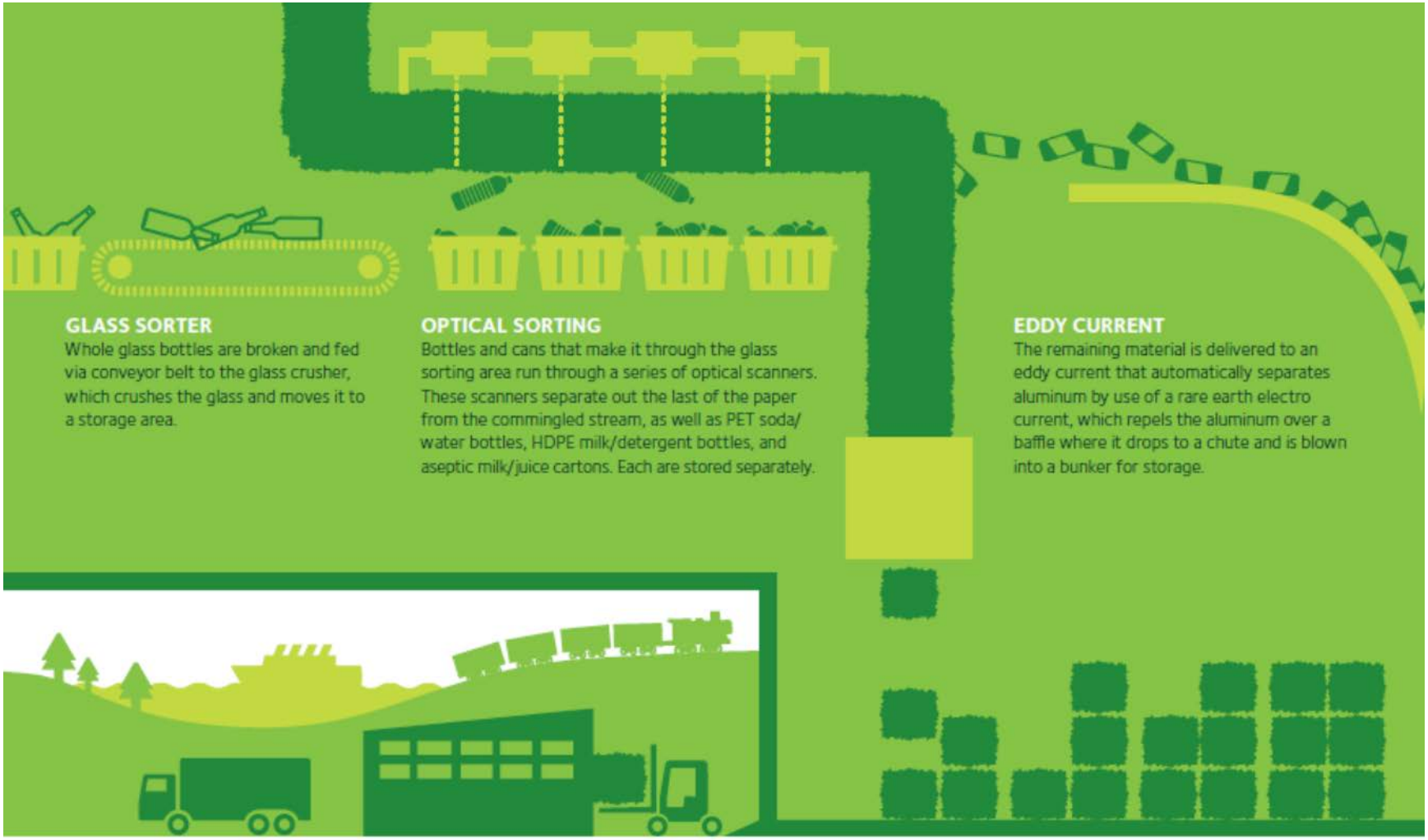
CORRUGATED SCREENS
Material crosses a triple-deck old corrugated cardboard (OCC) screen, which skims off the OCC from the rest of the material stream. The OCC floats over the screen, where it is inspected before being conveyed to storage bunkers.

STEEL MAGNET
Next, a steel magnet removes and stores ferrous materials from the material stream.

PAPER MAGNET
Material left in the main flow is now mostly containers. These materials flow over a paper magnet, designed to extract paper from the stream. It uses powerful vacuum technology to hold two-dimensional paper flat to the conveyor, while round three-dimensional containers continue on the flow.

GRAPHIC CONTINUES ON THE NEXT PAGE

NEWSPAPER SCREENS
At this stage, the materials pass through a series of disc screens, which separate containers, cans and bottles from old newspapers and remove any remaining fiber material.



GLASS SORTER
Whole glass bottles are broken and fed via conveyor belt to the glass crusher, which crushes the glass and moves it to a storage area.

OPTICAL SORTING
Bottles and cans that make it through the glass sorting area run through a series of optical scanners. These scanners separate out the last of the paper from the commingled stream, as well as PET soda/water bottles, HDPE milk/detergent bottles, and aseptic milk/juice cartons. Each are stored separately.

EDDY CURRENT
The remaining material is delivered to an eddy current that automatically separates aluminum by use of a rare earth electro current, which repels the aluminum over a baffle where it drops to a chute and is blown into a bunker for storage.

SHIPPING
Bales are shipped via truck, rail or ship to end users around the world, where they are used as feedstock for new products.

FINISHED PRODUCT
Forklifts move the bales to a finished product storage area where they are checked for quality.

BALING
Interior storage bunkers accumulate large quantities of each separated material stream, which are subsequently processed in ultra-high-efficiency equipment for compaction into "bales" for shipment to end-use markets.

COMMODITY OVERVIEW

The NRW held focused meetings to address each material category collected in the commingled residential recycling programs. The main commodities examined included cardboard (OCC), glass, metal, mixed paper (MP), newspaper (ONP), and plastic (PET, HDPE).

In order to gather data, each material used identical questions to discuss outcomes, and data. The identical questions address each recyclable passed through the system (Appendix A). Using an identical set of questions also allowed for incorporation of each perspective on the commingled recycling system.

The markets changed substantially during the course of the project. The NRW is presenting the most current information available as of the date of publication.

The following material overviews are the results of that research.

Corrugated Cardboard
(OCC - Old Corrugated Cardboard)

MATERIAL OVERVIEW

Cardboard includes all paperboard with corrugated layers. Cardboard does not include boxboard. Mixed paper contains boxboard. Some common examples of boxboard include shoeboxes and cereal boxes. Cardboard is the quickest, easiest, and least expensive to remove from commingled recyclables. The MRF can effectively sort cardboard. It also has a high value in local and export markets. Products, that otherwise use wood chips to manufacture, can also utilize recycled cardboard. Some examples of what cardboard can become are liner medium, boxboard (cereal boxes, etc., new corrugated boxes, and several grades of paper bags.

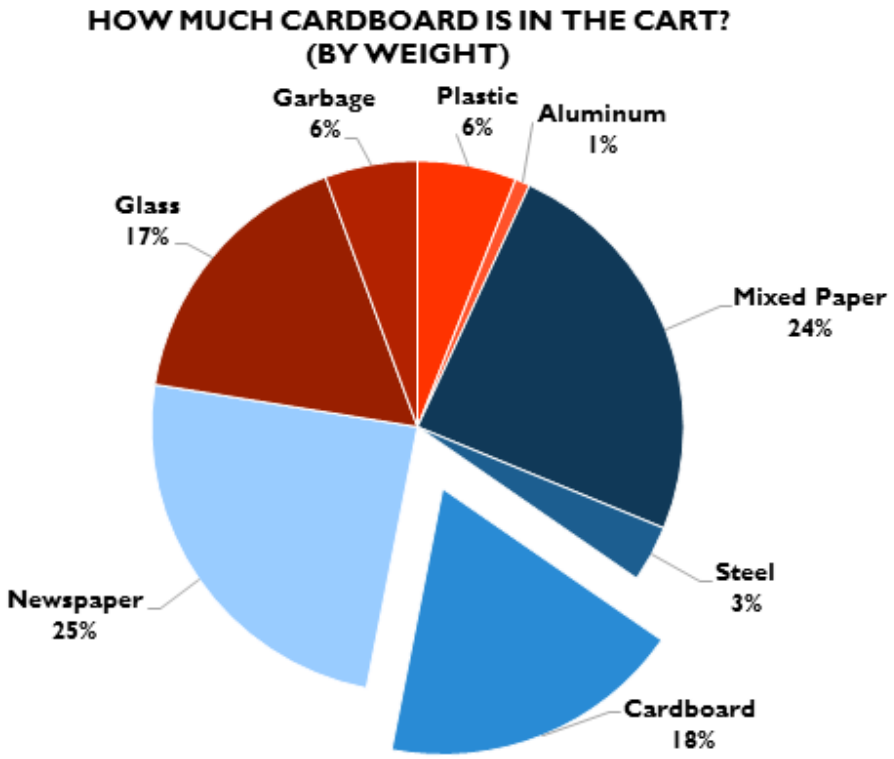
Environmental Benefits of Recycling Cardboard

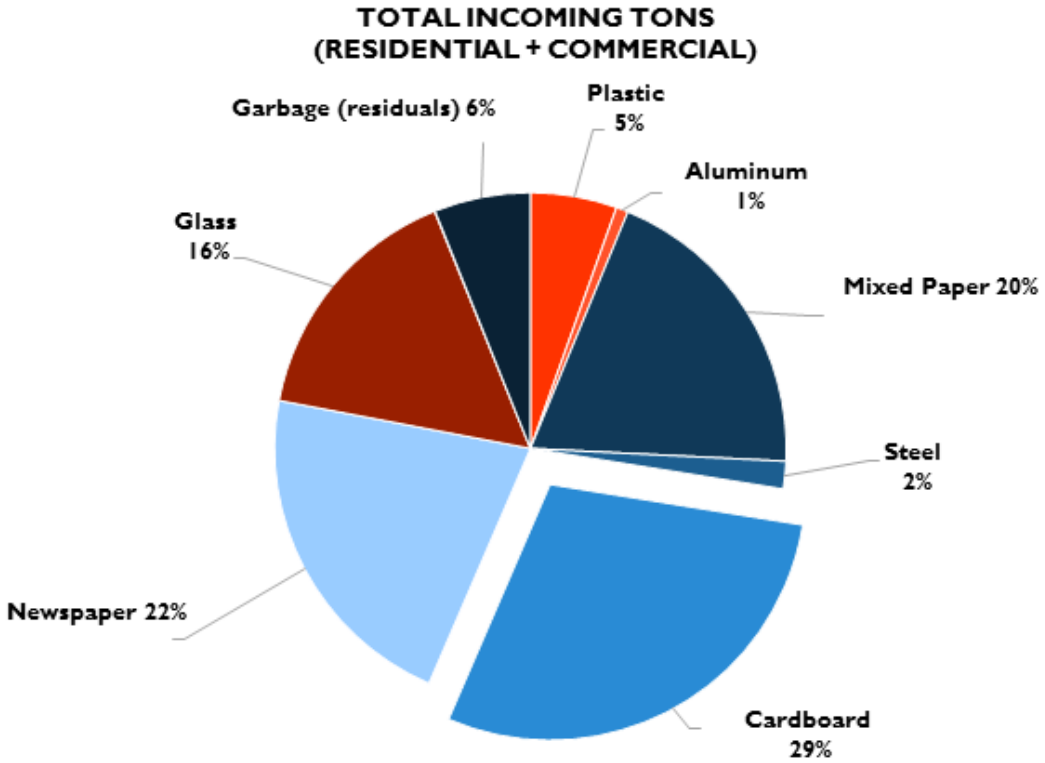
Recycling one ton of corrugated cardboard results in a net savings of 15.1 million BTUs of energy (EPA WARM Model, 2015). Recycled cardboard saves 55% of the total energy needed to manufacture cardboard from virgin fiber. Recycling cardboard provides manufacturers with a reduction in operating expenses.

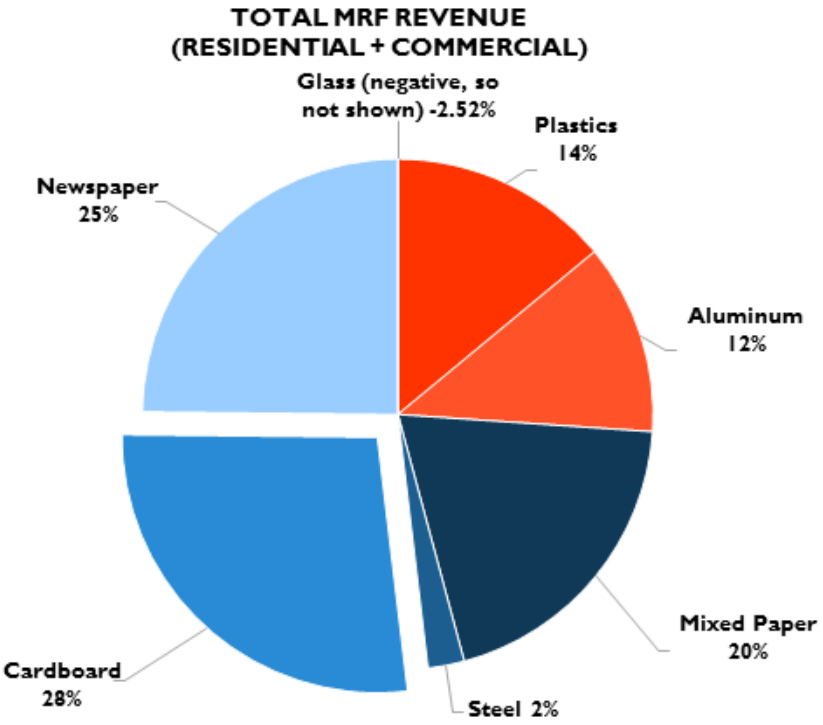
Material Accepted in Curbside Recycling System

One hundred percent of the curbside recycling programs accepts cardboard in the Northwest Region. None of the programs accepts waxed cardboard (see Appendix B for more information).

Amount of Cardboard in the Curbside Recycling System







Source: Aggregated data from Northwest WA Region MRFs

ISSUES

Issues at the Point of Collection

At the Curb

All jurisdictions surveyed accept cardboard in the recycling cart. All the regions counties also commingle cardboard with other recyclables. Most jurisdictions provide residents permission to place extra cardboard outside the recycling cart on collection day. An additional recycling cart offers space for extra cardboard. Separate customer-owned containers may hold additional cardboard, or a cardboard box beside the recycling cart to contain cardboard works. There are several collection issues with cardboard. Including managing oversized cardboard, unflattened boxes, wet cardboard, and cardboard that includes packing material such as tape, packing material or foam.

Public Education

There is a large variation within the messaging about how to prepare cardboard for curbside recycling. There are different instructions regarding the size of cardboard accepted at the curb.

The recycling of cardboard has conflicting information provided on the placement beside the recycling cart, and removal of contaminants from cardboard.

In some jurisdictions, it is not clear to the public that additional cardboard belongs beside the cart. Most jurisdictions ask their customers to flatten cardboard into pieces no larger than 2' x 3' feet or 3' x 3' feet. Some jurisdictions request removal of packing tape and other sticky materials from cardboard. Different messaging in neighboring communities can be confusing for the resident and can lead to contamination. There is a potential for coordination between the different jurisdictions to provide consistent messaging.

Issues at the Material Recovery Facility

Quality of Incoming

The quality of the materials delivered to the recycling processor is generally good. The quality is dependent upon weather, as wet cardboard is not ideal. However, there are several key issues with cardboard delivered to Material Recovery Facilities (MRFs):

- Shrink-wrap from beverage flats is a common contaminant. The shrink-wrap is difficult to remove.
- Other paper grades receive small cardboard pieces (smaller than 16" to 18" inches) due to mis-sorting.
- Sorting equipment gets tangled with bundling materials like twine and rope resulting in down time.

Problems in Processing at the MRF

Recycling centers prefer larger pieces of cardboard. The smaller pieces of cardboard often end up in other grades of fiber (J. Kohlstedt, personal communication, September 3, 2015). During processing at the MRF, workers presort the materials to remove contaminants. Then the cardboard screen diverts large, flattened cardboard away from other materials. Smaller pieces of cardboard can get mis-sorted into newspaper bales. Cardboard sorted into newspaper bales lowers the value of newspaper grades. Therefore, hand picking smaller pieces of cardboard further down the sorting line is necessary. Cardboard bales have the handpicked smaller pieces added back in.

"In my career, I have witnessed many process changes. The process changes are due to increased contaminants from the incoming supply. In my opinion, there was a dramatic change shortly after the introduction of single stream recycling."

"We are simply getting products delivered that were never intended to be made into paper."
Troy Ellson, OCC Superintendent at Kapstone Container Corporation.

Issues at the Secondary Processor

Paper mills process cardboard. When the paper mill purchases cardboard stock, moisture content is tested. Since the early 2000's, buyers of cardboard have seen a dramatic increase in contamination. Common contaminates are glass, random plastic and chipboard. The contamination

of cardboard is largely due to commingled collection (Cleiland, 2013). Plastics and expanded polystyrene foam clogs filters and the foam deposits into wastewater. One paper mill purchased a separate vacuum truck to extract foam debris. According to ISRI bale standards (2014), prohibitive materials may not exceed 1% and outthrows and prohibitives may not exceed 5% (see Appendix D).

Prohibitives

The most significant prohibitives in cardboard are glass, plastics, and packaging material. Common packaging material on cardboard includes shrink-wraps, straps from shipping and expanded polystyrene foam. One prohibitive is cardboard with a wax covering (also known as waxed cardboard). The wax melts during processing at the mill. The melted wax goes through the paper mill processing systems easily. However, melted wax causes dark spots on recycled paper products resulting in lower quality recycled paper. Fiberboard, chipboard, and wet strength fiber are the main out-throws. Due to contaminants, manufacturers experience approximately a 15% yield loss of cardboard bales from commingled residential recycling programs.

Outthrows

Landfill contaminants effect mills annual costs. A Washington mill that processes cardboard indicated its annual costs exceed $450,000 to landfill contaminants. The majority of the contamination is plastic, glass, chipboard. Small amounts of reported contaminants are metals and other fibers. A smaller portion of the landfilled waste is yield loss that is inherent in any mill process. Yield loss has increased as contamination has increased (Cleiland, 2013).

Whatcom County collects glass, plastic, and metals in a separate bin. This is in an effort to minimize contamination of the cardboard. Drivers manually screen cardboard for contaminants at the curbside collection point. For instance, cardboard boxes with polystyrene packing peanuts or with significant amounts of packing tape are not collected. Uncollected cardboard remains until the customer removes contaminants. Bundling materials like twine and rope are the main contaminants in Whatcom County cardboard. The twine and rope are relatively easier to manage at MRFs and end-users, than glass, plastics, and metals.

Issues with the Markets

Domestic/Local

As of publication, local markets include Georgia Pacific and International Paper, OR, and KapStone Container Corporation, Longview, WA.

Export

Foreign markets that were formerly importers of US cardboard are now either exporters or self-sustaining. Japan is a huge net exporter and Mexico is almost entirely self-sufficient. China's import inspection standards have become stricter as China domestically sustains cardboard product recycling.

Changes in the Material Stream

Photo 4: Corrugated corner protectors

Increases in online shopping and shipping result in smaller pieces of cardboard entering the recycling stream. Many companies are moving away from packing materials like Styrofoam. The companies are using cardboard for things like corrugated corner protectors and inserts to minimize shifting. MRFs have difficulty handpicking these small materials from the sort lines. Much of the smaller cardboard miss-sorts into other paper streams.

AREAS FOR IMPROVEMENT

Curbside programs need to tell residents cardboard must be dry. Local governments and solid waste management companies should develop best practices for oversized cardboard. Best practices provide residents with consistent instructions. Separating glass out of commingled carts would also provide a cleaner cardboard material stream.

Glass Containers

MATERIAL OVERVIEW

Glass containers include bottles and jars. This material category does not include non-program glass such as windows, plate glass, and heat resistant glass such as Pyrex®, mirrors, light bulbs, or drinking glasses.

Glass containers are 100% recyclable. Recycled glass containers remanufacture back into container glass such as jars, wine bottles, or beer bottles. Glass containers can also become fiberglass or aggregate, which is a substitute for sand, gravel, and fill. Between 50-60% of the glass containers from commingled recycling programs in the Northwest Region are made back into glass containers. Approximately 10% of additional glass containers are recycled as aggregate. The remaining glass is lost during processing.

The public understands glass is a recyclable. Including glass in the commingled system causes significant contamination issues for other recyclables. The contamination issue increases costs throughout the system for commingled recycling. Cross-contamination of glass with contaminants such as plastic, metal, and ceramics is a concern. This is of particular concern to end users that turn glass cullet back into glass containers.

Environmental Benefits of Recycling Glass Containers

Recycling one ton of glass containers results in a net savings of 2.1 million BTUs of energy compared to use of virgin materials. Recycled glass containers saves 28% of the total energy needed to manufacture new glass containers, providing manufacturers with a reduction in operating expenses (EPA WARM Model, 2015).

Increased cullet use in glass manufacturing results in reduced greenhouse gas emissions. For every 6 tons of recycled glass used, 1 ton of CO2 is reduced. Increasing the use of cullet by 10% in the production of glass reduces particulates by 8%, nitrogen oxides by 4%, and sulfur oxides by 10% (Flight, 2013). Less fuel use reduces nitrous oxide emissions. Lower consumption of sodium sulfate reduces sulfur oxide emission as well. (Worrell, 2008).

Photo 5: Container glass becomes cullet (broken or whole scrap glass) which manufactures back into glass containers. Photo courtesy of Recology CleanScapes.

Glass is heavy and there is a perception that it is not worth transporting long distances for recycling because the energy savings will be lost. However, information from Oregon DEQ indicates that there

are net energy savings from recycling glass even when it is transported long distances. See Appdenix E for more information. Nonetheless, glass is often not shipped long distances because the additional shipping costs can make it uneconomical to do so.

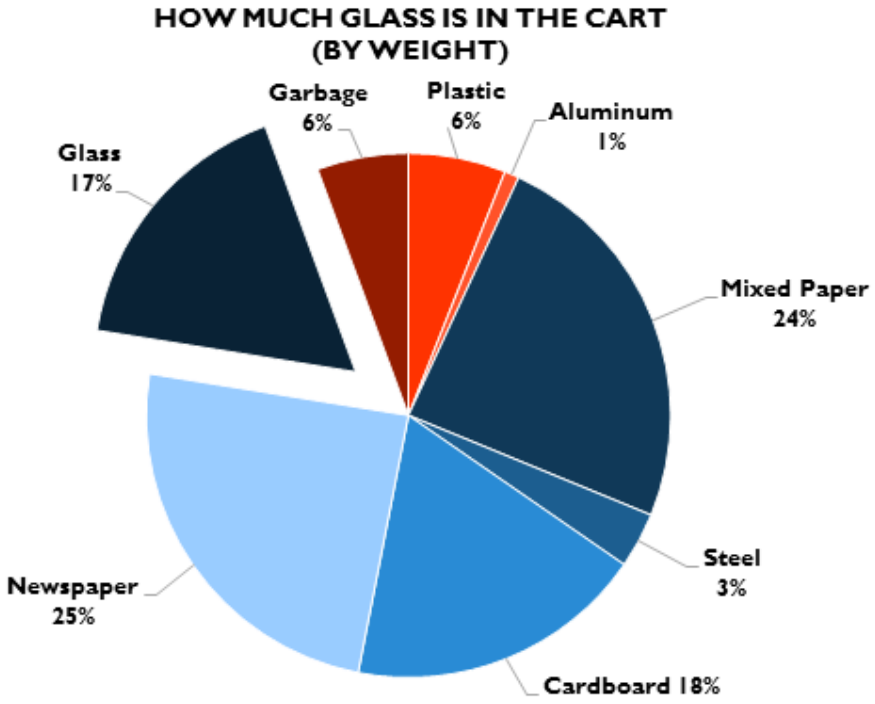
Every ton of glass recycled saves over a ton of natural resources.. Conserved resources include 1,300 pounds of sand, 410 pounds of soda ash, 380 pounds of limestone, and 160 pounds of feldspar (Glass Packaging Institute, 2015).

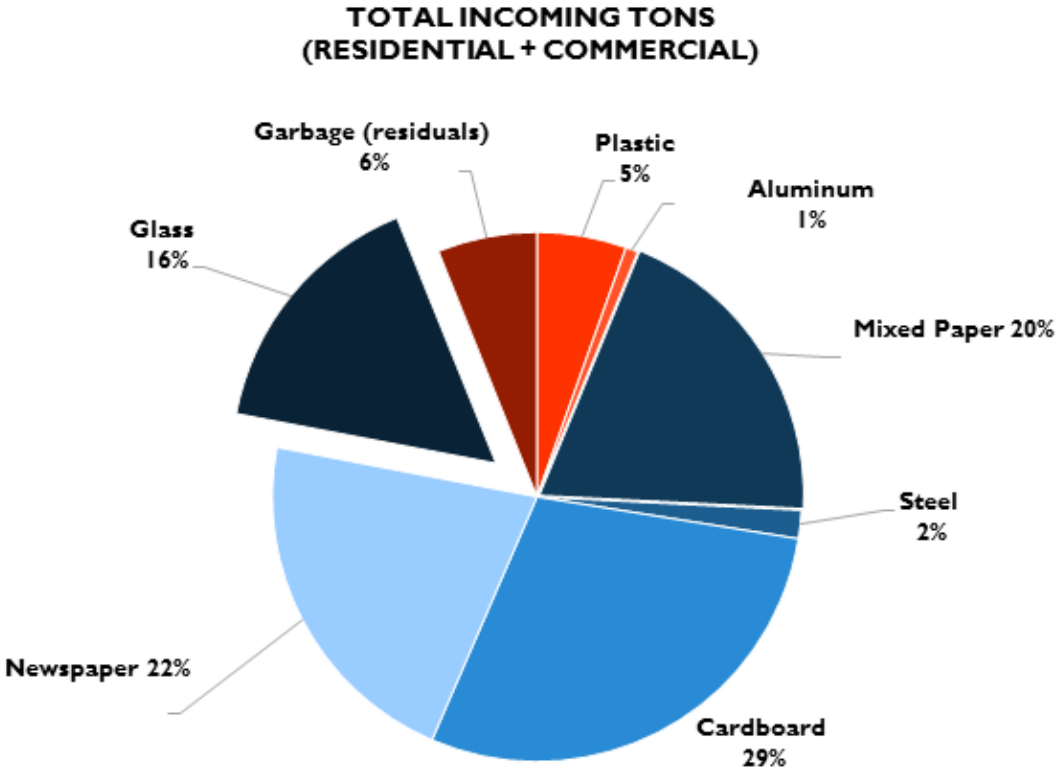
Material Accepted in Curbside Recycling System

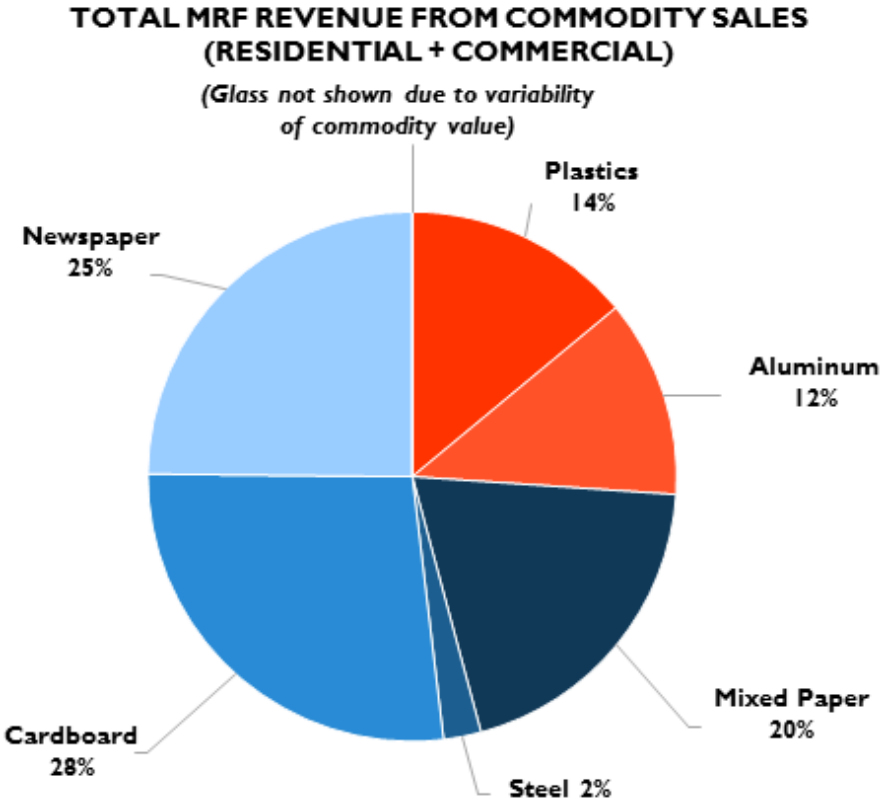
Ninety-eight percent of the curbside recycling programs accepts glass containers. (See Appendix B for more information). Only two curbside recycling programs in the Northwest Region - Oak Harbor and Coupeville - do not accept glass.

Amount of Glass Containers in the Curbside Recycling System

The following two pie charts show percentage of materials *by weight* collected in the curbside recycling system. If measuring quantities of materials by volume, glass would comprise a smaller percentage of the total.







Source: Aggregated data from Northwest WA Region MRFs, October 2014

The chart above is a "snapshot in time" of MRF revenue from commodity sales. The wide variability of glass commodity value excluded it from being in the chart. Historically, glass from commingled curbside collection has been low to negative value. Outbound glass from commingled collect cause MRFs to pay charges or not receive revenue.

Currently Strategic Materials, a secondary glass processor that opened in Seattle in May 2014, pays MRFs for clean glass from commingled curbside recycling programs. However, they charge MRFs for glass with high levels of contamination. The amount paid or charged depends on the amount of contamination in the glass and as of December 2015 ranged from +$15 to -$31 for container glass from commingled curbside systems (C. Quinto, personal communications, August 24, 2015 and December 4, 2015).

ISSUES

Issues at the Point of Collection

At the Curb

King, Kitsap, San Juan, and Skagit Counties include glass in the commingled recycling cart. Snohomish County includes glass in their commingled recycling cart except for two areas: one section of the City of Everett and one section of the City of Mukilteo. In those locations, Rubatino Refuse Removal uses a two-bin system that collects paper in one bin and containers, including glass, in the other. In Island County, curbside glass collection happens only on Camano Island and in the cities of Oak Harbor and Coupeville. While Camano Island accepts glass, the cities of Oak Harbor and Coupeville do not. Residents in Oak Harbor and Coupeville are encouraged to take glass to a recycling center. Whatcom County has a three-bin system. Glass is collected in one of the bins along with plastic containers and metal cans.

Local jurisdictions, MRFs, the paper industry, and other stakeholders are struggling to find the optimal method for collecting glass. Collecting glass in a commingled recycling system causes significant contamination issues for other recyclable materials, especially paper. Some communities have opted not to include glass in their commingled collection systems. They instead opt for either collecting glass in a separate bin or in a drop-off depot system.

Collecting glass in a separate recycling container greatly reduces contamination and costs for the paper industry, but adds to the labor and equipment costs associated with collecting the recyclable materials. When glass is collected in separate recycling bins, the driver must manually pick up and empty the glass containers which is less efficient that an automated system.

Glass can be a safety concern for the driver at the point of collection. If a customer has more glass than can fit in the recycling bin, they can place glass outside of the bin in a bag or box. If the bag or box gets wet, glass will fall out, break, and make a mess. Whatcom County only now only accepts extra materials placed in plastic tubs or sturdy cardboard boxes. This change significantly reduced incidence of litter and broken glass.

Glass is abrasive on truck compaction floors. In addition, for companies that use rear loader collection trucks, the glass can "explode" under compaction creating a safety hazard for the employee handling the materials and landing on the street.

Photo 6: Glass is abrasive on truck compaction floors.

Public Education

The most common message on residential curbside educational materials is *"Empty and rinse; labels okay; no lids.* Forty percent of the jurisdictions studied accept lids if measuring larger than 3 inches and are removed from the glass containers.

Issues at the Material Recovery Facility

Quality of Incoming

The quality of the materials delivered to the Material Recovery Facilities (MRFs) from commingled systems is good. Commingled collection requires removal of non-glass contaminants such as plastic, metal, and ceramics during processing. Loss of glass during processing reduces the quantities captured for recycling. In addition, including glass in the commingled system results in significant cross-contamination issues for other recyclables, especially paper.

Problems in Processing at the MRF

When the glass comes in at a Material Recovery Facility, it comes mixed with other commingled recyclables. It is broken into small pieces and then separated from the other materials using a series of screens or other technologies. Glass processing systems can vary at each MRF. Two MRFs in the Northwest Region have implemented significant improvements to their glass processing equipment and systems to decrease contamination. Cleaner glass commands a higher price per ton. More contaminated glass causes fines for the MRFs.

At one MRF, the glass is broken into pieces by the first screen and separated from the rest of the recyclable materials. The second screen filters out contaminants 1 1/8" by 3/8" and larger. This includes larger pieces of glass that were not broken up enough by the first screen. The third step is a controlled air separation system that separates contaminants that are lighter weight like paper and dirt. Shredded paper, a significant contaminant in the glass stream, separates from the glass at this point.

Even with these processing systems, some small non-glass contaminants mixes with the glass and makes it through the system. A secondary processor receives the glass for further processing after initial sorting.

Glass is abrasive and a small amount can damage the MRF equipment. The glass particles abrade equipment such as conveyor belts, gears, rollers, and idlers. Replacement of these parts increases costs.

Photo 7: Damage to a conveyor belt at a MRF due to glass. Glass shards moving through the system can cause punctures and tears, causing belts to wear out more quickly than they would if glass were not in the stream. Photo courtesy of Recology CleanScapes.

Line workers at MRFs deal with glass shards on the sorting line. This exposure can cause injury, even if they are wearing personal protective equipment. Throughout the process, fine pieces of glass can contaminate other materials, especially paper products. This lowers the value of the paper bale because glass is a significant problem for the paper industry. Costs to paper mills increase because of fiber replacement, increased maintenance, and unplanned shutdowns. See Appendix F for a description of the impact of glass from commingled systems at the NORPAC newsprint mill.

Glass is lost to recycling when it cross- contaminates other recyclable materials at MRFs and when it ends up in disposed residual at MRFs or the secondary processer. While accurate measurements of incoming glass from commingled systems can be challenging, one estimate indicated a 32% yield loss for glass as it moves from collection to final end use. This falls in the expected range of loss rates for glass, which vary, between 10 and 45 percent overall, depending on the collection and processing system. (Washington State Department of Ecology, 2016)

Issues at the Secondary Processor

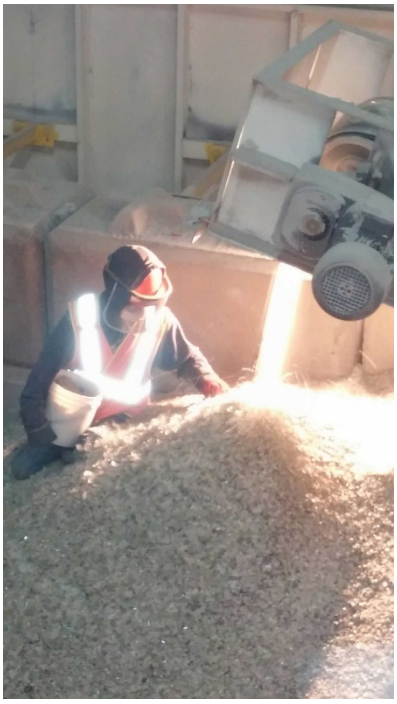


Photo 8: Glass processing at Strategic Materials in Seattle.

MRFs separate glass from commingled collection systems in the Northwest Region and send it to Strategic Materials, Inc. in Seattle. Strategic Materials uses optical sorters and XRF technology to remove materials that are contaminants and sort the glass by color and size. One MRF reports sending a small amount of glass for use as aggregate when Strategic Materials is unable to accept the glass due to capacity constraints.

Strategic Materials started operation in Seattle in May 2014. They received about 155,000 tons of glass in 2015 (C. Quinto, personal communications, March 23, 2016). About 60% of it was from Washington and the rest was from out of state. Approximately 80% to 90% of their material comes from MRFs serving

commingled markets. 10% to 20% comes from other sources, including drop off and dual stream recycling systems.

Overall, Strategic Materials considers the glass they receive from MRFs to be of good quality. Strategic Materials worked closely with one local MRF in Seattle to improve their vacuum recovery system and has significantly decrease contamination. Overall, about 81%-82% of glass that Strategic Materials receives becomes cullet. The remaining residual – mostly contaminants such as paper, plastic, metal and organics with a very small amount of glass – goes to the landfill. Strategic Materials does not market the non-glass residue for recycling. (C. Quinto, personal communications, July 21, 2015 and December 4, 2015)

For comparison purposes, states and provinces that have bottle deposit programs generate much cleaner cullet with only 2 -3% contamination versus glass from curbside programs that contains 15-25% contaminants by weight (Washington State Department of Ecology, 2010).

Contaminants in glass from commingled systems include paper, plastic, metal, ceramics, stones, and organics. Ceramics, stones, and metals create defects in new containers and can damage furnaces. Organic materials create carbon, which affects emissions and color. Non-program glass such as windows, picture glass, drinking glasses, heat resistant glass such as Pyrex®, mirrors, light bulbs and leaded glass such as crystal and television cathode ray tubes (CRTs) are contaminants. See Appendix D for industry specifications about contaminants in container glass.

At Strategic Materials, ceramics and metals are a particular concern because of their impact at Ardagh Glass Inc., an end user that turns glass cullet back into glass containers. Plastic contaminants are also an issue. Strategic Materials gets some non-program glass in their mix, but their machines do a good job of removing it. Shredded paper is landfilled which is an added cost (C. Quinto, personal communications, December 4, 2015).

In addition, medical sharps are a contaminant found in glass loads. Some people are under the misconception that the best way to dispose of medical needles is to put them into a glass jar, close the lid and put them in the recycling bin. While Strategic Material's system adequately removes the sharps, they are a significant concern because of employee safety.

Photo 9: Glass processed by Strategic Materials. Source: Photo courtesy of Recology CleanScapes.

Strategic Materials tests all loads of incoming glass from MRFs for quality, and uses a pricing matrix to determine how much they pay or charge based on the amount of contamination in the glass, i.e. the percent of glass in the load vs the percent of non-glass residue. Strategic Materials can process all incoming loads to quality specifications. However, they charge for more contaminated loads because of increased costs to landfill non-glass residue, longer processing

time for contaminated loads, and lower percentages of marketable glass. There are advantages to a MRF if they can produce cleaner glass. The MRF can decrease the amount they pay Strategic Materials, or the MRF makes a profit on the glass (C. Quinto, personal communications, December 4, 2015).

Strategic Materials sends 90% to 92% of its glass cullet to Ardagh Glass Inc. Ardagh Glass Inc. is located next to Strategic Materials in Seattle and manufactures the cullet into glass containers. The rest of the glass cullet goes to Owens-Illinois in Kalama where it becomes glass containers. Strategic Materials is not sending any glass cullet to fiberglass or aggregate markets (C. Quinto, personal communications, July 21, 2015 and March 23, 2016).

Issues with the Markets

Domestic/Local

In many areas of the country, there are limited or no viable outlets for glass from commingled recycling systems. The Northwest Region of Washington is fortunate to have a local secondary processor, Strategic Materials. Strategic Materials sorts glass from commingled systems, so that two glass container manufacturers in Washington can utilize the glass.

One concern is that primary dependence on one market means that other markets such as glass for aggregate may shrink if the flow of material to them is inconsistent. Eventually other markets could close entirely despite the region needing additional recycling alternatives for glass.

Container glass: In the Northwest Region, glass that has undergone processing primarily becomes glass containers. The glass cullet used for container glass mostly goes to Ardagh Glass Inc. in Seattle and a small amount goes to Owens-Illinois in Kalama.

Ardagh Seattle manufactures glass packaging containers, primarily wine bottles but also beer, spirits, and food containers. They use a combination of virgin materials (sand, limestone, and soda ash) and recycled glass cullet for feedstock. Almost all their glass cullet comes from Strategic Materials in Seattle. Ardagh Seattle also recycles their own glass. Ardagh Seattle rejects their own glass based on quality. The amount of recycled cullet used depends on a number of variables, such as quality of cullet and availability of certain color cullet (e.g. amber glass). However, Ardagh Seattle aims to run more than 50% recycled cullet across all their furnaces (L. Getubig, personal communications, December 3, 2015 and April 6, 2016).

Ardagh Seattle has high quality standards and the quality of the incoming glass cullet is critical. Problem contaminants include rocks, metal, plastics, and ceramics (L. Getubig, personal communications, December 3, 2015) Ardagh Seattle rejects occasional loads of cullet, because of contamination. The rejected loads go back to Strategic Materials, where the loads go through the processing system again. After processing, the load returns to Ardagh Seattle (C. Quinto, personal communications, December 4, 2015).

Container furnaces use color separated container glass and mostly run at 40-70% cullet (maximum 85%). Benefits include lower energy usage, improved air quality, increased furnace life, and increased production. Negatives are contamination and color variability. (Hinson, 2013)

Metal can damage glass container furnaces. It sinks to the bottom of the glass and acts like a drill.

Fiberglass: Currently, glass from the Northwest Region is not used to make fiberglass. Overall, however, use of cullet by fiberglass manufacturers continues to rise each year (Strategic Materials, 2015).

Most fiberglass furnaces run at 35-50% cullet. Benefits include lower energy usage, improved air quality, increased furnace life, and increased production. Negatives include contamination, color variability and increased production costs (Hinson, 2013).

Aggregate: Only a small amount of glass from commingled recycling programs in the Northwest Region becomes part of aggregate. Aggregate is coarse particulate material used in construction, including crushed stone, sand, gravel, slag, and recycled concrete. One MRF reports sending glass for use as aggregate when Strategic Materials is unable to accept the glass due to capacity constraints.

Over the years, when bottle-to-bottle secondary processors are off line, various aggregate suppliers have taken glass from MRFs. The glass sent to the aggregate suppliers meets the same specification as for Strategic Materials. The aggregate suppliers sort out the non-glass and the MRF typically takes the non-glass back.

Glass received by aggregate suppliers is run through a screen. The screen removes contaminants and then crushes the glass, resulting in 3/8 inch minus crushed glass aggregate. The product has been used for pipe bedding, slabs on grade applications (sidewalks, under concrete), locate layer for utility companies, water filtration layer, backfill, and as a replacement for pea gravel and 'pit run' (a Class A structural fill) (Washington State Department of Ecology, 2010).

Washington State Department of Transportation (WSDOT) has specifications for the use of recycled materials in aggregate in WSDOT projects. Recycled glass (glass cullet) used as, or blended uniformly with, naturally occurring materials for aggregate. The final blended product and the recycled material component included in a blended product must meet the specification requirements for the specified type of aggregate. Glass cullet must meet the American Association of State Highway and Transportation Officials' requirements of AASHTO M 318 and is limited to a maximum allowable percentage by weight for various specific aggregate usages. Additional information is available in WSDOT's Standard Specifications in Section 9-03.21 (Washington State Department of Transportation, 2015).

Emerging Markets: Some emerging uses for glass are developing. For example, EnVitrum, a Seattle-based company, has developed a manufacturing process that converts mixed colored glass cullet into a building material.

Export

Foreign markets do not receive glass containers from the Northwest Region.

Changes in the Material Stream

The 1980's saw significant shifts from the use of glass containers to plastic, but the market has now leveled out. In the past several years, a "reversion" to glass has occurred with items such as baby food, health-conscious beverages, and salsa containers moving back to glass containers. In addition, use of glass containers is increasing with the growing wine and craft brewery markets (Flight, 2013).

There has been a great deal of "light-weighting" in the glass industry. Glass container redesigning allows less material use and weight to new products.

AREAS FOR IMPROVEMENT

To achieve ideal optimum rates of recovery and recycling, glass requires separate collection. Communities that do not commingle their glass in with other recyclables in the curbside recycling programs should continue to keep glass separate.

There is a need to conduct a study to determine the costs and benefits of collecting glass in a commingled system at the curbside. In addition, the study should explore alternative methods of collecting and recycling glass including drop-off locations, redemption programs, and producer financed programs and partnerships with local glass manufacturers.

The influence of the secondary processing facility that has entered the market in the Northwest Region needs additional study. The study should consider the roles and relationships between the MRFs in the region, secondary processor Strategic Materials, and final glass markets at Ardagh Seattle and Owens-Illinois as they work to decrease contamination and optimize glass recycling.

Metals – Aluminum and Steel
(UBC - Used Beverage Containers (Aluminum)

MATERIAL OVERVIEW

Metals collected in the commingled system are aluminum including used beverage containers referred to as UBCs in the industry, foil food trays and foil, steel cans, and mixed metals including ferrous metals, nonferrous metals, scrap metals and small metal appliances.

Environmental Benefits of Recycling Metals

Recycling one ton of aluminum results in a net savings of 153 million BTUs of energy and saves 76% of the total energy needed to manufacture aluminum from virgin materials. The savings in energy to manufacturers allows a reduction in operating expenses.

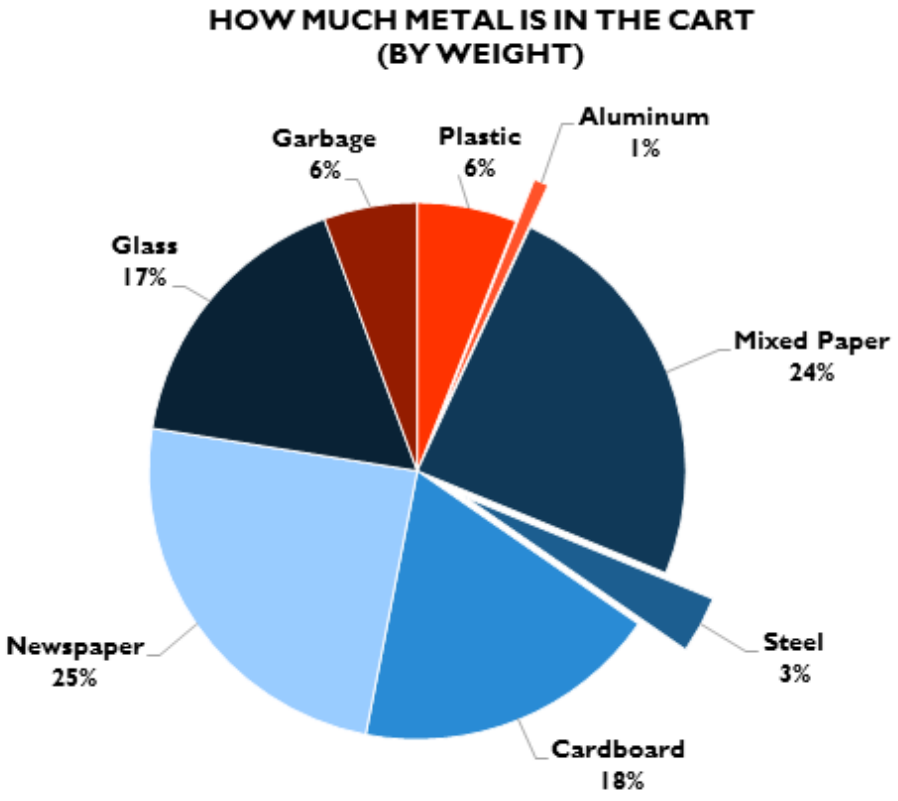
Recycling one ton of steel cans results in a net savings of 20 million BTUs of energy and saves 55% of the total energy needed to manufacture steel from virgin materials. It is eight to ten times more expensive to buy virgin steel than recycled steel. Practically the only time virgin steel is used is when specifications require it. Recycled steel makes up the majority of all steel products.

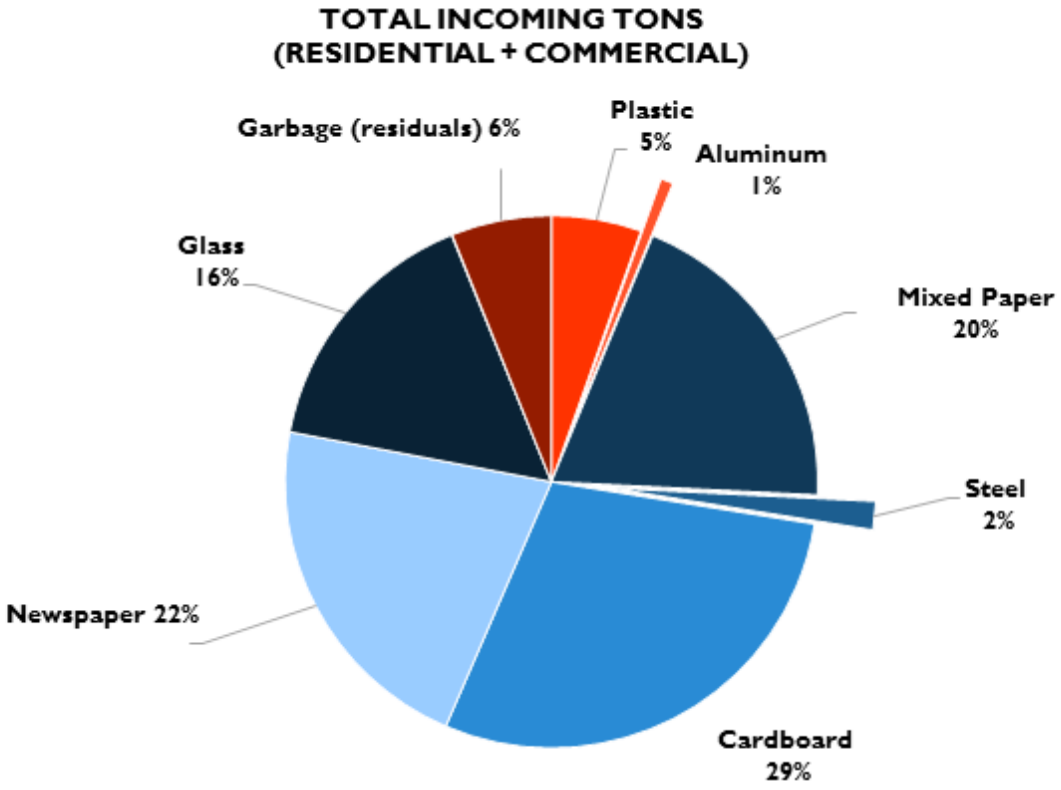
Recycling one ton of mixed metals results in a net savings of 66.6 million BTUs of energy and saves 75% of the total energy needed to manufacture metals from virgin materials (EPA WARM Model, 2015).

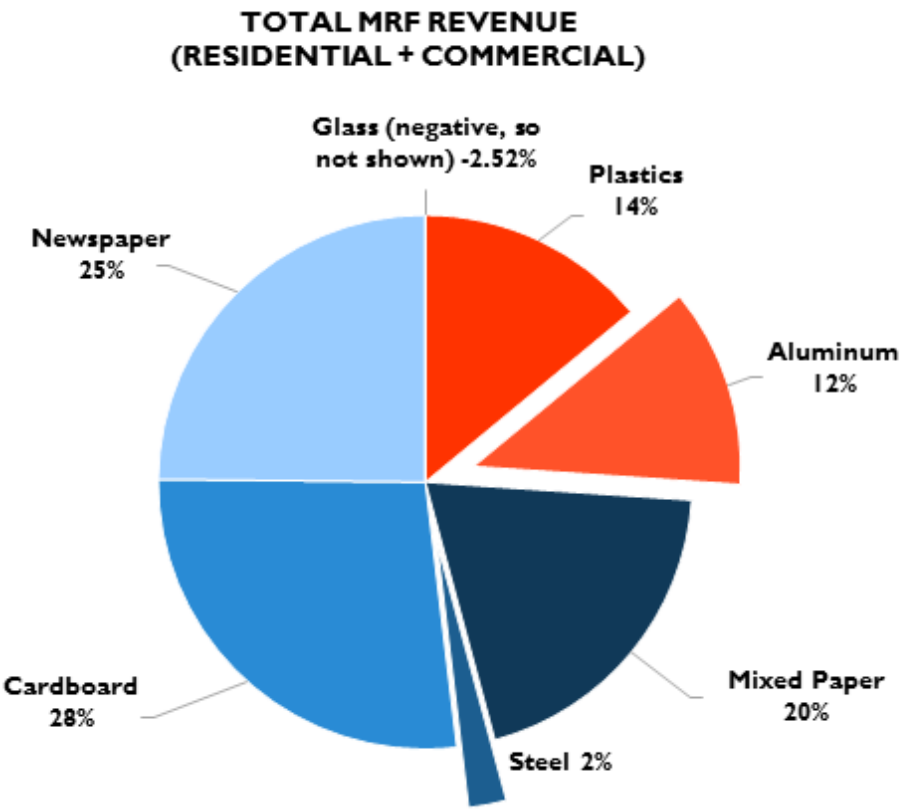
Material Accepted in Curbside Recycling System

All curbside recycling programs accept aluminum UBCs and steel cans. Most programs include scrap metal smaller than 2 ft. and less than 35lbs. Many programs include aluminum foil and trays, small metal appliances, metal lids greater than three inches in diameter and aerosol cans. Not included are large scrap metal, loose lids smaller than 3 inches in diameter, hangers, sharp or greasy metal, foil juice pouches, batteries, and ammunition (see Appendix B for more information).

Amount of Aluminum and Steel in the Curbside Recycling System







Source: Aggregated data from Northwest WA Region MRFs, October 2014

ISSUES

Issues at the Point of Collection

At the Curb

Scrap metal accepted at the curb, oversized and overweight items cause collection problems. Some scrap metal such as long pipes and bulky metal objects, can be a hazard when compacted in the recycling truck. Full or partly full aerosol cans containing toxic or hazardous materials are also problematic and may jeopardize worker safety when compacted.

Public Education

Most jurisdictions provide instructions that say, "rinse, no food residue, labels okay". However, there is a potential problem with promoting "labels okay". Aluminum processors require that label removal from aluminum food cans before processing (see Appendix D). Some communities provide residents with size and weight restrictions for scrap metal, for example 2'x2'x2', 35lbs, or ask that no wood or plastic be attached, no hangers, and no batteries.

Issues at the Material Recovery Facility

Quality of Incoming

The quality of the metals delivered to the recycling processor is good. The key issues at the MRF are food contamination, foil and foil food containers, flattened cans, and loose lids. See Appendix D for bale specifications for steel and aluminum.

Problems in Processing at the MRF

Steel and mixed metals: Scrap metal and small appliances are typically hand sorted and manually pulled off the sorting line. Scrap metal is an issue due to its inconsistent size and shape. The magnet picks up small, ferrous metal (steel and iron products). Ferrous metal goes to the tin sorting area. Non-ferrous metals (aluminum, brass, and copper) require hand sorting. Large and irregular shaped metal objects can get caught in MRF equipment and cause machinery damage. Heavy scrap metal can be safety issue on fast moving belts as it is hand sorted. Pipes can fling causing a safety issue or can damage the equipment belts. Electrical cords attached to small appliances can tangle in the machinery.

Aluminum: Foil trays and other metal food containers can be highly contaminated with food that attracts vectors such as rats and mice at the MRFs. Completely flattened aluminum cans create a problem because they can act like paper in the sorting equipment and end up sorting into the mixed paper streams. Loose lids are sharp and can be a safety issue for employees. The sorted lids can get sorted into paper, or get caught in fines. (Hart, 2015)

Foil can be difficult to process. The eddy current leaves foil rather than sorting it. Balled foil sorts into the residual materials stream where it is disposed. Flat aluminum foil and foil pans missort into paper and cardboard streams. Sometimes foil makes it to the aluminum bunker. When this happens foil mixes with other aluminum, and too much foil in a bale can downgrade the bale's quality. Foil contaminated with food also degrades bale quality and causes problems at the smelter. UBC bale specifications allow up to 10% non-UBC aluminum. UBC processors often rely on secondary sorting facilities to remove non-UBC products (see Appendix D).

Issues at the Secondary Processor

Steel: Steel mills process steel. Nucor Steel in Seattle reported that 99.8% of their feedstock supply is scrap steel (Adams, 2013).Eighty-seven percent of their feedstock comes from within Washington State. Curbside residential makes up a small percentage, 5-8% based on weight, of their overall supply. Key issues for the mills include contamination from plastics, paper, whole containers (aerosol cans) and liquids. Food contamination is an issue for health and safety reasons due to vectors such as rats and mice.

Aluminum: The manufactures of aluminum beverage containers want UBCs for recycled feedstock, not just any aluminum. Manufacturers that roll aluminum for the production of

beverage containers and other aluminum products accept UBCs. Key issues include contamination by plastics, glass, foil, other non-ferrous metals, and liquids.

Prohibitives

Steel: Prohibitives include lead and paper. The prohibitives cause emissions problems due to increased temperature of vapor and increased energy used. Labels are undesirable, but not enough to refuse a load. Food is not an issue from a product quality standpoint, but it does cause vector concerns. Plastics mixed into the bale also cause emissions and temperature issues.

Aluminum: Common prohibitives include lead, lead cell batteries, pressurized aerosol cans, plastic, glass, shredded paper, and moisture. There are two common indicators of contamination in bales. The first is crushed glass falling out of a UBC bale during unloading. The second is finding crushed glass on the floor of the shipping container. Contamination with paper, plastics, or other non-aluminum contaminants cause refused shipments. A refused shipment can be expensive because cans are shipped from the West Coast to manufacturers in the Southeast USA.

Outthrows

Steel: Non-ferrous metals are the primary outthrows in a steel bale.

Aluminum: Aluminum containers that are not UBCs such as pet food cans, foil and foil trays, siding, are outthrows. Aluminum foil products contain more iron and melt at a much lower temperature than cans. Consequently, they end up as ash when melted with cans. Paper wrappers and food residue from pet food cans make them undesirable, as there is less tolerance for paper in an aluminum smelter. Food can mold, attract vectors, and cause odor problems. According to Novelis Aluminum (McKee, 2013), pet food cans and other aluminum food cans are acceptable interspersed with UBCs but must not take up more than 10% of each bale or bundle by volume and must be clean, dry and free of paper/labels removed.

Equipment

Steel: The design of the baghouse pollution systems cannot handle oil, plastic, mercury, and other contaminants. Contaminates cause pollution although the steel remains unaffected. Both paper and plastics cause problems with the emissions equipment because they cause high temperatures that can destroy the bags in the baghouse. Replacement bags are expensive as they are very large, measuring 35'x 8' in size and there are over 3,500 in a baghouse. Liquids are also a problem as they can cause explosions in the melting pot.

Aluminum: The most problematic issue for a UBCs smelter is plastic, particularly PET bottles, due to their combustibility. When furnaces are burning paint ("decoating") from the aluminum cans, the plastic can ignite and shut the smelter down. Shredded paper can also cause similar problems if a bale contains a large amount of paper.

Excessive moisture causes inputs to feed poorly and allows sand and dirt to mix with fines generated in the shredding process. Sand and dirt can plug the grates in the shredding process and in the downstream separation process.

Issues with the Markets

Export

Steel: Fifty percent of recycled steel becomes export material. Eighty-five percent is used to make rebar and 15% is used for other steel products. Demand for steel has been declining over the past years due to a slowing in China's economy.

Aluminum: Markets for aluminum are strong and there has always been a demand for these materials. Processors could easily absorb more aluminum UBCs because aluminum is a high value commodity.

Domestic/Local

Steel: Domestic markets receive fifty percent of steel. Nucor Steel, Seattle, WA and Schnitzer Steel, McMinnville, OR are local end-users.

Aluminum: The markets for aluminum are mostly domestic. Anheuser Busch is a large consumer of aluminum cans from this region. Their mills are located in Alabama, Kentucky, and Tennessee. Novelis and Alcoa are the other large domestic consumers of aluminum and steel cans collected from northwest curbside recycling programs.

Changes in the Material Stream

Steel: There has been no significant change in the material stream for residential tinned steel. To reduce contamination, Nucor purchases scrap already sorted and processed from a scrap yard to a specification. By using this practice, Nucor ensures limited impurities before scrap gets to the mill. (P. Jablonski, personal communication, March 13, 2016)

Aluminum: Manufactures report a decrease in domestic consumption of Beverage Can Sheet largely related to the soft drink industry (brewery consumption has increased). Recycling rates for 2015 will not be available until June 2016 however, according to the over 600 nationwide scrap suppliers doing business with Novelis, flows of UBCs into yards are down 30-40% year-over-year. While consumption of aluminum cans is down in the US, global consumption is up slightly. The introduction of the aluminum bottle has had little impact on recycling and Novelis has re-alloyed the material for manufacturing to use higher amounts of recycled product (including UBC). Declining commodity prices have affected the ability of "MRF" suppliers to operate at a financial benefit. The ripple down effect has been evident in the quality of the material, "We seemingly have a higher rate of rejections due to high plastic, paper, etc. There are a handful of suppliers we can no longer take mill direct but instead have to steer towards a

third party resorting operation first, and there are a few operations that are no longer operating at all". (McKee, 2016)

AREAS FOR IMPROVEMENT

Curbside commingled systems should not collect aluminum foil, trays, and pie pans. Foil products contain more iron and melt at a much lower temperature than cans. Consequently, they end up as ash when melted with cans. Aluminum mills refuse cans due to melting, and food contamination.

Only unflattened metal containers should go into commingled recycling. Lids left attached or crimped inside the tin can are recyclable. Lids separated from the can and measuring less than three inches in diameter, they should not be included in the recycle bin. Removed metal lids from glass, plastic and other containers that are larger than 3 inches go into the cart.

Mixed Paper
(MP – Mixed Paper)

MATERIAL OVERVIEW

Mixed paper consists of all paper and paperboard of various qualities not limited to the type of fiber content, sorted, and processed at a recycling facility (ISRI, 2016). Specific materials include mail, magazines, catalogs, paperback books, phonebooks, envelopes, boxboard (cereal and shoeboxes) paper bags, and non-foil gift-wrap. Mixed paper does not include paper towels, plates, napkins, tissues, food contaminated paper, and metallic gift-wrap. Mixed paper makes up a large percentage of the residential waste stream. Mixed paper has a strong export market, and has environmental benefits when used as a feedstock for making fiber products. Mixed paper becomes a variety of other paper products such as linerboard, high quality corrugating medium for corrugated boxes, and unbleached kraft pulp.

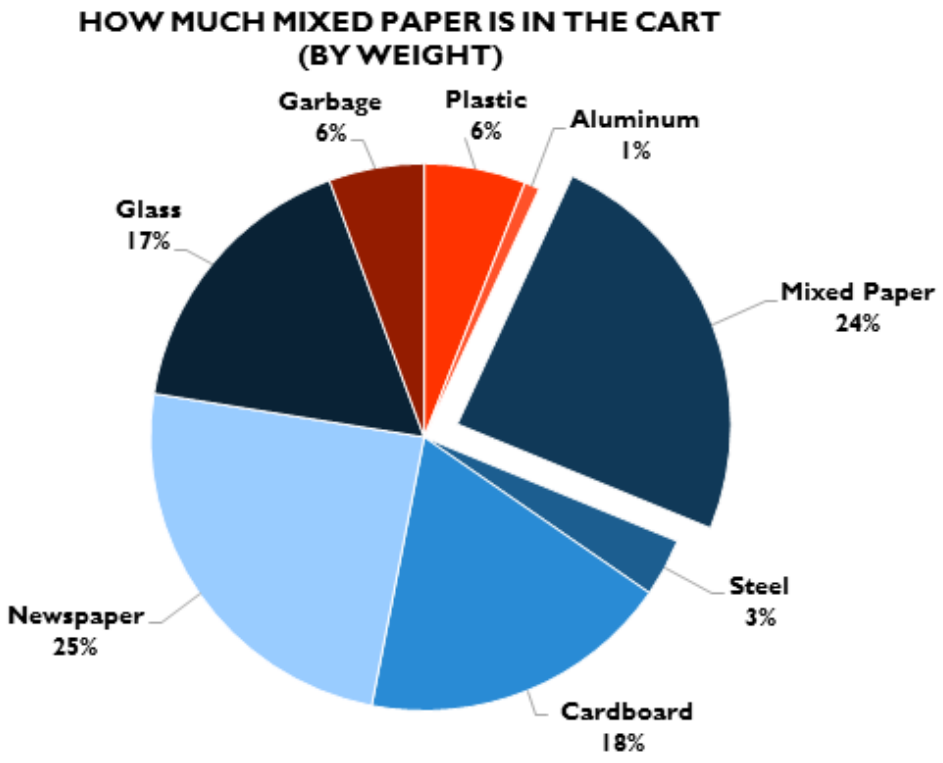
Environmental Benefits of Recycling Mixed Paper

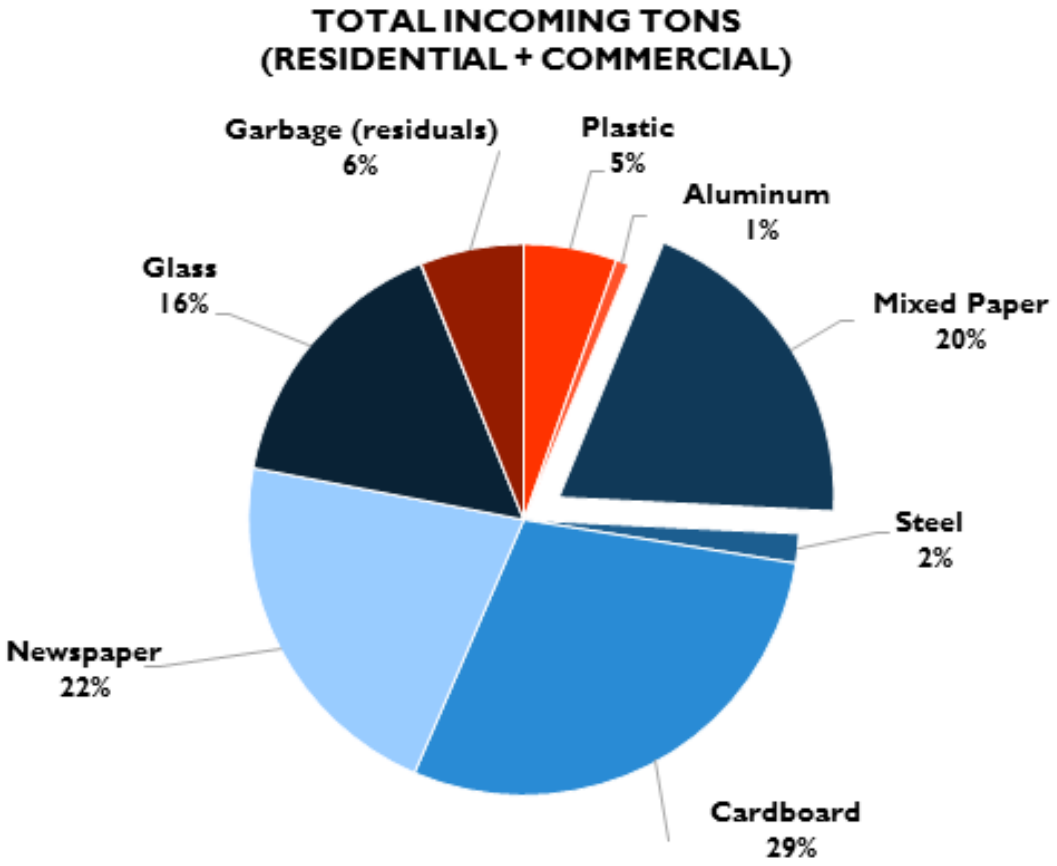
Recycling one ton of mixed paper results in a net savings of 21 million BTUs of energy. Recycled mixed paper saves 62% of the total energy needed to manufacture new paper (Environmental Protection Agency, 2015). Unless incoming mixed paper bales are highly contaminated, the mills easily recover the paper. Recovered paper is economical compared to virgin fiber. Recovered paper reduces energy and water use.

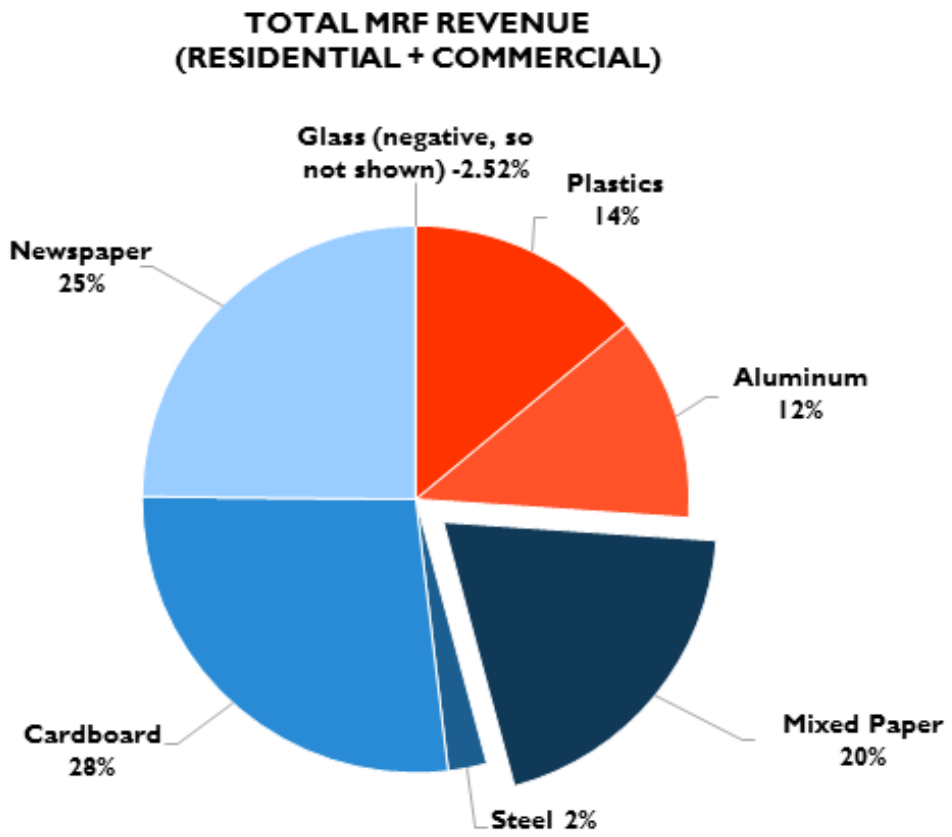
Material Accepted in Curbside Recycling System

All of the curbside recycling programs in the Northwest Region accept phone books, mail, magazines, catalogs, envelopes, boxboard (cereal and shoeboxes), paperback books, paper bags, and non-foil gift-wrap. Most programs also accept frozen food boxes, milk and juice cartons, polycoated food boxes, egg cartons, soda and beer cartons, and paper cores/rolls. Close to 50% of the programs also accept aseptic boxes and cartons, shredded paper, and paper cups (see Appendix B for more information).

Amount of Mixed Paper in the Curbside Recycling System







Source: Aggregated data from Northwest WA Region MRFs, October 2014

ISSUES

Issues at the Point of Collection

At the Curb

Loose shredded paper can be problematic during curbside collection because it is lightweight. The shredded paper can fall out of the cart during automated collection, littering the street. Paper can also become wet in the recycle bin if mixed with containers still containing liquid, which causes problems later at the MRF.

Whatcom County's programs sort paper separately at the curb and paper sacks of shredded paper are allowed. The collected paper is moved directly into the baler without any sorting required.

Public Education

Most curbside education programs tell residents that mixed paper should be kept "Loose, clean, and dry". Messaging concerning the preparation of shredded paper is not consistent throughout the region. Forty-eight percent of jurisdictions tell residents to put it in paper or clear plastic bags in the recycling. Eighty-seven percent of jurisdictions promote shredded paper in compost as an option (see Appendix B).

Issues at the Material Recovery Facility

Quality of Incoming

The quality of the materials delivered to the recycling processor is fair. Quality has become worse in the last 5 years, with residue rising from 11 to 15% nationwide. For instance, mixed paper can only accept certain tolerances of less recyclable paper and non-recyclables (ISRI, 2016). According to new ISRI bale standards implemented in April 2016, the new higher grade fiber ISRI is now using for curbside recycling is Sorted Residential Paper (SR), which will allow 2% prohibitives and 3% outthrows, but does not tolerate cardboard. MRFs generally can produce this slightly higher-grade material. The new lower grade fiber ISRI is now using for curbside recycling is Mixed Paper (MP). This new Mixed Paper grade now allows the brown grades and all fiber. It has similar tolerances, 3% outthrows (i.e. wax cardboard), and 2% prohibitives (ISRI, 2016).

Many curbside programs in the Northwest Region currently list certain paper fibers as acceptable despite being outside of the published ISRI grades. This miscommunication can lower the value of the mixed paper bales in the open market due to contamination of unsuitable material. Due to demand from the collection side, some collection programs accept low volume paper fiber types such as polycoated gabletop and aseptic cartons. The polycoated gabletop and aseptic cartons enter into mixed paper. However, secondary processors may classify them as unusable. Strong developed markets for those paper fiber types exist in overseas markets (Korea and Thailand) as well as domestic markets in Mexico and the eastern US. In the Northwest region, the majority of the MRFs do not believe there is a large enough incoming volume to make positive sorting of polycoated gabletop and aseptic cartons economically valuable (J. Epstein, J. Frey personal communication, 2016).

Food contaminated paper (such as paper plates, pizza boxes, paper towels) is a common contaminant in commingled systems and is NOT accepted/recyclable in any jurisdiction. However, pizza boxes that are not food contaminated (made possible by a paper liner) are acceptable in the April 2016 Mixed Paper grade (ISRI, 2016).

Problems in Processing at the MRF

Shredded paper is an issue. It enters the MRF either loose or in paper or plastic bags. Loose shredded paper is too small to be captured and is thrown away as residual and contaminates glass. Plastic bags containing shredded paper rip open and get caught on MRF machinery. Shredded paper also contaminates glass. Vacuum equipment is used, but most shredded paper remains unrecovered. Alternatively, shredded paper from local shredding events is easily recycled and is of high quality because it remains separated from other materials. Shredded paper that remains separate can be independently baled.

Wet paper sticks to other materials. Glass fines also stick to wet paper. Paper torn on the screens into small pieces, ends up with glass fines or residual. Wet paper that is baled may mold by the time it gets to a paper mill, causing health hazards and contaminating dry mixed paper.

Polycoated gabletop and aseptic cartons, that are not being sorted into their own paper grade (ISRI Grade #52), end up cross-contaminating as undesirable paper in newspaper, cardboard and mixed paper , and the plastic container bales. Low volume and the lack of the necessary equipment at MRFs in the Northwest region, justify MRF operators not sorting polycoated and aseptic containers to ISRI Grade #52 (see Appendix D).

Issues at the Secondary Processor

MRF's bale mixed paper. The bales go directly to a paper manufacturing facility. The paper manufacturer pulps and turns the bales into new paper products. Glass and the high percentage of other unsuitable and unusable materials are the biggest issues at the paper mill.

In paper markets, the category of Mixed Paper is a specific ISRI grade and does not include all the types of paper or paper containers collected in the commingled system. Currently Northwest region MRFs are not equipped to sort out polycoated gabletop and aseptic cartons. The items enter mixed paper bales which is resulting cartons being identified by a paper manufacturing facility as undesirable due to their lower fiber yield from pulping. The categorization by manufacturers as undesirable is despite the fact that the new ISRI Mixed Paper grade does not actually identify polycoated gabletop and aseptic cartons as outthrows (see Appendix D). (J. Epstein, J. Frey, personal communication, 2016).

Currently almost all residential mixed paper bales from Northwest region commingled MRFs export overseas to mills in China. There is a perception that all material sent to China is resorted and sent to the right market for remanufacturing. Smaller Chinese mills may sort everything out of the bales they receive and send different materials to the proper end-users. Most of the larger mills do not pre-sort and machines extrude out non-paper items as sludge (S. Choi, personal communication, 2013). Material rejected by the paper pulping process that is not suitable for fuel, goes to a landfill.

Prohibitives

Prohibitive is the term for items that do not meet ISRI bale standards. According to ISRI bale standards, prohibitive materials may not exceed 2%.

The most significant prohibitive in mixed paper is glass. Glass destroys the screens, can cause streaking during paper coating process, and can become embedded in the final paper product. See Appendix F for more information on the impact of glass on paper mills. Other prohibitives include metal, plastic, aluminum, self-adhesive paper, waxed paper and aluminum foil coated paper, heavily glued material (i.e. book bindings), mill wrappers, and non-tear paper (ISRI, 2016).

Outthrows

The term outthrows is defined by the ISRI bale standards as all papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified. According to ISRI bale standards, outthrows may not exceed 3%. Mixed paper bales include all types of paper and paperboard of various qualities. Mixed paper bales are not limited to the type of fiber content when sorting and processing at a recycling facility (ISRI, 2016).

Equipment

Prohibitives and outthrows accelerate the wear and tear on the paper industry machinery. Heavy glue can create a sticky mess that clogs screens.

Issues with the Markets

Even as China increases domestic sourcing of recovered paper, the demand will continue for recovered paper produced in the US. The paper consumed in China that becomes domestic mixed paper is not as high a grade as the imported mixed paper.

Domestic/Local

Currently no local markets regularly accept residential mixed paper. Local MRFs do not make newspaper grade bales and mix all the newspaper into the mixed paper bales. Northwest regional mills process and accept newspaper grade bales, and will usually only accept mixed paper bales if it contains a heavy news mix. Because of this, local mills that only process newspaper do not accept bales from local MRFs (B. Kovich, personal communication, 2016).

Export

Chinese paper mills receive mixed paper bales from the Northwest region.

The Chinese government has become cautious of quality of mixed paper imports. The government has concerns that it may contain residuals and other undesirable material. Added MRF floor sweepings, residuals or other contaminants contaminate mixed paper bales at times. In other cases, contaminants from the mixed paper stream remain in the stream. The desire of MRFs to sell the maximum amount of product, and contractual obligations to municipalities setting limits on how many total inbound materials can be deemed waste causes these inconsistencies. Bales need to be sorted better or resorted to remove contaminates before shipping to China or elsewhere.

The Chinese Government has specified that imported recovered paper may have less than 1.5% non-paper contamination (although some outthrows are considered prohibitives and fall under the 1.5% limit). They also have zero tolerance for banned items such as food waste, textiles, green waste, e-scrap, etc. (Powell, Resource Recycling, 2013). The experience of a broker participating in the Northwest Region Workgroup is that a lot of mixed paper exceeds these percentages, particularly mixed paper from commingled MRFs.

As the rapid expansion of Chinese paper production begins to slow, they will supply more of their raw material needs from domestic sources. Although they will still need to import significant quantities, quality is going to become one of the first criteria for deciding whom they will buy from. Exporters have increased inspections of outgoing bales and Chinese Customs have and will refuse loads due to contamination at the port of entry (Powell, Resource Recycling, 2013). Japan produces the cleanest of all waste paper grades. Their mixed paper grade meets the ISRI standard (sold using Japan's industry standard, not ISRI). Compared to Japan, the U.S. and Europe produce waste paper that is of poor quality, certainly more so now than compared to pre-commingled days.

Changes in the Material Stream

Paper products considered low volume are included within mixed paper bales. This practice is increasing in volume and may become an issue. More companies are using polycoated gabletop and aseptic cartons to package their product instead of a plastic, metal or glass container. Chinese mills consider polycoated gabletop and aseptic cartons as unacceptable. The mixed paper bales containing these two materials pass inspection, because the incoming material is at such a low volume overall within a bale. The Carton Council is working with MRFs in the Northwest region and both export and domestic end markets. The council's goal is to build a strong supply system for those cartons through positive sorting to ISRI Grade #52 specifications. The supply system has emerging active export markets already in Korea and Thailand (J. Epstein, J. Frey, personal communication, 2016).

AREAS FOR IMPROVEMENT

Chinese mills are purchasing the vast majority of the mixed paper produced in this region. Certain types of paper have low to no fiber yield after pulping. The following two examples with this fiber yield should find new markets.

- Polycoated gabletop and aseptic (aluminum coated) cartons (milk and juice cartons)
- Finely shredded paper (also problematic for processors)

Consider removing shredded paper from the list of accepted materials. Small size paper (2"x2" or smaller) is a problem. Shredded paper gets sorted with materials other than paper, or landfilled as residual.

Most MRFs in the Northwest region have polycoated gabletop and aseptic cartons sorted into mixed paper due to comingled collection. Cartons may cause problems at the secondary processor. They also have a lower fiber yield at the Chinese mills that take mixed paper from the Northwest region as a feedstock (see table below). If the volume of this material grows, MRFs will have to work to address how to separate these cartons. Some options for carton sorting include optical sorting, automated sorting, manual sorting, or other means.

Chinese customs view aseptic packages of all types (both polycoated paperboard cartons as well as aseptic flexible pouches) and egg cartons as contaminants in mixed paper shipments, even though many collection programs accept them. Many Chinese mills do not sort out polycoated gabletop and aseptic cartons. When extracting fiber, the cartons require different and more extensive pulping methods. Alternatively, Korean and Thailand paper mills actively purchase the ISRI Grade #52 bales from MRFs throughout the west coast.

Positive sorting of polycoated gabletop and aseptic cartons to the ISRI Grade #52 specifications have high market value and high yield of ink free bleached fiber. They are some of the cleanest fiber remaining in the commingled recycling system. The chart below shows the different solutions to carton recycling based on overall yield, ranging from 90% to 100% in the most favorable end markets to 33% to 42% in the least desirable end markets.

Table 3. Carton Recycling Options

Priority	Bale Type	Mill Type	Byproduct	Fiber Yield	Poly/Al Yield	Total Yield
Highest	Grade #52	Whole carton processing	Building materials	90% to 100%	90% to 100%	90% to 100%
Highest	Grade #52	Tissue mill w/ poly/al recovery	Tissue, Toweling, molded products	90% to 100%	90% to 100%	90% to 100%
Highest	Grade #52	Pulp mill w/ poly/al recovery	Dry or wet lap market pulp	90% to 100%	90% to 100%	90% to 100%
High	Grade #52	Tissue mill w/no poly/al recovery	Tissue, Toweling, molded products	90% to 100%	0%	70% to 79%
High	Grade #52	Pulp mill w/no poly/al recovery	Dry or wet lap market pulp	90% to 100%	0%	70% to 79%
High-Medium*	Mixed Paper	Mill w/ byproduct energy recovery	Variety of paper products	90% to 100%	90% to 100%	90% to 100%
Medium*	Mixed Paper	Mill w/no byproduct energy recovery	Variety of paper products	60% to 75%	0%	45% to 56%
Low-Medium*	Mixed Paper	Mill w/out good match technology	Variety of paper products	45% to 55%	0%	33% to 42%
Not acceptable	Disposal	Landfill	none	0%	0%	0%

Source: Carton Council, July 2014

**The NRW recognizes that in there diverse opinions exist related to waste to energy and the waste recovery hierarchy. Members of the NRW do not necessarily agree with the priority rankings of some of the solutions on this table.*

Newspaper
(ONP - Old Newspaper)

MATERIAL OVERVIEW

The definition of newspaper is newsprint, which is a low-grade, machine-finished paper, made from wood pulp and a small percentage of chemical pulp. Non-newspaper grades inserted into the newspaper, such as shopping flyers (inserts), are included in this material grade. Newspapers from this region become; paper/hard back books, newspapers, phone books, advertising inserts, and paper bags. Newspaper adds value to exported mixed paper bales. Newspaper is a common recyclable to the public, and collected in all curbside programs.

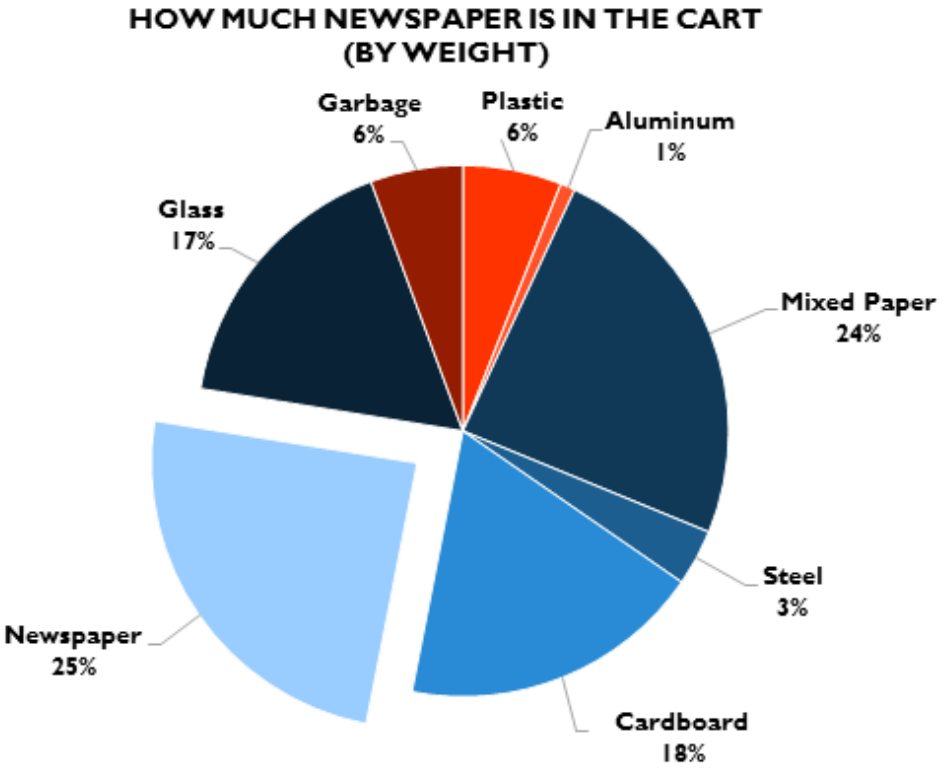
Environmental Benefits of Recycling Cardboard

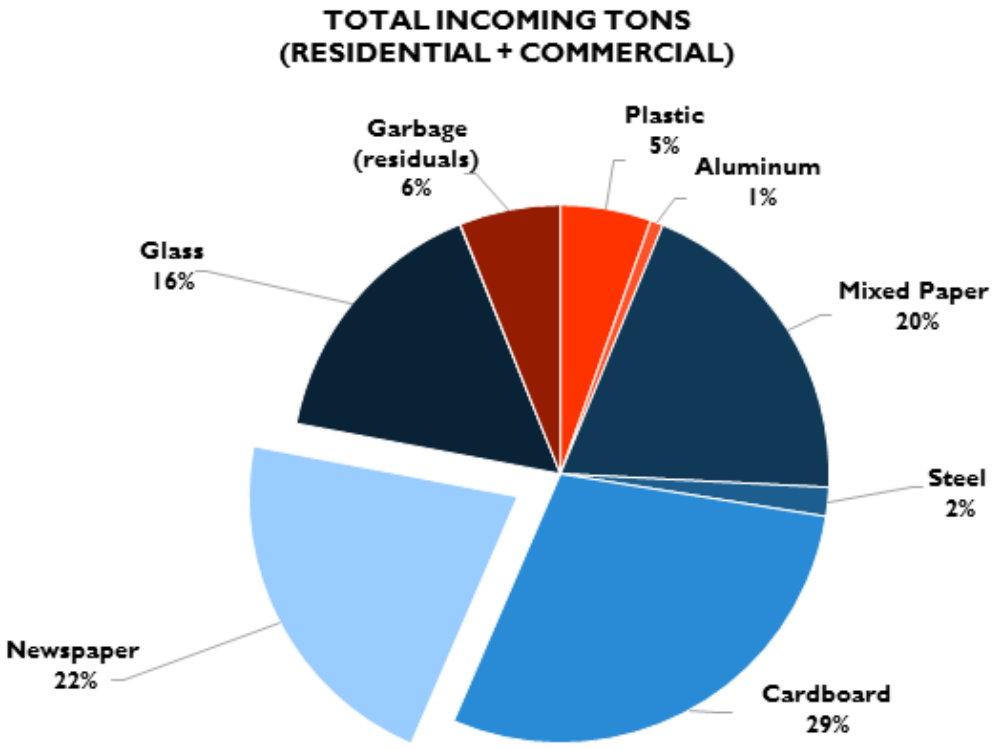
Recycling one ton of newspaper results in a net savings of 16 million BTUs of energy (Environmental Protection Agency, 2015). Recycled newspaper saves 41% of the total energy needed to manufacture newsprint from virgin materials.

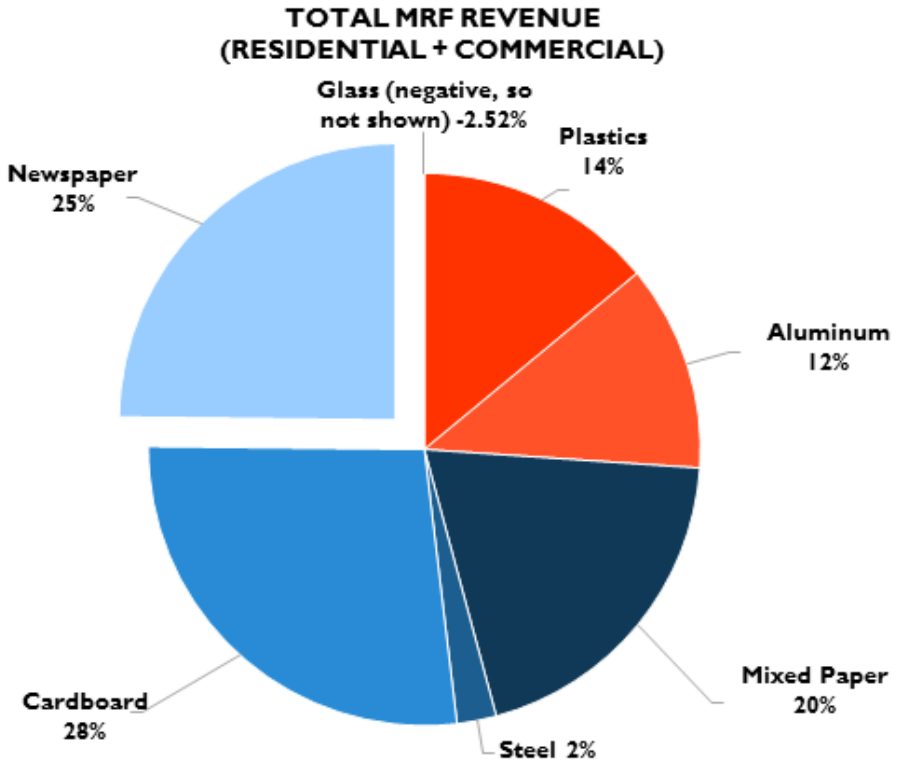
Material Accepted in Curbside Recycling System

One hundred percent of the curbside recycling programs in the Northwest Region accept newspaper.

Amount of Newspaper in the Curbside Recycling System







Source: Aggregated data from Northwest WA Region MRFs

ISSUES

Issues at the Point of Collection

At the Curb

Commingled cart standards for newspapers are to place them loosely in the commingled cart. Commingled carts do not allow newspaper bagging, bundling, or tying together. Some residents do bundle their newspapers together or put them in a plastic newspaper bag. The habit of bundling or bagging newspaper presents a problem at the MRF.

Public Education

The message to customers is to keep newspapers clean, dry, and loose. Some jurisdictions specifically ask residents not to bag their newspapers and to keep plastic bags out of the recycling cart.

Issues at the Material Recovery Facility

Newspaper had its own bale specification. Processing newspaper as a bale without mixing other paper in was common. (See Appendix D). Due to the reduction in the use of newsprint and the lower volumes coming into the MRFs, baled mixed paper includes newspaper. This is rather than leaving newspaper as its own material type.

Quality of Incoming

The quality of incoming newspaper to the MRF from commingled recycling programs is fair. As long as it is dry, there typically is no contamination of the paper itself. When wet, any broken glass can adhere to the paper.

Problems in Processing

Newspaper is "negatively sorted" at the MRF which means that newspaper is left on the sorting line while other materials are removed. The "positive sorting process" removes contaminants by actively picking them out. The biggest processing challenge is keeping the newspaper uncontaminated through to the end of the sorting process.

Smaller pieces of cardboard are becoming more prolific in the recycling bins due to the increase in online shopping and shipping. Small cardboard pieces are use to protect corners and edges of products and are used to package small goods. According to paper mills, MRFs would need to slow the belts down to give employees more time to pull out (positive sort) all of the small brown paperboard, cardboard and other contaminants to achieve the quality of newspaper bales required to make recycled newspaper locally (Tolan, 2013). Wet, bundled, or bagged newspaper affects processing efficiency. Flat contaminants, such as plastic lids and metals that are not removed by the "positive sort" tend to remain with the newspaper. Newspaper does not cause much cross-contamination for most materials.

Issues at the Secondary Processor

Paper mills process newsprint. Since the early 2000's, buyers of newsprint have seen a dramatic increase in contamination of glass, random plastic, small pieces of cardboard and chipboard largely due to commingled collection programs (Cleiland, 2013). According to ISRI bale standards, prohibitive materials may not exceed 2%, outthrows plus prohibitives may not exceed 4%, and other acceptable papers may not exceed 30% (Appendix D).

Prohibitives

Collecting newspaper in commingled recycling systems causes paper mills to experience significant issues. **Error! Reference source not found.** shows the rise of contamination in fiber at the NORPAC mill with the introduction of commingled collection systems. The most problematic prohibitive is glass because even small volumes, it can damage costly paper manufacturing equipment. According to Nippon Paper Industries USA (NPIUSA) in Port Angeles, WA, plastics and metal sort out into a residual pile and do not make it into the pulping machines, but glass does and it acts like a sandblaster on all of the mill equipment. Plastics and expanded polystyrene foam clog filters and the foam ends up in wastewater. In the case of one paper mill, they purchased a separate vacuum truck for extracting foam debris. In addition, a high volume of plastic bottles and jugs, metal containers, and other non-fiber objects have impacts on various aspects of the paper mill operation as shown in

Table 4: Commingled Contaminants and Operating Impacts at NORPAC's Paper Mill.

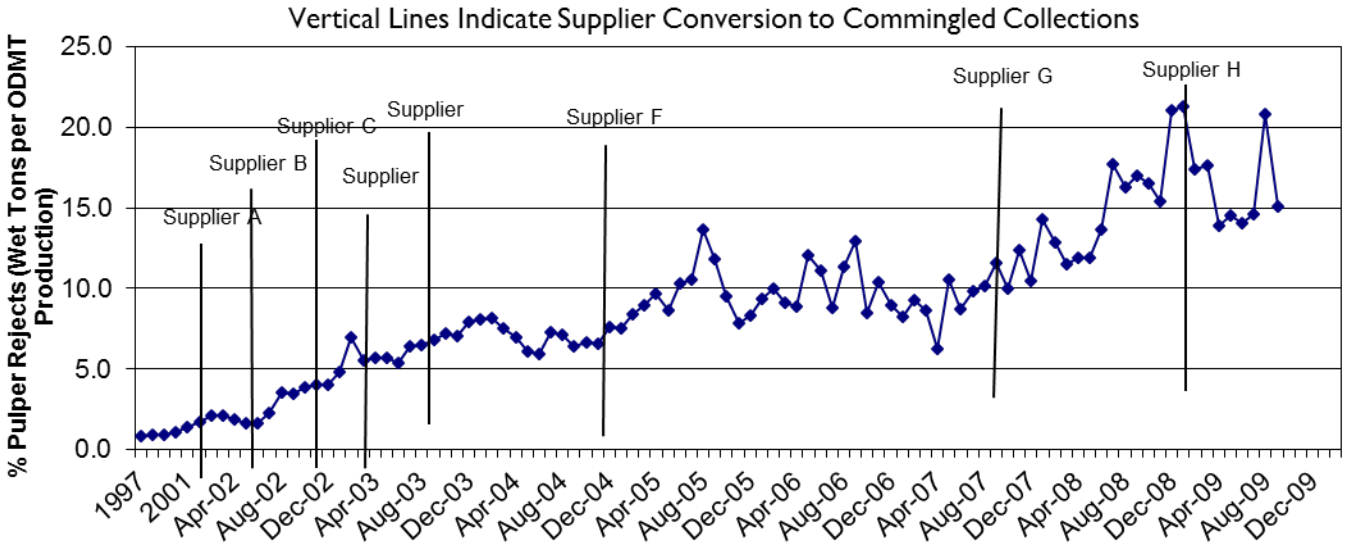


Figure 2. Commingled Collection and the Rise of Contamination of Fiber at NORPAC Paper Mill – Deinking Facility, Longview, WA

Table 4: Commingled Contaminants and Operating Impacts at NORPAC's Paper Mill

Contaminant	Cost Impact	Quality Impact	Operating Impact
Glass	Increasing wear rate of process equipment, maintenance, downtime and safety risks	Decreases efficiency of stickies removal	Will shut process down
Brown Fibers	Rejected by pulper. Replaced with additional fiber purchases. Disposal costs. Bleaching costs	Increases risk of hot melt and glue stickies. Reduced brightness	No measurable impact on operating efficiency at this time
Junk Mail	Requires more chemicals to counter macro and micro stickies	Viewed as significant contributor to increased macro and micro stickies	No measurable impact on operating efficiency at this time
White Ledger/Colored Ledger	Inks can contribute to macro and micro stickies increasing costs to manage contaminants	Toner/heat fused inks not easily removed with news deinking chemistry / technology	No measurable impact on operating efficiency at this time
Tin/Aluminum	Small impact to cost as this is a small percentage of total	No measurable impact to quality	Will reduce yield and operating efficiency
Plastic	Large impact to cost as the volume is rather large. Disposal and fiber displacement costs high	No measurable impact to quality as it is easily removed by our process equipment	Will reduce yield and operating efficiency

Outthrows

- Small, colored cardboard and brown fiber comprise 50-60% of outthrows. Magazines are considered an outthrow due to the glue in the binding. The materials listed below are outthrows because they have a higher wet strength which means they maintain a percentage of their strength when treated with water. They include polycoated fiber coated with an outer layer of plastic designed to resist water. Because they do not disintegrate when wet, they contribute to the poor recovery, contamination and/or total yield loss of newspaper. The yield loss can be 16% or more.
- Carrier board (beer and soda cartons)
- Polycoated cartons (milk and juice cartons)
- An example of aseptic containers is TetraPak containers. Products include soy/rice milk, soup, and juice boxes).
- Microwavable food boxes
- Frozen food boxes and cartons

Equipment

Refer to Appendix F for the impact of glass from commingled collection systems on the equipment at paper mills.

Issues with the Markets

The demand for recycled-content newsprint is declining. Many customers request paper that contains certified sustainably grown wood instead (hemlock, spruce). Certification comes from the Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC) or Programme for the Endorsement of Forest Certification (PEFC) programs. NORPAC produces SFI, PEFC and FSC certified paper. NPIUSA is a PEFC and FSC certified paper mill.

Domestic/Local

As of publication, no local mills accept newspaper from the Northwest Region MRFs that get their paper from commingled curbside programs. Most MRFs in the Northwest have not produced an ONP grade that meets ISRI specifications (see Appendix D) for 20 years. They instead mix the newspaper into mixed paper bales. NORPAC does take some newspaper from drop boxes and source separated recycling programs (J. Simmons, personal communication, February 29, 2016).

Export

Newspaper mixes in with Mixed Paper (MP) bales and exported to China. The value for a newspaper bale by itself is not enough to make it worth separating out the newspaper from the mixed paper. When it makes economic sense, MRFs will categorize these bales as a "newsy mix" and get a slightly higher price for a MP bale. ONP has to be $20-$30 more/ton to make the sorting out cost positive. (B. Kovich, personal communication, Jordan Trading, 2016)

Changes in the Material Stream

The volume of newspaper available for recycling has declined due to lower readership and related lower production of newspapers. With the onset of commingled programs, newspaper has a high contamination of glass, food, liquids, plastics, small cardboard, and paperboard. Many MRF's do not separate ONP into newspaper bales. MRFs combine ONP with other papers in a mixed paper bale, which sells overseas.

Newspaper buyers are demanding paper made with sustainably managed wood, rather than recycled content paper due to the cost and difficulty in getting quality ONP. Other non-

newspaper customers mills request recycle content for book grades and such. NPIUSA would rather use sustainably managed wood because of the poor quality of paper coming from commingled collection programs and the damage to equipment from glass contamination. Printing customers are also using less paper and have adopted paper-saving practices such as printing all the way to the edge of the page rather than leave 2-3 inches as they had in the past (Tolan, 2013).

AREAS FOR IMPROVEMENT

Commingled recycling is negatively affecting the fiber markets. The most direct way to reduce contamination would be to collect glass separately, rather than mixing it with paper. Some improvements for commingled glass at the MRFs would improve the quality of bales. Cities that contract for recycling services could require provisions in their recycling contracts that require MRFs to meet bale specifications and include enforcement measures. Contracts could also require verification that the materials accepted in the curbside program are actually being recycled.

Plastic

MATERIAL OVERVIEW

Plastic is a ubiquitous material. Plastic used to make a wide variety of products including carpet, toys, car parts, clothing, furniture, product packaging, and thousands of other products. Most curbside recycling programs limit the type of accepted plastics to certain plastic containers and packaging.

If sorted correctly, many plastic items are highly recyclable and have strong markets. Plastics can be a challenging material to recycle. Plastic can be made out of a variety of plastic resins, it can be challenging to sort, and the public is generally confused about what types of plastic items can be included in recycling resulting in high contamination and frustration.

Plastic containers collected in the NW Region's residential commingled curbside collection programs are shown by resin type in Table 5: Plastic by Resin Type and Code, although most communities instruct residents to recycle by container type.

Table 5: Plastic by Resin Type and Code

SPI and ASTM Resin Codes	Resin type	Plastics that may be included in curbside recycling programs
1 PETE 1 PETE	Polyethylene Terephthalate	Pop bottles, sports drink bottles, juice containers, peanut butter jars
2 HDPE 2 HDPE	High Density Polyethylene	Milk jugs, shampoo bottles, soap bottles, laundry detergent bottles

SPI and ASTM Resin Codes	Resin type	Plastics that may be included in curbside recycling programs
3 V	Polyvinyl Chloride	Some bottles collected incidentally through "all bottles' message". PVC bottles are undesired for recycling.
4 LDPE	Low Density Polyethylene	Bags, container lids, bottles (such as squeeze bottles and honey bears), and film.
5 PP	Polypropylene	Yogurt, margarine containers, take-out food cups and clamshells.
6 PS	Polystyrene	Take out clamshell containers, yogurt containers, cups
7 OTHER	Other plastics including acrylic, polycarbonate, nylon, fiberglass, bioplastics, multi-layer and any other plastic not listed above	The "all bottles" messaging causes collection of some bottles, These bottles are undesirable based Whether these bottles are not desired for recycling depends on the bottle and the buyers.

Source: Photos from Canadian Plastics Industry Association

Recycled plastics become a variety of products including new bottles, packaging, plastic lumber, park benches, furniture, clothing, carpet, plastic containers, and many other items.

Environmental Benefits of Recycling Plastic

Recycling one ton of PET plastic results in a net savings of 32.1 million BTUs of energy and saves 62% of the total energy needed to make plastic from virgin materials (EPA WARM Model, 2015).

Recycled HDPE saves 50.4 million BTUs and saves 75% of the total energy needed to manufacture new plastic, providing manufacturers with a reduction in operating expenses materials (EPA WARM Model, 2015).

Material Accepted in Curbside Recycling System

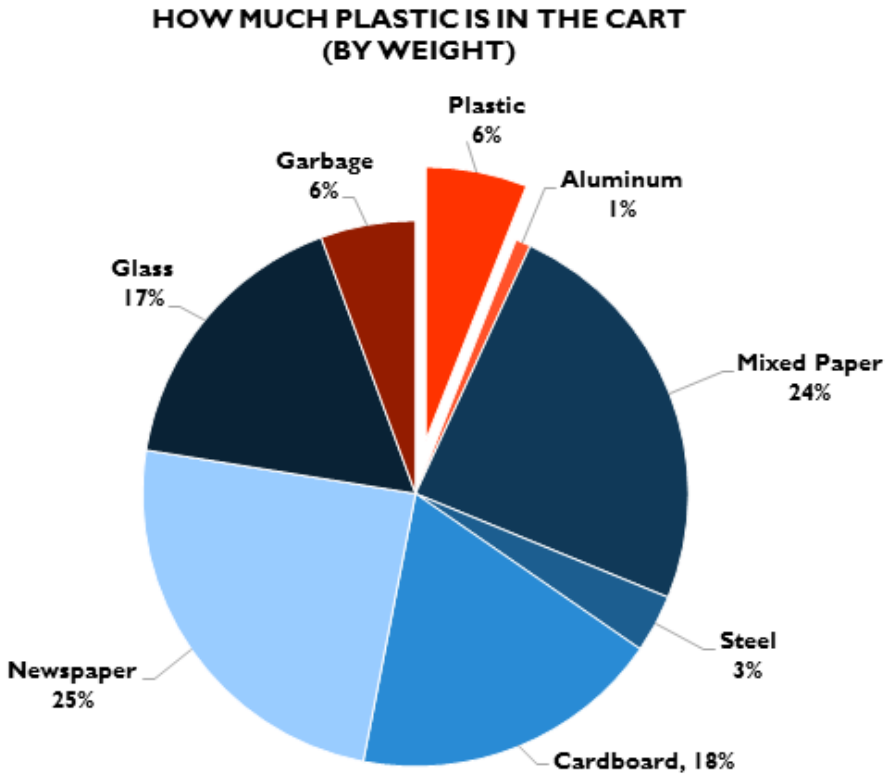
One hundred percent of curbside recycling programs in the NW Region accepts PET and HDPE bottles, jars, and jugs (see Appendix B for more information).

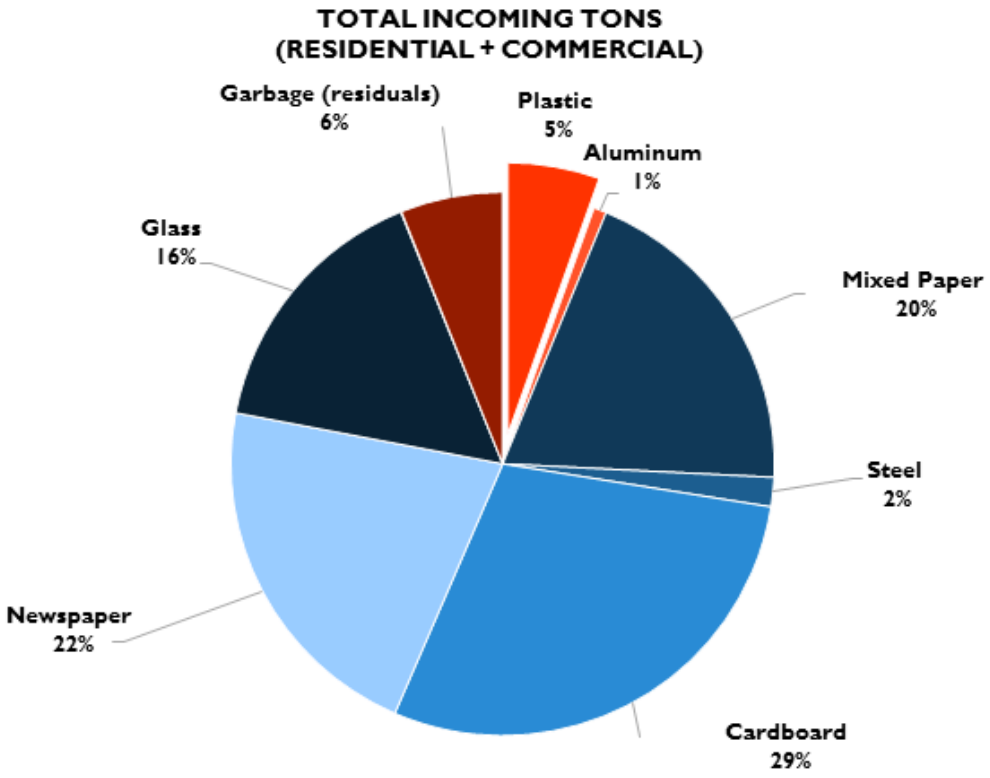
Other plastics collected in the NW Region's residential commingled curbside collection program vary by community.

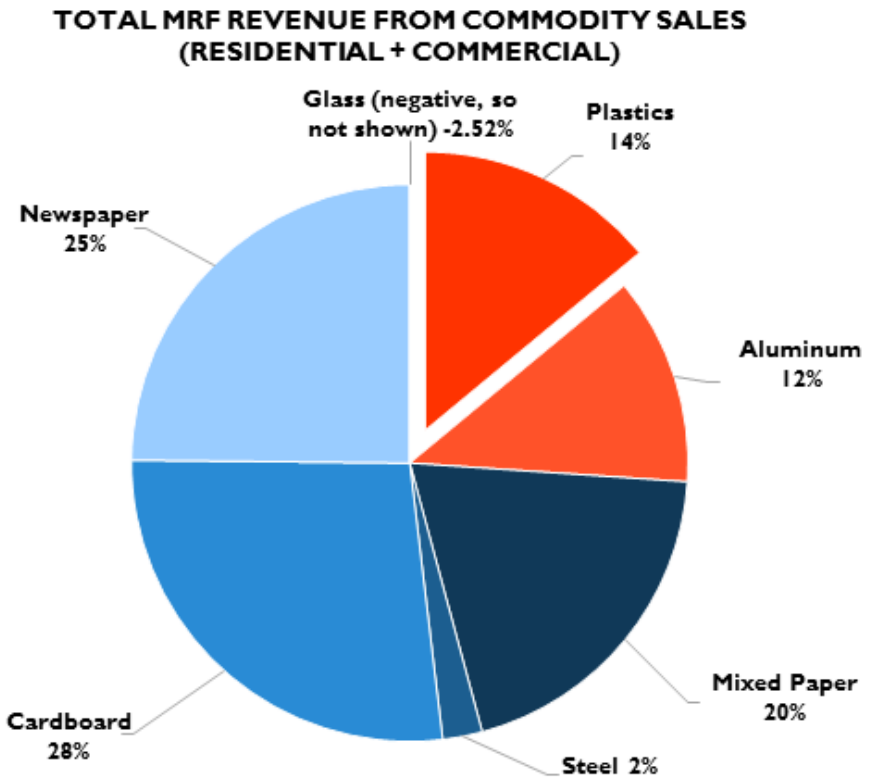
- All programs accept plastic bottles, jars, and jugs.
- Most programs accept plastic bottles, jars, jugs, cups and tubs.
- Some programs also accept nursery plant pots, deli, bakery and takeout containers, bagged plastic bags, bottle caps (on plastic bottles) and lids larger than three inches.
- Few programs also accept bulky rigid plastics, such as lawn furniture and laundry baskets, and PVC pipes.
- No programs accept chip bags, foam containers or cups, packing peanuts, frozen food bags, plastic non-food containers, plastic wrap, toys, flexible-multi-layered packaging, prescription pill containers, plastic cutlery (such as spoons and forks), hazardous waste containers or motor oil bottles.

Amount of Plastic in the Curbside Recycling System

Although plastic does not make up a large percent of the recyclables in the cart by weight, the volume of plastic in the cart is much higher than 6%.







Source: Aggregated data from Northwest WA Region MRFs, October 2014

ISSUES

Issues at the Point of Collection

At the Curb

King, Kitsap, San Juan, Island, and Skagit Counties accept plastic in the commingled recycling cart. Snohomish County accepts plastic in the commingled recycling cart except for two areas: one section of the City of Everett and one section of the City of Mukilteo. In those locations there is a two-bin system operated by Rubatino Refuse Removal that collects paper in one bin and containers, including plastic, in the other. Whatcom County has a three-bin system. One bin collects plastic, while the other collects glass bottles and metal cans.

Over the past decade the volume and variety of plastic packaging and products has increased significantly. During this same timeframe, several jurisdictions have expanded their list of accepted plastics to include more types of food and beverage containers, lids, plastic non-foam clamshell containers (produce, deli and to-go containers), plant pots, PVC pipe, and bulky rigid plastics such as lawn furniture, laundry baskets, and 5-gallon buckets.

The type of recyclable plastic materials accepted in residential curbside programs vary across neighboring jurisdictions. In most cases, what can be recycled differs depending on where an individual works, lives, or goes to school. The public has become confused about which plastics are recyclable, resulting in a higher number of non-program plastics thrown in the bin.

Public Education

"Clean and empty" is the universal message for plastic containers. In addition, most jurisdictions focus on shapes of containers and use photos rather than the resin codes to tell the public what to recycle. Only two programs use the SPI Resin Identification Codes (RIC). Photos accompanied by a message that may say "Ignore the numbers, Recycle by shape!"

Information about how to prepare plastic containers for recycling is changing. About 60% of curbside programs in King County and 1 program in Skagit County accept plastic bags. Residents receive advice to put their plastic bags into another bag to reduce the problem that loose plastic bags cause at the MRF. Loose bags tangle in the gears of processing equipment. Due to the problems plastic bags create at the MRFS, some jurisdictions have deemphasized the collection of bagged plastic bags in curbside recycling. Outside of King County, many jurisdictions emphasize that plastic bags do not belong in curbside recycling.

There is a considerable amount of confusion among the industry and residents about whether to leave screw-on cap on plastic bottles. Historically, programs have instructed removal of plastic caps from plastic bottles. The caps were disposed as garbage in the past. The predominant reason for this is that since the bottle cap material is a different type of resin, the caps contaminate the bottle resin in the recycling process. Other reasons for excluding the cap include concern that bale weights are unattainable with capped bottles, caps would become projectiles when compressed, and liquids would remain if the bottles caps stay on.

These issues have largely been resolved, though most local programs continue to promote removing caps from plastic bottles and discarding. "Empty Bottles and Replace Caps" messages are under review by some jurisdictions. This is a potential area for harmonization.

Issues at the Material Recovery Facility

Quality of Incoming

The quality of the plastic materials delivered to most Material Recovery Facilities is fair.

Whatcom County, which uses the three-bin system, reports that their incoming plastics are very good so the processor has very few issues. Plastic and paper stay divided in Whatcom County. In Whatcom County cross contamination from plastic in the paper stream is not an issue.

Problems in Processing

Plastics separate from other materials using a combination of hand and machine sorting technologies. Plastic sorting happens by resin types or groups of resin types. The baled

materials ship to secondary processors for further sorting and processing.

There are many different ISRI bale standards (see Appendix D) for different categories of plastics. ISRI and APR are in the process of harmonizing their specifications. In addition, APR has added model bale specifications for PE, PP and PET resin. These specifications provide a benchmark to suppliers.

Photo 10: Plastic bags and film caught in MRF screens

Quality of the baled plastic is the primary factor, which determines the value. A reduction in the contracted price of the material occurs if bales contain over 2% of unspecified materials. In addition to the reduction in contracted price, charges for disposal of the contaminants occur at times.

Certain materials specified as "prohibited" and will render the bale "non-specification." When there is gross contamination or misrepresented materials, some customers may reject the entire shipment. These include plastic materials, which have a deleterious effect on each other when reprocessed, and materials such as agricultural chemicals, hazardous materials, flammable liquids and/or their containers, and medical waste.

There are several key issues with plastic containers delivered to Material Recovery Facilities (MRFs):

- **Container Size and Shape:** As most of the equipment at the MRF sort containers by shape of the container, anything that is not three-dimensional has the potential of causing problems. Flat plastics often "behave" as paper in the sorting machines and end up being sorted into paper bales and contaminating the bale.
- **Non-Program Plastics:** Non-program plastic materials, such as plastic trays, are often difficult to sort from 'program' plastics, can contaminate other recyclables, and often lack a market. There are often labor and disposal costs associated with removing this material. . In King County, 16% of plastics collected are non-program/non-conforming which equates to about one out of every six pounds of plastic collected.
- **Plastic Bags and Film**: Plastic bags and film make up a small percentage of incoming material by weight (.2%, which is approximately a bale a day) but has a big impact. Plastic film (such as, grocery bags) tangles in the gears of the processing equipment. This regularly requires stopping the machines at the MRF to remove the film. The exact MRF operators can usually remove 30-40% of the plastic bags during the pre-sort process, but the rest tangle in the machinery. It costs $700-$1000 a ton to remove this material. Overall, 20-30%

of recycling center labor entails dealing with film. Curbside collected bags are highly contaminated, dirty, and gritty. According to Moore Recycling, MRFs are typically unable to create bales of film from curbside programs that meet domestic quality standards The film that is successfully sorted at the MRF is only suitable for export markets. In today's (2016) down market, the export market does not want curbside film. When residents told to take bags, film and wraps to retail collection, the material has a much higher value. The City of Vancouver Washington in conjunction with Clark County, Waste Connections of Washington and other partners conducted a study that showed a 75% decrease in plastic bag contamination within recycling carts of consumers who had received informational notices of where to recycle the bags. (City of Vancouver, 2016)

- **Food or Liquid Soiled Plastic Containers:** Liquid left in plastic containers results in three issues:
  - Sorting machinery fails to separate plastic bottles with significant liquid correctly, due to their weight.
  - Plastic bottles and containers containing liquid or food contaminates other recyclables like paper and cardboard
  - Food and liquid often weighs more than the plastic and this can affect bale yields.
  - Food and liquid residue stuck on plastic recyclables impact the quality of the plastic used for re-manufacturing
- **Screw-on Caps:** There is ongoing discussion about the best way to handle screw-on caps. Loose caps placed in the recycling container fall through screens at the MRF and become part of the residual, and are therefore lost to recycling. A new opportunity has emerged to recycle plastic screw-on caps. Caps screwed back onto empty plastic bottles by the consumer before placing in the recycling container will move with the bottle through the MRF. After the MRF, a secondary processor receives the caps and plastic bottles. Plastic processors are now able to separate the cap resins from the bottle resins and sell cap resins for making new products. Caps make up 6 to 12% of the weight of many bottles. Capturing caps for recycling actually results in a significant increase in plastic available for recycling.
- **Flexible packaging:** This type of packaging is often comprised of multiple plastic resins and foil. Flexible packaging is not currently recyclable and unacceptable in curbside by municipalities. However, consumers are putting flexible packaging into their curbside recycling bin. Due to its flat shape and light weight this packaging material tends to behave like paper and flows through a MRF with the paper stream. This practice allows the flexible packaging to potentially contaminate the paper stream. It requires manual sorting to remove the laminated plastics. Today's optical sorting technologies are unproven in removing all contaminants from the fiber stream. When removed at the MRF, flexible packaging typically ends up disposed. There is no large-scale end market for this packaging type at this time.

- **Full-Wrap Bottles:** Bottles wrapped in a sleeve, made from a different plastic resin than the bottle. In an optical sorter, the bottles may be missorted.

Issues at the Secondary Processor

A secondary processor is a facility where the plastic materials are either further sorted by specific plastic resin types called a Plastics Recycling Facility (PRF). For the purposes of this report, secondary processors can also refer to the reclamation facility. Reclamation facilities take in plastic material for further sorting, washing, and grounding into flake. Sometimes reclamation facilities also re-melt plastics into plastic pellets. The plastic pellets become a commodity. The sold commodity goes to companies for use in making new plastic products.

Photo 11: Plastic pellets. Photo credit: Moore Recycling

Most plastic resins have a different melting temperature. Due to each resins melting point, sorting into specific resin types allows plastics to melt properly. If incompatible plastic resins mix, the plastic with a lower melting temperature will burn. When plastic burns rather than melting, it causes the plastic pellets to become discolored and unsuitable for making new products, such as new bottles.

Photo 12: PET flake. Photo credit: Pinnacle Recycling Private Ltd.

The most concerning issues at reclamation facilities are changes in product packaging design, non-program plastics, and contamination of plastics.

- **Compostable Plastics:** Compostable plastics, such as PLA, are sorted with near infrared (NIR) optical sortation. Any of the major brands of NIR optical sorters can read the unique light wavelength signature of PLA in use today. MRFs (usually into a mixed plastic stream), secondary MRFs, plastic recovery facilities (PRFs) and PET reclaimers sort out PLA. Compostable plastics, though technically recyclable, are not currently commercially recyclable in the U.S. due to the low volumes in the recycling stream and limited markets. However, as volumes grow and markets for recycled PLA develop, the recovery of this material will also grow. At least one secondary MRF located in Los Angeles is proving this concept out, and other PRFs around the country are showing interest in this concept. In Taiwan, the recycling of PLA at a number of PRFs in the country has been ongoing for years.

- **Degradable Plastics:** Optical sorters cannot tell the difference between a plastic cup with a degradable additive and a traditional plastic cup. Plastics with degradable additives are being sorted into the same bale as traditional plastics, which degrades the quality of the bale.
- **Full-Wrap Bottles:** Bottles wrapped in a sleeve that made from a different plastic resin than the bottle. In an optical sorter, the bottles may be missorted.
- **Calcium carbonate loaded HDPE and PP:** A 'sink/float' technology divides HDPE and PP by plastic resin. Adding calcium carbonate into the HDPE or PP, causes the flake to sink instead of float. This reduces the amount of material captured for recycling.

Issues with the Markets

Markets and market price for various grades of plastic vary widely. Several factors affect the price. The market and market price fluctuate based on investment in new virgin plastic production, state of the general economy and its impact on import/export of goods, transportation costs, and the price of oil. The plastic scrap market moves through valleys and peaks and is currently in a valley. This is primarily due to an oversupply of virgin plastic. Most markets for recycled plastic use the material because it is a cheaper feedstock than virgin plastic. When the price of virgin drops it becomes less feasible to use recycled content. Fortunately, there are a number of large established markets that continue to use recycled content in the down market, either for ethical reasons or because they are specifically designed to handle that type of material.

Proper collection and consumer education is very important for plastic recycling. Sorting is necessary for plastic to have a value. This is especially true in a down market. One example of proper collection being important is with plastic film and bags. If they enter a curbside bin and run through the MRF, they collect contaminants and become too dirty to recycle. On the other hand, if bags and film returned to a store drop-off point and backhauled to a distribution center, they stay clean enough for selling to companies that make composite lumber.

At times, certain plastic commodities, such as PET and natural HDPE, are of very high value. Fluctuating oil prices have significantly influenced the market value of recycled plastic.

Recovered PET goes into fiber such as carpet, clothing, and fiber fill. Its use in packaging such as bottles and clamshells is rapidly growing. Recycled HDPE makes bottles, pipe, lumber, lawn and garden items, and transport packaging.

LDPE "film" (plastic bags and stretch wrap) and non-bottle rigid plastic (often PP and PE resins),

Operation Green Fence
For over 20 years, the United States has shipped much of its plastic to China for recycling. In 2013, China launched Operation Green Fence, which implemented strict quality standards on imports of recycled material. It restricted the amount of allowable contaminants, raising the bale specs and cause rejected bales. This led to a temporary glut of plastic materials that MRFs were unable to move and forced MRFs to reduce contamination in their bales. This primarily affected bales of mixed plastic resins.

which are not as frequently recycled as bottles and jugs, also have new uses such as crates, carts, buckets, composite lumber, auto parts or new film.

Virgin PET (vPET) competes with cotton in manufacturing. Manufacturers can use either one for textiles. Suppliers purchase either depending on price. The price of one affects the other. As with any material, the price of virgin affects the price of recycled supplies.

The use of Recycled PET (rPET) into thermoform (*see Glossary*) is growing. Disposable cups, containers, lids, trays, blister packs, clamshells, and other products for the food, medical, and general retail industries is made out of thin-gauge thermoform material. Vinyl and polystyrene use to make this type of packaging, but the shift away from those materials towards using PET and rPET feedstock is due to processability, durability, the ability to protect the product and sustainability.

Domestic/Local

Major materials that have established markets in the US include HDPE, PET, Non-bottle Rigid, Film and Expanded Polystyrene (EPS). Based on the 2014 Plastic Recycling Reports by Moore Recycling Associates recovered domestic materials: nearly 1 billion lbs. of HDPE bottles, nearly 1.4 billion lbs. of PET bottles, over 800 million lbs. of Non-bottle Rigid and over 500 million lbs. of Post-consumer Film.

Plastic markets include both manufactures that use recycled content in producing new products and companies that flake or pelletize plastic to sell to manufactures. Plastic bales from the Northwest go to both types of markets.

Export

Most of the exported plastic goes to China, Canada, and Southeast Asia.

The green fence initiative along with developing local collection abroad has made it increasingly difficult to export subpar material. Based on the same reports referenced above the following materials were exported in 2014: over 200 million lbs. of HDPE bottles, over 400 million lbs. of PET bottles, over 450 million lbs. of Non-bottle Rigid and over 640 million lbs. of Post-consumer Film.

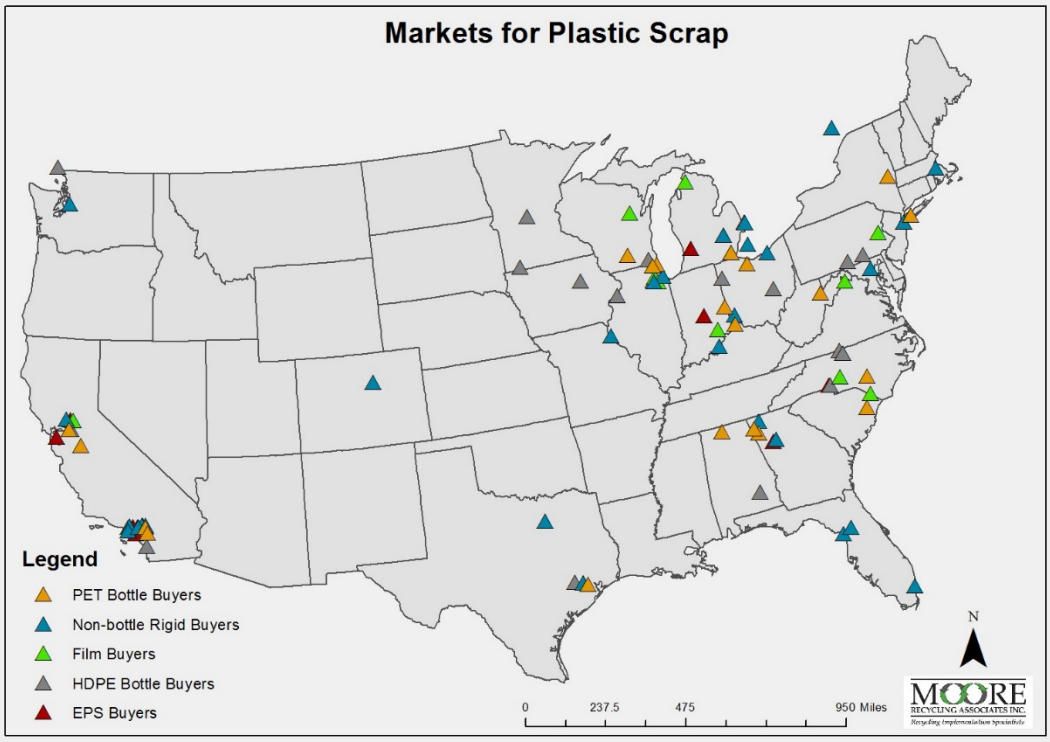
PET and HDPE bottles and jugs have strong, sustainable markets, and the public understands descriptions of these plastics. They generally work well in the commingled system. Flattened PET and HDPE plastics cross-contaminate paper and cardboard, and end up disposed by the large paper mills.

Plastic resins PET, HDPE, and PP have strong export markets. For other types of plastic, there are some markets, but there are high labor costs to get it to a marketable quality. The more refined the plastic sort, the higher value it has and the easier it is to sell.

"MRF film", which is defined as plastic bags and plastic film collected and processed with curbside materials, is very dirty. The "MRF film" relies solely on the export market.

Market Map

The map below highlights the geographic spread of postconsumer plastic buyers in the US. It is important to mention that most, if not all of them, accept material from anywhere in the country as long as the supplier can create a full load (40,000lbs). The full list of domestic plastic scrap buyers is on the market directory www.plasticsmarkets.org.



Changes in the Material Stream

Over the past decade the volume and variety of plastic packaging and products has increased significantly. Due to the light weight and low cost of plastic packaging, many items traditionally packaged in glass or metal containers have shifted to plastic.

There has also been significant light weighting of plastic packaging. Less material and reduction in weight drives plastic packaging design. This means that it now requires more labor to create one bale of plastic.

There is significant increase in the use of flexible packaging. Flexible packaging use will continue to gain market share. The Sustainable Packaging Coalition, PAC Next and others

formed workgroups. These workgroups are working on addressing design issues and end-of-life management options for flexible packaging. Alan Blake with PAC Next demonstrates the implications by explaining that to get the same weight of plastic collected as is contained in 10,000 bottles, one would have to collect 100,000 flexible packages. (A. Blake, personal communication, 2015)

AREAS FOR IMPROVEMENT

Plastic Bags and Film

Plastic bags and film are not compatible with the curbside commingled mix. They entangle in sorting equipment at MRFs and negatively impact the sorting of other commodities. Plastic film wraps around the spinning screens at the MRF, diminishing the screens' ability to sort materials. Several times a day the sorting line shuts down so workers can physically cut the film from the screens.

Communities that currently accept plastic bags should consider removing them from the accepted materials list. They can also de-emphasize bag collection through curbside education programs.

Communities where plastic bags are not accepted should not add them to the accepted list. All programs should encourage residents to use the recycling collection through retail grocery networks. The plastic bag and film recycling collection through retailers already exists and is convenient for residents.

Commercially collected plastic film is generally of high quality and successfully marketed. Increasing film recycling through commercial recycling is beneficial. Communities should direct residents to use drop-off programs. This gets bags into this commercial recycling stream. Additionally, the drop-off programs typically collect a wider range of bags in cleaner, more valuable condition. The retailer drop-off programs also include wrap and films not accepted in any local curbside collection programs.

Nationally, a unified effort to increase plastic film recycling through drop-off programs instead of curbside programs has begun. The many companies involved in plastic bag production through the Flexible Film Recycling Group (FFRG) launched the national movement. FFRG has created many tools to increase film recycling. Plasticfilmrecycling.org provides a zip code search feature to find local drop off locations for plastic bags. The website includes many other tools to move plastic bags for recycling into drop off programs. City of Vancouver collaborates with the Flexible Film Recycling Group's Wrap Recycling Action Program. City of Vancouver has been able to expand bag/film drop-off locations and materials collected through a pilot program. This effort has reduced the amount of bags going into the curbside program. Others to improve drop-off film options can utilize lessons learned.

To reduce the number of plastic bags at MRFs, municipalities could explore plastic bag bans. Before deciding on a course of action, municipals should also consider that most of the film used in households is unaffected by a plastic bag ban. In addition, that a ban could harm the

Figure 3. Two Sided Tip Card and Retail Poster

existing retail drop-off network.

Determining Acceptable Recyclable Plastics

A variety of dynamics and competitive forces result in accepting materials. Items such as lids, black plant pots, and plastic bags have low value, low recovery potential, are of low volume, create harm to the MRF, or reduce the successful recycling of primary recyclables.. Currently there is an assumption that a longer list of recyclables means that more is being recycled however, contamination reduces the total amount recycled.

Recyclable materials to prioritize in the curbside system and in public education programs include those that have these thee characteristics: have viable markets; MRFs have the ability to effectively sort them; and generate revenue

When adding items to the list of acceptable, the following considerations need addressed:

- Costs, benefits, impacts and implications of adding new materials
- Actual costs of removing or adding new materials for the MRF to process
- The availability and strength of a market for the material

Tracking collection changes through additional research is necessary. Some areas to focus on include if collecting a broader list of recyclable

Spotlight on Bulky Rigid Plastic
As market conditions change, MRFs perform upgrades, and may want to explore including bulky rigid plastics to recycling programs. Bulky rigid plastics include items as or larger than a 5-gallon bucket, such as large water bottles, crates, storage bins, baskets, totes and lawn furniture. These plastics do not yet have the depth of markets that PET and HDPE do, but they do have local buyers and are relatively easy to sort in a MRF because of size, so are good candidates for a commingled system.

plastics results in a change for recyclables collected at the curb; increases or decreases in contamination; better recovery of primary recyclables through processing at MRFs; etc.

MRFs should vary rates charged to curbside programs based on the quality and type of materials included in the curbside program. The variance in rates would encourage thoughtful lists of acceptable recyclables and incentivize the collection of clean material.

Explore whether end-user companies using materials that have high processing costs or high facility impacts can help finance the processing of their materials to offset ratepayer costs.

Packaging Design

Selling, protecting, and adding ease to products all factor into a products design. Ignoring recyclability causes unintended consequences. Some examples include:

- Additives to plastic containers hinder the effectiveness of the sink/float sorting method used by secondary processors of plastics. The additives disrupting the sorting method lead to contamination and lowered yield.
- MRFs cannot sort flexible packaging pouches made from multiple layers of plastic and foil. Some examples of flexible packaging are plastic frozen food bags, tuna fish pouches, etc. The flexible packaging products also have no end market. Flexible packaging is displacing recyclable materials (such as plastic, paper, and glass).
- Sleeves on some bottles such as single-serve milk bottles, cause optical sorters to missort the bottle. The optical sorter reads the resin type of the wrap, rather than the bottle.

Encourage dialogue between MRF operators, processors, and packaging and product manufacturers, throughout the product development stage. The end goal of this dialogue is to communicate the sorting and processing limitations at MRFs and processing facilities.

Participate in existing national packaging design efforts (APR, PAC Next, Container Recycling Institute, Sustainable Packaging Coalition, phone book industry, etc.), to share information with packaging designers and manufacturers about our local recycling infrastructure. For instance, APR works with package designers, engineers, and brand companies on product design for recyclability issues. They have developed design guidelines and testing protocols to determine if a new product is recyclable within the existing reclamation system. APR has also created an on-line Problem Contamination Notification form that serves to notify APR of potential issues with a specific container or package. Upon receiving this information, APR works with the container manufacturer to suggest changes to ensure compatibility with the most current recycling technology. http://www.plasticsrecycling.org

Improve Recycling Messaging, Labeling and Terminology

The proliferation of recycling-related labels on today's packaging creates confusion in the marketplace. Recycling messaging and its associated iconography on packaging, such as the

chasing arrows symbol on plastic products, give the erroneous impression that a package can be recycled everywhere.

The Sustainable Packaging Coalition (SPC) provides an online life-cycle assessment (LCA) tailored for packaging design evaluations. The Comparative Packaging Assessment (COMPASS) allows design professionals to access key environmental performance criteria to guide their concept development and material selection. https://www.sustainablepackaging.org

Creation of a new workgroup with an objective is to understand how the Federal Trade Commission calculates "recycling rate" and recyclability claims on packaging. This will provide the region with a better framework for communicating which plastics are recyclable and help to limit the amount of misleading information delivered to the public. The workgroup can determine processes for filing complaints against packaging with false recyclability claims and determine feasibility of filing complaints. The FTC provides an on-line complaint form at https://www.ftccomplaintassistant.gov/#crnt

Labeling Standards

Familiarize the public with the Association of Post Consumer Plastic Recyclers (APR) and the Sustainable Packaging Coalition (SPC) standardized labeling systems. For instance, APR and SPC have worked to develop standardized messaging to emphasize that bottles should be emptied and caps replaced. SPC's How-to-Recycle label system incorporates this message, which provides specific recycling instructions on a package. Local focus groups have shown that some residents believe that information on a package, such as the "chasing arrows" symbol tells them if a package belongs in curbside recycling. The SPC label system attempts to make this belief accurate and the consumer properly informed. A number of companies have adopted and piloted the label system. http://www.how2recycle.info/

Coordinate at a local and national level to support national efforts to remove "chasing arrows" symbol from resin codes on plastics. The arrows symbol confuses the public, and leads to an increase in contamination of the commingled recycling stream. The new ASTM D7611standard for coding plastic manufactured articles for resin identification establishes revised symbols. There needs to be more work to speed up transition to the new symbols. Additionally RCW 70.95F.020 requires plastic containers sold in the state a resin code label that includes arrows in a triangle. There is consideration to whether this requirement needs to be changed.

Plastics Terminology

Standardize the terminology to describe the types of plastics accepted in commingled curbside recycling programs. During the NW Commingled Recycling Group's meetings, it became

apparent that the various participants did not have a common set of terms to describe the many types and forms of plastics under discussion. Similarly, there is variation in the terms used in outreach materials to the public. The Plastics Division of the American Chemistry Council has recognized this as a universal problem and has worked with Moore Recycling Associates to develop a set of web-based resources for recycling professionals (http://www.recycleyourplastics.org/about/). Adoption of the recommended terms for professionals and for outreach materials could alleviate some confusion by various sectors of the recycling profession when communicating with each other, and improve and harmonize public outreach.

Caps on Plastic Bottles

Encourage residents to put caps back onto empty plastic bottles and into the recycling cart together. Caps can make up 6-12% of the weight of a many plastic bottles. Capturing the caps for recycling actually results in a significant increase in plastic available for recycling.

Caps removed from the bottle and not properly disposed create a litter and marine debris problem. Caps removed from the bottles and put separately into the recycling cart will not be recycled. The caps are too small and slip through MRF equipment. Caps become part of the residual, which is disposed.

An additional benefit to replacing the cap on the empty bottle is to help the bottle maintain more of its two dimensional shape. The bottle retaining its shape assists with sorting at the MRF. Compaction of recyclables in the collection truck flattens lightweight water bottles. Flattened bottles cause missorting at the MRF.

According to Moore Recycling, caps on PET bottles are typically PP or PE. Unless loaded with calcium carbonate, they float and separate from the PET, which sinks. There are markets for this material. Caps on HDPE jugs and bottles are typically LDPE or PP. Color sorting of the plastic flake causes separation. The caps go with the colored HDPE material, with no adverse impact. Small amounts of PP, such as pour spouts for laundry bottles, combine with the HDPE.

Observations at local MRFs show that regardless of instructions to do otherwise, many bottles in the recycling stream have caps sealed on top. According to Moore Recycling, about half the bottles collected curbside already have the caps on. Some of these do contain liquids, which creates problems.

Other issues that have been a concern in the past are addressed at the Association of Post Consumer Plastic Recyclers (APR) website: http://www.plasticsrecycling.org/faqs/caps-on-faqs

Waste Management has materials for their Recycle Often, Recycle Right nation-wide campaign. Including messaging to the empty and replace cap messaging for plastic bottles. As well as clarifying that, plastic bags should not go into curbside.
http://recycleoftenrecycleright.com/wp-content/uploads/2014/10/WM-MythBuster.pdf

ITEM	ANSWER	MORE INFO
Plastic bottle caps/lids	Yes. After bottles are empty, plastic caps should be placed back on bottles.	"Until recently the plastics recycling industry was not able to effectively recycle bottles with caps on so the message to remove the cap was created. But recycling collection and processing technology have improved and demand for the recyclable material has increased and this allows for the updated caps-on recycling message and process." Association of Post Consumer Plastic Recyclers: http://www.plasticsrecycling.org/faqs/caps-on-faqs
Plastic bags	No. Do not put loose plastic bags or bagged recyclables into cart – empty recyclables into cart.	Plastic bags are not accepted in most curbside recycling programs (they get tangled in the MRF equipment, breaking or stopping machinery.) (See KAB Sept 15, 2014 campaign). Empty plastic bags should go back to a participating retail outlet or grocery store for recycling. For more information, visit: http://recycleyourplastics.org/Main/Plastic-bags-film.html.olc OR http://www.plasticfilmrecycling.org/s01/s01dropoff.html

Figure 4. Messaging from Waste Management's Recycle Often, Recycle Right Campaign

Compostable and Degradable Plastics

Encourage or require the use of clear and accurate labeling on compostable and degradable plastic packaging. Purchasers and residents will be able to distinguish compostable and degradable packaging, from non-compostable and non-degradable packaging. This effort for clarification would include plastics. There is increasing use of compostable plastics in the region. Some residential and commercial organics programs collect compostable plastics.

Compostable and degradable plastics are prohibitive in plastic bale specs developed by APR. Recommendations from recyclmoreplastics.org include using the following phrase in public outreach: "No products that are compostable". The amended phrase needs to state "No plastic products that are compostable". The amended phrase addresses the fact that paper products maybe composted or recycled if clean.

Generally, degradable plastics refer to standard resins, such as PET or HDPE with degradable additives formulated into the plastic. Often these types of plastics are referred to as degradable, biodegradable, UV-degradable, or oxo-degradable. These degradable plastics are a contaminant to the plastics recycling stream. The degradable plastics are not compatible for recycling with their commercially recyclable counterparts. Such degradable plastics result in the breakdown of the product into smaller plastic particles. The smaller plastic particles are unsuitable for recycling and for composting. They also exacerbate the problem of small pieces of plastic in the environment, which is another concern.

Compostable plastics are those that have met ASTM D6400 Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities. Additionally, these plastics should be third party verified. BPI certifies compostable plastics.

Cedar Grove Compost provides testing for compostability in local facilities for this kind of plastic.

Some compostable plastics such as PLA are technically recyclable if sorted from other plastics. Compostable plastic is incompatible with recycling of commercial recyclable plastic due to the sorting requirement. If a MRF uses optical sorting equipment, PLA will typically end up with mixed plastics. Like other plastic resins, PLA has a unique light wavelength signature that allows it to be detected when using near infrared (NIR) optical sortation. PLA can be sorted out of this stream if the mixed plastics stream is sold to an end-market that does further sorting,

PLA is not in the beverage bottle market in North America. PAC NEXT a Canadian-based organization bringing together the packaging industry and recyclers to work on North American recycling solutions. According to a PAC NEXT report, the use of optical sortation is reducing concerns around contamination of PET recycling by PLA. PAC NEXT further reported that there is less than 0.1% of PLA in any PET bale. Some end-markets exist to recycle this material but are limited. A secondary MRF located in southern California is sorting out PLA for recycling. Markets for recycled PLA continue to develop. As new plastic recycling facilities (PRFs) begin throughout the country, the recycling of PLA will continue to grow.

Not all bio-based plastics are compostable, and some fossil-based plastics are compostable. A fully recyclable PET and HDPE plastic made partially from plants can be recycled with fossil-based plastic. For example, Coca-Cola uses up to 30% plant-based material in its PlantBottle™. The PlantBottle™ is an example of designing for recycling. However, it is not compostable.

Plastic Recycling Facilities (PRF)

Explore the potential for siting a high technology Plastics Recycling Facility (PRF) in the NW Region. A Plastic Recycling Facility separates plastics into more resin categories than a typical MRF. The PRF separates resins using advanced technology rather than low-tech manual sorting. A separate location presorts mixed plastics before they reach a PRF. If the PRF is collocated within or next to a MRF, it is common to sort plastics through a separate plant process, within the MRF.

Mixed recyclable plastics makeup incoming material at the MRF. The mixed recyclable plastics become separated commodity grades through a variety of processes, including near-infrared processing. Processes employed include washing, grinding, pelletizing, and other processing technologies.

PRFs are now operating in six cities within the United States: Atlanta, Baltimore, Los Angeles, Newmanstown PA, New Albany IN, and St. Louis. A PRF located locally in the greater Seattle area could improve the ability to collect and process existing "curbside" and a broader range of plastics.

Oregon DEQ and Metro completed an initial assessment of how to recycle and recover more plastic after its initial use. The report titled "Oregon Plastics Recovery Assessment" is located

online at http://www.deq.state.or.us/lq/sw/PRAproject.htm. The assessment explores PRFs in detail, including economies of scale. It reports that the minimum needed for a small-scale facility to be viable is at least 15,000 tons per year. For a PRF to perform reclamation steps such as washing and pelletizing; the recycling rate required is 50,000 tons per year. For comparison, Department of Ecology reports that in 2013 approximately 77,495 tons of plastics were recycled in Washington State. The 2009 Washington Statewide Waste Characterization Study shows 12.7% of the residential waste stream disposed in Washington State. The 2009 Washington Waste Characterization Study broke the 12.7% down further as plastic packaging (8.7%, 159,779 tons) or plastic products (4%, 73,025 tons).

KEY ISSUES & RECOMMENDATIONS

The Northwest Region Commingled Workgroup identified key issues with the commingled curbside recycling programs. Outlined key issues fall in two separate sections. The first section highlights the issues with specific commodity streams collected via the commingled systems. The second section identifies problems with the commingled recycling system as a whole. Following each issue, the Workgroup has provided recommendations for addressing the issues. Many of the recommendations require further study and work by a broader group of industry experts and policy makers.

Problematic Materials in Commingled* Curbside Systems

A. Plastic bags and film

Plastic bags and film entangle in sorting equipment at MRFs. This negatively affects the sorting of other commodities.

ISSUES:

- Plastic film wraps around the spinning screens at the MRF. When the film wraps around the screen it diminishes the screens' ability to sort materials. The sorting line shuts down several times a day when this happens. Workers physically cut the film from the screens.

RECOMMENDATIONS:

- Remove bags/film from curbside single-stream collection. Promote the taking of these items to participating retailers. Build on national efforts when feasible (i.e. Re-Trac's WRAP; www.plasticfilmrecycling.org).
- Explore bag ban legislation.

B. Plastic caps

Plastic caps are recyclable. Caps end up as residual at the MRF unless put back onto the container.

ISSUES:

- Removed caps that are not disposed can create litter and marine debris problems.
- Caps can make up 6-12% of the weight of a many plastic bottles. Caps are made of plastic resins that are highly recyclable.
- Caps that placed into the recycling bin but not attached to the bottles are lost as residual at the MRFs and disposed of. Caps are being disposed when not placed back onto bottles within the recycling bin.

RECOMMENDATIONS:

- Encourage residents to put caps back onto empty plastic bottles and into the recycling cart together. To ensure correct plastic sorting at MRFs, replace the cap on the empty bottle. The cap allows the bottle to maintain its two dimensional shape.

C. Compostable and degradable plastics

Compostable and degradable plastics are currently not commercially recyclable.

ISSUES:

- Compostable plastics are prohibitive in plastic bale specs developed by APR. However, compostable plastics such as PLA are technically recyclable. NIR optical sorting technology sorts PLA from other plastics. Low volumes in the recycling stream and limited markets are currently inhibiting the recovery of PLA. Low volumes in the recycling stream will likely change over time.

- Degradable plastics are not easily distinguished from commercially recyclable plastics and can contaminate plastics bales.

RECOMMENDATIONS:

- Encourage or require the use of clear and accurate labeling on compostable and degradable plastic packaging. Clear labeling allows purchasers and residents to distinguish compostable and degradable packaging from other plastics.

D. Glass:

Glass in commingled collection bins breaks into fine pieces. Broken glass contaminates other materials, especially paper products, damages equipment, and is a safety hazard for MRF workers.

ISSUES:

- Glass collected in a commingled system results in a loss of ~30% due to breakage into very small pieces (fines).

- Glass fines damage MRF and processor/mill equipment.

- Glass is a safety hazard at MRFs and paper mills

- Glass fines that get into the paper pulp at a mill tear the paper. The torn paper jams the mill machinery. Paper products that contain glass fines are not acceptable to the market.

RECOMMENDATIONS:

- Glass should be collected separately and recycled.

- Communities that do not take glass in their commingled programs should keep it separate.

- Explore alternative methods of collecting glass. Alternative methods include redemption programs, producer financed programs, and partnerships with local glass manufacturers.

- Conduct a study on the feasibility of collecting glass curbside now that commingled systems are in place. Include an analysis of the existing types of systems. Existing systems include commingled systems with "glass in", curbside collection with "glass on the side", or separation from fiber and collection depots.

- Examine the impacts of the secondary glass processing facility, Strategic Materials. The study should consider the roles and relationships between MRFs, secondary processors, and final glass markets at Ardagh Group and Owens-Illinois as . The study should focus on the way these relationships successfully decrease contamination and optimize glass recycling.

E. Shredded paper:

Shredded paper is too small. Machinery at MRF's cannot sort shredded paper. Shredded paper contaminates other commodities and the majority is not recycled.

ISSUES:

- Shredded paper is a processing problem in MRFs because of the small pieces and light weight. Shredded paper is very difficult to separate from other materials. It often spreads throughout the facility.

- Can create a litter problem at point of collection in commingled systems. Problems occur when uncontained shredded paper is included, or if bags containing shredded paper break.

RECOMMENDATIONS:

- Do not collect shredded paper in commingled recycling systems.

- Request customers to tear off and shred only sensitive information. Promote use of shred events that collect and recycle the material in bulk.

F. Food-contaminated paper:

Paper contaminated with food cannot be recycled.

ISSUES:

- Food contaminated paper (such as paper plates, pizza boxes, paper towels etc.) is a common contaminant in commingled systems. Food contaminated paper is NOT accepted/recyclable in any jurisdiction.

RECOMMENDATIONS:

- Do not add food contaminated paper to list of accepted recyclables.

- Do not put food-contaminated papers in the recycling bin.

G. Poly-coated paper (milk cartons, juice boxes, cups, and frozen food boxes):

Poly-coated paper currently cannot easily be positively sorted into their own bale at MRFs. Paper mills are not equipped to process poly-coated paper into mixed paper bales.

ISSUES:

- Poly-coated papers are a low-volume item in comparison to other recyclable materials. They can't be adequately separated into their own paper grade (#52 – aseptic cartons and gable top containers) with the sorting technology currently available at MRFs. Sorting by hand at the MRF is costly.
- The current practice for recycling poly-coated papers is to include them in mixed paper bales. However, Chinese customs view polycoated cartons and aseptic containers as contaminants in mixed paper bales, Even though poly-coated paper is unlisted as a contaminant in ISRI bale specs. Most Chinese paper mills do not sort gabletop containers and aseptic carton out of the mixed paper bale. Gabletop containers and aseptic cartons process improperly. The excluded items become sludge in the pulping process.
- Poly-coated papers in mixed paper bales are problematic at kraft paper mills. The plastic layer separated from the pulp and disposed. Cartons are recyclable if pulped separately from other paper. Pulping poly-coated papers requires using harsher chemicals to break down the wet strength resins and de-poly the fiber. It prevents the kraft mills from obtaining high fiber recovery rates from poly-coated materials. Aseptic containers include an additional layer of aluminum. This causes the same problem as poly-coated paper, and the aluminum ends up discarded.
- The pulping process for cartons requires more energy than is used for uncoated paper.

RECOMMENDATIONS:

- Continue to collect poly-coated paper in commingled systems at this time. Work with a diverse stakeholder group to address these issues. Work of the stakeholder group could include:
    - Engage the Carton Council. Set goals to address issues, provide analysis, and improve collection and sorting, and researching end markets.
    - Explore whether non-carton items, should be handled separately or combined with cartons in specific (Grade #52 poly-coated) bales. Engage manufacturers of these packaging materials and the products that use them in the stakeholder discussions.
    - Determine system costs and per ton costs for various approaches to collecting and processing poly-coated packaging materials. Include collection in commingled curbside programs and focus on attaining high yield during the analysis.
    - Identify funding sources for pilots/system improvements.
- The Workgroup should review their research. Consider removing poly-coated items from lists of materials accepted in the commingled curbside recycling programs. Poly-coated items are not high yield. To ensure enough analysis time a delayed decision after three years from the start of these efforts is prudent.

H. Metal lids:

Loose metal lids, less than 3 inches in diameter, are lost as residual at the MRF. These small loose lids are disposed.

ISSUES:

- Removed metal lids from containers are sharp. The sharp edges can be a safety issue for employees. The sorted lids get into paper because they are flat. Fines catch lids if they are less than 3 inches in diameter.

RECOMMENDATIONS:

- Metal lids from metal containers left attached or crimped inside the can, are recyclable.
- Metal lids separated from the can measuring less than 3 inches in diameter should not be recycled.
- Metal lids from glass jars that are greater than 3 inches in diameter can be recycled. Metal lids removed, rinsed, and added to the cart are recyclable.

I. Aluminum foil, trays, and pans:

Food contamination is a common problem of aluminum non-beverage containers. They are difficult to sort, and have low recoverability at smelters.

ISSUES:

- Aluminum non-beverage containers contaminate aluminum cans according to the main end market for our region. At aluminum smelters, a secondary sort is necessary to separate aluminum cans from non-beverage containers. The secondary sorting allows items like aluminum foil, trays, and pie pans to be recycled successfully. If the non-beverage materials remain unseparated, they end up incinerated in the recycling process. Non-beverage containers melt at a lower temperature than aluminum cans. Because of added processing costs, aluminum foil, trays, and pie pans lower the value of aluminum can bales. Non-beverage containers ultimately, may not be recycled at aluminum smelters.
- Flat foil and trays act like paper in the MRF sorting machinery. They end up as a contaminant in the paper bales.

RECOMMENDATION:

- Do not collect aluminum foil, trays, and pie pans in curbside commingled systems.

COMMINGLED RECYCLING SYSTEM ISSUES

A. Commingled curbside recycling programs accept marginally recyclable materials. Accepted materials may also be disruptive to the regional recycling system.

ISSUES:

A variety of dynamics and competitive forces result in accepting materials (such as lids, black plant pots, buckets with handles, and plastic bags) that are low value. These items typically have a low recovery potential, and are of low volume. They create harm to the MRF by reducing the successful recycling of primary recyclables. They also increase cross contamination of primary recyclables. Currently there is an assumption that a longer list of recyclables means that more is being recycled. In reality, contamination may reduce the total amount recycled.

RECOMMENDATIONS:

- Sorting viable recyclables occurs at MRFs. Prioritizing recyclables with viable markets allow the MRF to generate revenue in the curbside system. Emphasizing primary recyclables in public education outreach programs would benefit MRFs. Non-viable recyclables which do not have viable markets, but are collected in existing contracts, should be de-emphasized in public education outreach programs.
- Careful examination of the costs, benefits, impacts and implications of adding new materials are necessary.
- Before materials are added or removed the actual costs of removing or adding new materials for the MRF to process should be determined.
- MRFs should be encouraged to vary rates charged to curbside programs. The quality and type of materials included in the curbside program would determine rates.
- Additional research on the effects of a longer list of recyclables is required. Areas to review are if longer lists encourage increased recycling of primary recyclables, lead to increased contamination, result in higher or lower recovery of primary recyclables through processing at MRFs, etc.
- Explore how manufacturers can help finance the processing of materials to offset ratepayer costs. Particularly obtaining financing from companies who use materials that have high processing costs or high facility impacts.

B. Commingled curbside recycling programs vary across the NW region. The variance leads to confusion by the public about what can be recycled.

ISSUES:

Residents are confused about what can be put in the commingled recycling bin. This is due in part to the lack of standardization between programs in the NW region. What is acceptable in one city may not be in the neighboring community.

RECOMMENDATIONS:

- Create a workgroup of jurisdictions within the NW Region. The workgroup would develop a standardized list of recyclable materials for commingled curbside recycling programs. Create a set of criteria to determine which materials should be included, such as:
    - materials that are already universally accepted in NW Region commingled programs
    - materials that can be effectively sorted at the MRF with high yield and minimal cross contamination
    - materials that have viable end markets and
    - materials that generate revenue.
- Develop a plan to communicate this approach to the local government officials in the NW Region.
- Create language for use in RFPs for recycling service contracts (See Toolkit below in System Issues C). The language would standardize the types of recyclable materials accepted by curbside recycling programs.
- Create an organized education program and content about acceptable materials. Include in this messaging the planning methods for recycling to share with all communities. Ensure that the practices are consistent with national efforts such as How2Recycle and Plastic Recycling Outreach Terms.

C. There is a lack of assurance that materials collected in curbside programs occurs at high recovery rates and high value at MRFs. Information about the fate of recyclable materials from curbside collection programs is lacking.

ISSUES:

Local governments are in charge of guaranteeing that recyclable materials collected at the curbside get returned to commerce. Information is lacking about the sorting and sales of recyclable materials as commodities. There is a need for information about recyclable materials that are disposed. The difference between recyclable materials that end up as commodities or recyclables that are disposed is the type of recyclable. Local governments need access to this information and the ability to certify recycling system performance.

RECOMMENDATIONS:

- Create a Toolkit for cities to use to create RFPs for recycling service contracts. The Toolkit would include ways to:
    - Assess the performance of the MRFs. Examples would be seeing the bale breaks to level the level of contamination;
    - Get waste characterization information on the makeup of leftover materials after recyclables have been removed;
    - Gather information from reclaimers/processors receiving the baled materials to find out the condition of bales. This would also allow cities to track practical end markets;
    - Confirm that the materials that are accepted in the curbside program are being recycled;
    - Require set commodity bale specifications be met.
- Consider creating regional or statewide MRF operation guidelines.
- Create verifiable transparency throughout the recycling system (i.e. a chain of custody from cart to new product).
- Make the calculation of the state recycling rate better by:
    - Gathering better information about the amount of unused material at MRFs.
    - Gathering information about levels of contamination. Include downstream recycling to improve calculation and the details of the state recycling rate.

D. Designs for packaging and products lack consideration of recyclability.

ISSUES:

Selling, protecting, and adding ease to products drives packaging design. Ignoring recyclability is a large problem. Some examples include:

- Additions such as calcium carbonate to plastic container: The additional chemicals stop the success of the sink/float sorting method for plastics. This causes contamination and a lowered yield of recovered material.
- MRFs cannot sort flexible packaging pouches made from multiple layers of plastic and foil. Some examples of this type of packaging include plastic frozen food bags, tuna fish pouches, etc. Flexible packaging recyclables have no end market. Although flexible packaging weighs less and uses fewer shipping items than other packaging, it is displacing more recyclable materials such as plastic, paper, and glass.

- Sleeves on some bottles (such as single-serve milk bottles) cause optical sorters to missort the bottle. The optical sorter reads the resin type of the wrap, rather than the bottle.
- Hybrid packaging materials, such as the below examples, are not recyclable. The hybrid packaging cannot be taken apart, even if the separate pieces are recyclable:
    - Paper wine bottle with plastic sleeve inside
    - Soup containers with foam, metal, plastic in one.
- Phone books, junk mail, and greeting cards with items such as magnets and plastic credit cards inserted into them contaminate the recycling stream.

RECOMMENDATIONS:

- Encourage dialogue between MRF operators, processors, packaging, and product manufacturers at the product development stage. This allows MRF operators to discuss the sorting and processing limits at processing facilities.
- Take part in existing national packaging design efforts (PAC Next, Container Recycling Institute, Sustainable Packaging Coalition, phone book industry, etc.). Share information with packaging designers and manufacturers about our local recycling system.
- Explore additional options such as:
    - Banning non-fiber items from phone books and junk mail.
    - Attaching a fee to products containing problematic components (i.e. disruptor fee).
    - Getting funding from manufacturers/packaging producers for alternative recycling systems. The funding would address packaging that is not compatible with current curbside/MRF systems.

E. Messaging, terms and symbols on packaging can create confusion. Messaging should improve recycling.

ISSUES:

The recycling labels on today's packaging creates confusion in the marketplace. Recycling messaging and its symbols can make people believe that a package can be recycled everywhere. Workgroup members, decision makers and the public do not have common terms to discuss types of plastic.

RECOMMENDATION:

- Decision makers should understand how the Federal Trade Commission calculates "recycling rate" and recyclability claims on packaging.
- Work with the Sustainable Packaging Coalition's How2Recycle Label Program to

- Reduce confusion by creating a clear, well understood, and industry wide label. The label would enable industry to convey to consumers how to recycle a package after its use.
- Assess what types of packaging can be readily recycled. This will protect consumers against false claims of recyclability
- Provide reasons for industry to take part in a pre-competitive labeling effort that follows FTC Green Guides.
- Work together with and support national efforts to remove "chasing arrows" symbol from resin code on plastics.
- Decide processes for filing complaints against packaging with false recycling information listed. Determine the feasibility of filing complaints.
- Use the same words and messages to describe the types of plastics accepted in commingled curbside recycling programs.
- Adopt the suggested terms from the Plastics Division of the American Chemistry Council for professionals. Include these suggested terms into outreach materials.

F. The mix of plastic resins and containers is becoming more complex. Explore possible options for siting Regional Plastics Recycling Facility (PRF).

ISSUES:

According to the Department of Ecology, in 2013 approximately 77,495 tons of various plastics were recycled in Washington State. In addition, per the 2009 Washington Statewide Waste Characterization Study, 12.7% of the residential waste stream was made of plastic. The plastic totals from the 2009 study were broken into two categories: plastic packaging (8.7%, 159,779 tons) and plastic products (4%, 73,025 tons).

The 2009 plastic disposal rate shows that Washington State would be able to support a Plastic Recycling Facility (PRF). A PRF is a small-scale sorting, washing and pelletizing facility. It would need 15,000 tons per year of plastic and could reach a midsize operation with 50000 tons per year. The needed tonnage information is according to the Oregon DEQ and Metro report, "Oregon Plastics Recovery Assessment".

Currently, sorted plastics fall into only two resin types, HDPE and PET at NW Region MRFs. The remaining plastic types go into mixed plastics bales. A Plastic Recycling Facility (PRF) would sort the plastics into more resin categories. PRF uses advanced technology rather than with just several optical sorters supplemented with low-tech manual sorting. Plastics sorted into additional resin types could get higher market value then being included as bales of mixed plastics.

RECOMMENDATION:

Explore the potential for funding and siting a PRF in the Northwest region. A PRF located in the greater Seattle area would be preferable. This siting could improve the ability to collect and process existing "curbside" plastics. It would also allow for plastics from a broader range of sources than only "curbside".

*NOTE: *Curbside sorted programs (such as Whatcom County) collect materials in separate bins and are not subject to the above problems/limitations, or recommendations.*

CITED RESOURCES

Adams, J. (2013, September). Nucor Steel Seattle [Powerpoint Slides]. Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWMetal1.pdf

Alcoa, (2013, September 12). UBC Product Quality Specifications AR-001 Rev 09. Retrieved from https://www.alcoa.com/rigid_packaging/en/pdf/UBC_Product_Quality_Specifications.pdf

American Chemisty Council. (2016, April 25). *Find a Drop off Location*. Retrieved from American Chemisty Council: http://www.plasticfilmrecycling.org/s01/s01dropoff.html

Association of Plastic Recyclers. (2015, October 27). Keep Your Caps On! A 2015 Update Webinar. Retrieved from APR: http://www.plasticsrecycling.org/education/web-seminars

Association of Plastic Recyclers. (2015, September 15). Resources to Support Domestic Plastic Recycling Markets Webinar. Retrieved from APR: http://www.plasticsrecycling.org/education/web-seminars

Association of Plastic Recyclers. (2016, April 25). Caps On Frequently Asked Questions. Retrieved from APR: http://www.plasticsrecycling.org/education/faqs/caps-on

Association of Plastic Recyclers. (2016, April 25). Problem Container Notification Form. Retrieved from APR: http://www.plasticsrecycling.org/component/rsform/form/3-problem-container-notification-form?Itemid=337

Association of Plastic Recyclers. (2016, April 25). The APR Design Guide for Plastics Recyclability. Retrieved from APR: http://www.plasticsrecycling.org/apr-design-guide/apr-design-guide-home

Association of Plastic Recyclers. (2016, July 1). APR Position Statement Degradable Additives Use in Bottles, Forms, and Films. http://www.plasticsrecycling.org/images/pdf/resources/Position_Statements/APR_Position_Degradable_Additives.pdf

ASTM. (2016, April 25). ASTM D7611 Standard Practice for Coding Plastic Manufactured Articles for Resin Identification. Retrieved from ASTM: http://www.astm.org/COMMIT/d7611.pdf

BPI. (2016, April 25). BPI. Retrieved from Confused by the terms Biodegradable & Biobased: http://www.bpiworld.org/Resources/Documents/Confused%20by%20the%20terms%20Biodegradable%20Jan%2015.pdf

City of Vancouver. (2016, April 25). Reducing, Reusing and Recycling Plastic Bags and Wrap. Retrieved from City of Vancouver:

http://www.cityofvancouver.us/publicworks/page/reducing-reusing-and-recycling-plastic-bags-and-wrap

Cleiland, J. (2013) Kapstone Container Corporation [Powerpoint Slides]. Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWFiber1.pdf

Coca-Cola Company. (2016, April 25). Coca-Cola Company. Retrieved from Plantbottle: http://www.coca-colacompany.com/plantbottle-technology/

Federal Trade Commission. (2016, April 25). Guides for the Use of Environmental Marketing Claims ("Environmental Guides" or "Green Guides"). Retrieved from FTC: https://www.ftc.gov/enforcement/rules/rulemaking-regulatory-reform-proceedings/guides-use-environmental-marketing-claims

Flight, K. (2013) Verallia: Saint-Gobain Containers [Powerpoint Slides]. Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWGlass1.pdf

Franklin Associates. (2011). Life Cycle Inventory of 100% Postconsumer HDPE and PET Recycled Resin from Postconsumer Containers and Packaging. Prairie Village. Retrieved April 25, 2016, from https://plastics.americanchemistry.com/Education-Resources/Publications/Life-Cycle-Inventory-of-Postconsumer-HDPE-and-PET-Recycled-Resin.pdf

Glass Packaging Institute, (2015, December 21). Why Recycle Glass? Retrieved from http://www.gpi.org/recycling/why-recycle-glass.

Hinson, D. (2013) Strategic Materials [Powerpoint Slides]. Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWGlass2.pdf

Institute of Scrap Recycling Industries, Inc. (ISRI). (2015). *Scrap Specifications Circular 2015*. Retrieved from www.isri.org/specs

Jackson, S. (2015, July 16). WRAP: Best Practices for Boosting Plastic Film Recycling in Your Community [Powerpoint Slides]. Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWMetal1.pdf

McKee, A. (2013) Novelis Aluminum [Powerpoint Slides]. Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWMetal2.pdf

Association of Postconsumer Plastic Recyclers and Moore Recycling Associates. (2016, April 25) Sort for Value Calculator. Retrieved from http://www.recyclemoreplastic.org/sortforvalue

Moore Recycling Associates. (2014). 2012 National Postconsumer Non-Bottle Rigid Plastic Recycling Report. Sonoma. Retrieved from: https://plastics.americanchemistry.com/Education-Resources/Publications/2012-National-Report-on-Post-Consumer-Non-Bottle-Rigid-Plastic-Recycling.pdf

Moore Recycling Associates. (2016, April 25). Plastics Recycling Terms & Tools. Retrieved from Recycle More Plastic: http://www.recyclemoreplastic.org/termsandtools

Moore Recycling Associates. (2016, April 25). Recycled Plastic Commodity Terms and APR Model Specifications. Retrieved from Recycle More Plastic: https://www.recyclemoreplastic.org/commodityterms

Moore, P. (2013) Plastics Recycling and MRFs – WA Commingled Project [Powerpoint Slides]. Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWPlastics1.pdf and http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWPlastics2.pdf

PAC NEXT, (2016, March). Top 15 Packaging Challenges (+ Recommendations) for Recycling in a Material Recovery Facility.

Personal communication from D. Allaway, Oregon Department of Environmental Quality, 2009, based on data from US EPA and Franklin Associates.

Personal communications from D. Allaway, Oregon Department of Environmental Quality, August 12, 2015

Personal communication from A. Blake, Executive Director, PAC Next, 2015

Personal communication from T. Buwalda, Senior Consultant, Reclay StewardEdge, 2015

Personal communication from S. Choi, America Chung Nam, 2013

Personal communication from J. Epstein and J. Frey, Carton Council, 2016, based on data from market research conducted by Carton Council

Personal communication from L. Getubig, EHS Manager, Ardagh Glass Inc., April 6, 2016

Personal communication from A. Hart, Revenue Share Administrator, Republic Services, October 22, 2015

Personal communication from P. Jablonski, Environmental Manager, Nucor Steel Seattle, 2016

Personal communication from J. Kohlstedt, Education and Outreach Coordinator, Waste Management, September 3, 2015

Personal communication from B. Kovich, Paper Broker, Jordan Trading, 2016

Personal communication from A. McKee, Sustainability Specialist, Novelis Aluminum, 2016

Personal communication from C. Quinto, Plant Manager, Strategic Materials August 24, 2015, December 4, 2015 and March 23, 2016

Personal communication from K. Reimer, Sustainability Specialist, Amcor Rigid Plastics North America, 2015

Personal communication from J. Simmons, NORPAC, February 29, 2016.

Personal communication from J. Standish, Technical Director, Association of Postconsumer Plastic Recyclers, 2015

Personal communication from D. Weston, Washington Department of Ecology, 2015, based on U. S. Environmental Protection Agency WARM model estimates

Plastics Industry Trade Association. (2016, April 25). SPI Resin Identification Code – Guide to Correct Use. Retrieved from SPI: http://www.plasticsindustry.org/AboutPlastics/content.cfm?ItemNumber=823&navItemNumber=2144

Plastics Industry Trade Association. (2016, April 25). SPI Resin Identification Code – Guide to Correct Use. Retrieved from SPI: http://www.plasticsindustry.org/AboutPlastics/content.cfm?ItemNumber=823&navItemNumber=2144

Presentation by Peter Spendelow, Oregon Department of Environmental Quality, 2009

Powell, J. (2013) Operation Green Fence is Deeply Affecting Export Markets. Retrieved from http://resource-recycling.com/node/3679

Randell, T. (2015) Plastics Recycling Doesn't Need to Be So Confusing EPA Sustainable Materials Management Web Academy Webinar, [Powerpoint Slides]. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/tonya_randell_epa_smm_web_academy.pdf

Reclay StewardEdge with Cascadia Consulting Group. (2015, January). Oregon Plastics Recovery Assessment Project. Retrieved from Oregon Department of Environmental Quality: http://www.deq.state.or.us/lq/sw/docs/ORplasticRecovery.pdf

Reclay StewardEdge, Resource Recycling Systems and Moore Recycling Associates. (2013, February). Analysis of Flexible Film Plastics Packaging Diversion Systems. Retrieved from Continuous Improvement Fund: http://cif.wdo.ca/projects/documents/714-Flexible_Film_Report.pdf

Spendelow, P. and Allaway, D. (2009) Oregon Department of Environmental Quality [Powerpoint Slides]. Retrieved at http://www.ecy.wa.gov/programs/swfa/commingled/pdf/GSLifeCycleAnalysis.pdf

Strategic Materials (2015). Fiberglass. Retrieved from http://www.strategicmaterials.com/fiberglass/

Sustainable Packaging Coalition. (2016, April 25). How2Recycle Label System. Retrieved from How2Recycle: http://www.how2recycle.info/

Tolan, Ed (2013). Nippon Paper Industries [Powerpoint Slides] Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/pdf/NWFiber2.pdf

United States Environmental Protection Agency, (2015, March). Waste Reduction Model (WARM). Retrieved from https://www3.epa.gov/warm/index.html

Washington State Department of Ecology (2009). 2009 Washington Statewide Waste Characterization Study, Retrieved from https://fortress.wa.gov/ecy/publications/documents/1007023.pdf

Washington State Department of Ecology (2010). Beyond the Curb - Tracking the Commingled Residential Recyclables from Southwest WA. Retrieved from http://www.ecy.wa.gov/programs/swfa/commingled/results.html

Washington State Department of Ecology (2014). Solid Waste in Washington State Twenty-Third Annual Status Report. Retrieved from https://fortress.wa.gov/ecy/publications/documents/1407035.pdf

Washington State Department of Transportation (2014, amended 2015, August 3). Standard Specifications for Road, Bridge and Municipal Construction. Retrieved from http://www.wsdot.wa.gov/Business/Construction/SpecificationsAmendmentsGSPs.htm

Washington State Legislature. (2016, April 25). Washington State Legislature, RCW 70.95F.020 Labeling Requirements – Plastic industry standards. Retrieved from Washington State Legislature: http://apps.leg.wa.gov/RCW/default.aspx?cite=70.95F.020

Waste Management. (2016, April). Recycle Often. Recycle Right. Retrieved from Recycle Often. Recycle Right: http://recycleoftenrecycleright.com/about/

Why Recycle Glass? (2015, December 21). Retrieved from http://www.gpi.org/recycling/why-recycle-glass

Worrell, Ernst et al. (2008). *Energy Efficiency Improvement and Cost Savings Opportunities for the Glass Industry: An Energy Star Guide for Plant Managers, Environmental Energy Technologies Division*, (LBNL-57335-Revision). Berkeley, CA: Ernest Orlando Lawrence Berkeley National Laboratory. Retrieved from http://www.energystar.gov/ia/business/industry/Glass-Guide.pdf

GLOSSARY

APR: – The Association of Postconsumer Plastics Recyclers is a national trade association. APR represents companies who collect, reprocess and sell the output of more than 90 percent of the post-consumer plastic processing capacity in North America Founded in 1992, its membership is made of companies in North America and includes independent recycling companies of all sizes. The companies represented process many difference kinds of plastic resins. www.plasticsrecycling.org

Aggregate – Coarse particulate material used in construction, including crushed stone, sand, gravel, slag, recycled concrete, etc. Aggregate is a common construction material for the making of concrete, mortar, grout, asphaltic concrete, and roofing shingles. Leaching fields, drainage systems, roof ballast, landscaping, and as a base for pavement and grade slabs require aggregate.

Boxboard – Thin, lightweight paperboard used in making packaging boxes or cartons such as for cereals or shoes. Boxboard is often confused with cardboard because of its shared usage and similar general form. Besides not having the wavy middle layer, boxboard is usually grayish in color when you tear it and look at the inner layer.

Brightness Impact – Something that affects the intensity of the paper when measured under a specially calibrated blue light. Not necessarily related to color or whiteness, brightness tracking isin percentage.

Bulky Rigid Plastic: A term used to describe bulky plastic-based items. This term includes things such as: Carts – (Such as curbside roll carts); Crates (Such as milk crates); Curbside recycling bins; Laundry baskets; Lawn furniture; 5-gallon buckets

Cardboard – see **Old Corrugated Containers (OCC).**

Carrier Stock – Made of printed or unprinted, unbleached new beverage carrier sheets and cuttings. May contain wet strength properties. Examples include beer bottle 6-packs and soda 12-pack cartons.

Chipboard – see **Boxboard**

Commingled Recycling – Mixing recyclable materials for the goal of simple collection. Commingled recycling collection systems usually have a wheeled cart with a lid that ranges from 32-90 gallons in size.

Commingled System –The commingled system is defined as places or people, which are involved in the process of residential commingled recycling programs. The commingled system includes the house, curb, MRF, and mill. The people involved with the commingled system include residents, recycling program managers, policy makers, haulers, processors, brokers, and manufactures.

Compostable – A product which, under certain environmental conditions, is broken down in the presence of microbes, to create water, biomass, and carbon dioxide at a defined rate. Compostable plastic and coated paper food service packaging must meet ASTM D6400 or ASTM D6868.

Containerboard – The term includes both the linerboard and corrugating medium, the two types of paper that make up corrugated containers.

Cullet – Whole, crushed or broken scrap soda-lime-silica container glass.

Degradable – In this document, this term references a variety of claims regarding decomposition. Included in this paper are "degradable", "oxo-degradable", "UV-degradable", and others.

Drum-pulper – A horizontal tube where wastepaper, water and deinking chemicals come together to begin separation of ink from fiber. A drum-pulper creates a mix of fibers, water, and ink.

Dual-stream – One type of a commingled collection system in which recyclable materials are split between two bins (or carts). An example would be all materials except glass in one cart, and glass in a bin next to the cart.

Eddy Current – Eddy current separation is used to remove aluminum from various ferrous and non-ferrous metals or waste products. The effect is to create a magnetic field around the non-ferrous material. This field reacts with the magnetic field of the rotor, resulting in a combined driving and repelling force, which literally ejects the conducting material from the stream of mixed materials. This repulsion force in combination with the conveyer belt speed and vibration provides the means for an effective separation.

End User – A company that first uses recycled material to make a product. The product of an end-user may be further converted into further value-added products An example would be a sheet of boxboard from a paper mill becoming a box.

Fines – With respect to commingled MRFs, anything smaller than 2 inches.

Flexible Packaging – Any package or any part of a package with an easily changed shape. Examples include bags, envelopes, pouches, sachets, wraps, etc. Items that are made of easily yielding materials would also be flexible packaging. Such as film, foil, or paper sheeting, which when filled and sealed, becomes a pliable shape.

Hogged – Paper that has been mechanically torn or ripped to reduce its original size.

ISRI – Institute of Scrap Recycling Industries is a private, non-profit trade association. The ISRI works on behalf of recycling companies that deal with scrap goods. In 1989, ISRI combined all of the scrap trade specifications created by the previous associations. ISRI published them in one book for the first time in the scrap industry's history. The Scrap Specifications Circular provides guidelines for buying and selling a variety of processed scrap commodities include ferrous, nonferrous, paper, plastics, electronics, rubber, and glass. The Scrap Specifications Circular has

been through many changes since it began. New editions have been published whenever new specs are added or old specs are deleted or modified.

Kraft Paper — A sturdy brown paper with a high-pulp makeup. Kraft paper is made into wrapping paper, grocery bags, and some varieties of envelopes. Kraft paper is a generic description for fibers made using the kraft pulping technology. These fibers can be either unbleached or bleached.

Most fibers used in manufacturing office paper for printers, copiers, and commercial printing generate from the kraft pulping process. After the pulping process, makers use various bleaching technologies. The bleaching allows them to reach the higher brightness fibers required by these high grades.

Light-weighting – Redesigning a product, such as a glass container, to use less material and lower its weight.

Linerboard – Outside layers of a combination board used to manufacture corrugated shipping containers.

Materials Recovery Facility (MRF) – Pronounced "merf". A facility that accepts, sorts, processes, and bales different types of recyclables for sale to an end-user. For the purposes of this report, a MRF refers to facilities that sort residential commingled recyclables.

Mixed Waste Paper (MWP) – Mixed paperboard, magazines, and catalogs. Mills use mixed paper to make paperboard and tissue, as a secondary fiber in the production of new paper, or as a raw material in a non-paper product such as gypsum wallboard, chipboard, roofing felt, cellulose insulation, and molded pulp products such as egg cartons. Typically not used for molded pulp products due to the contamination level and risk of damage to food. Also used for production of medium used in corrugated containers.

Negative Sort – In a MRF, a negative sort occurs when a known material remains on a conveyor line for collection at the end of the line. The line removes contaminants and other materials. Opposite of "Positive Sort"

Old Corrugated Containers (OCC) – Contains a wavy middle layer. Mills use old corrugated containers to make new recycled-content shipping boxes. (AKA - corrugated containers, cardboard)

Old Newspapers (ONP) – Mills primarily use old newspapers to make new recycled-content newsprint. Old newspapers also become recycled paperboard and tissue. This grade transforms into in cellulose insulation, and molded food products. It is also a fiber source in medium production for corrugated containers.

Outthrow – Materials of like type (paper at a paper mill) that create quality issues or are not useable to make the final product. Examples: aluminum foil is an outthrow for an aluminum beverage container bale. OCC is an outthrow for a newsprint manufacturer.

Paperboard – Denotes paper products used for packaging (corrugated boxes, folding cartons, set-up boxes, etc.).

Plastic Reclamation Facility or Plastic Recycling Facility (PRF) – Pronounced "perf." A plant designed for sorting plastics coming from separated waste collection. The PRF divides the plastics into classes of polymer, density and color.

PET – Polyethylene terephthalate. Also abbreviated as PETE. Its resin identification code is 1.

Plastic Film – A thin flexible sheet of plastic, which does not hold a particular shape when unsupported. Plastic film is made in a thin flat continuous manner. The uses for plastic film include shopping bags, pallet shrink-wrap, food packaging, transparency film, and protective overlay material.

Polycoated – A type of fiber packaging that contains an outer layer of plastic coating to protect the fiber from breaking down in wet and freezing conditions.

Positive Sort – In a MRF, a positive sort occurs when a person or machine physically pulls out and collects an identified material from the rest of the material.

Prohibitve – Materials of dissimilar types (plastic at a paper mill) that cannot process together into a final product. Prohibitives include material types that are similar (paper at a paper mill) but either damage equipment or is completely unusable as a feedstock source for that mill. Examples: Glass for aluminum container manufacture; ceramics for glass manufacture, glass or any non-fiber for paper manufacture; and milk cartons for a non-tissue paper mill.

Pulp Substitutes – A high-grade paper, pulp substitutes are often shavings and clippings from modifying operations at paper mills and print shops. Mills can use pulp substitutes in place of new materials to make high-grade paper products. Pulp substitute grades typically have zero printing or glues, thus allowing it to be re-pulped and used directly back into paper machines.

Pulper– A generic term to describe technology used to convert dried paper into a liquid solution. Pulpers use a vessel where mechanical energy creates the altering process.

Rigid Plastic Container – A package (formed or molded container) which maintains its shape when empty and unsupported.

Shredded Paper – Although not a separate grade of paper, shredded paper can be recycled (usually as a mixed grade) as long as the paper is a correct size and does not contain too large a level of contaminants, such as plastics, or outthrows. Outthrows include such manila folders, gold bond paper, or other dyed papers.

Single-stream – One type of a commingled collection system where recyclable materials go into one cart at the curb.

Stickies – Classified as any glue or ink based materials that are used in making that when recycled turn into tiny tacky particles. Typical sources of stickies are envelope glues, stamps, magazine/paperback bookbindings, credit card promotional mailings, etc.

Test Liner – Liners, which are the outer ply of any kind of paperboard, containing 100% recycled material.

Thermoforming – A manufacturing process where a heated plastic sheet reaches a pliable forming temperature, forms to a specific shape in a mold, and becomes a usable product after trimming.

UBCs – Used beverage containers.

Wet Strength – Paper treated with a moisture resistant chemical. The chemical gives the paper the ability to maintain a percentage of its strength when it has been soaked with water. It has traits that are immune to breaking and dissolving when wet. See **Polycoated.**

Yield Loss – Loss of material made through the changing of one form of material into the form required by the customer.

Appendix A
Methodology

The Northwest Region Workgroup (NRW) addressed seven general material categories collected in the curbside residential commingled recycling programs. The counties assessed included Island, King, Kitsap, San Juan, Skagit, and Snohomish. As a comparison, the study included Whatcom County, which has a three-bin system. The seven categories were: cardboard (OCC), glass containers, metal, mixed waste paper (MWP), newspaper (ONP), plastic containers, and odd materials (batteries, textiles, etc.).

For the purposes this work, 'the commingled system' includes the physical entities (house, curb, MRF, and mill); and the people (including residents, recycling program managers, policy makers, haulers, processors, brokers, and manufactures) which contribute in the inputs or outputs of the residential commingled recycling programs.

The NRW began the process by developing a shared understanding of the similarities and differences of the commingled collection programs. The NRW identified which processors were receiving material flow from each jurisdiction (Appendix C).

The group held meetings once a month for half-day sessions. They focused on one material type at a time, for all materials. During each meeting, stakeholders shared their perspective on the issues they face with each material. Guests representing end-users presented information in order to obtain data on the final use of each material. Additional information gathering occurred on field trips and site visits to materials processors and MRFs. The group tracked materials and obtained data in a consistent and fair manner by using an identical set of questions for each material.

Due to the scope of the project, the workgroup agreed to rely on existing data when available and on anecdotal information. Using both allowed the workgroup to understand the 'story' of each material as it made its way from the curb, to the MRF(s), and eventually to its final end-use.

Methodology for Northwest Region Residential Recyclable Materials List

In addition to data gathering data for the report, the group developed a spreadsheet. The spreadsheet captured every item recycled in the collection systems for 100 regional jurisdictions (see Appendix B). These jurisdictions represented cities, towns, and unincorporated areas in counties.

Each jurisdiction reviewed the publicly available print and website materials.

Discussion Questions for Each Material Category

For Local Governments and Collectors

- What messaging do you have for preparing recyclable material to go into the bin?
- Do you have other special/extra messaging?
- Does all material collection happen in the same way?
- Does it provide revenue for your program; is it at cost or an expense?
- What percent of each type of material make up your total amount of materials collected in your program?

For Processors

- [This commodity] makes up what percent of the total incoming materials?
- What is the quality of incoming materials?
- Are there any problems in processing this material?
- What are areas that need improvement from a MRF perspective?
- What is the percent of residual materials?
- How do you rate the market: Strong, medium, weak for local and export?
- Is this a high value commodity?
- Is [this commodity] easy to move?

For Manufacturers/End Users

- What are the "prohibitives"?
- What are the "outhrows"?
- What is the yield loss?
- What is the capacity to process this material?
- Are there any problems with your equipment?
- What is the value in using recycled feedstock vs. virgin feedstock?
- What are the final products for this material?

Appendix B

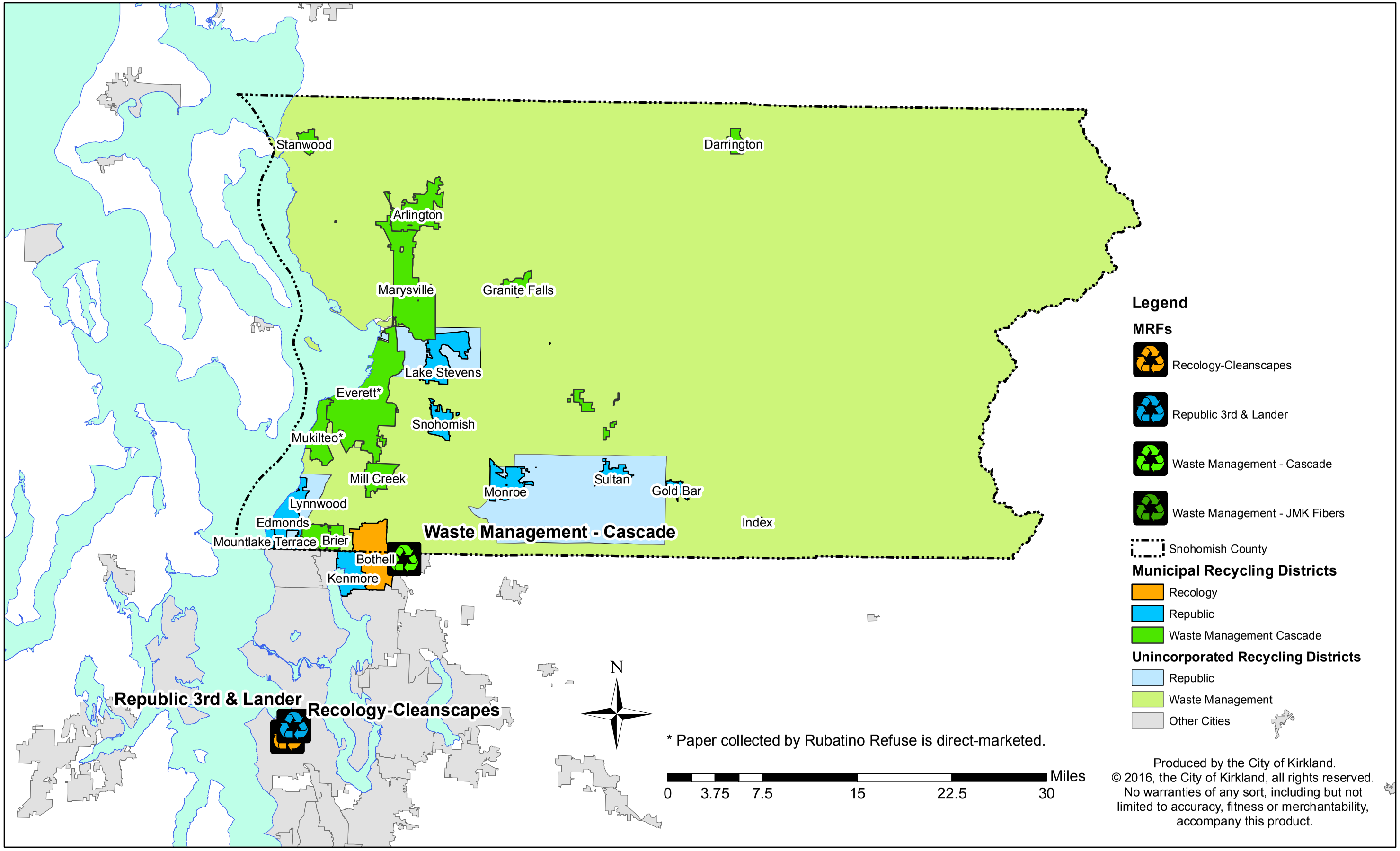
NW Region Residential Curbside Recycle Material List

Appendix B. NW Region Residential Curbside Recycle Material List is available on request.

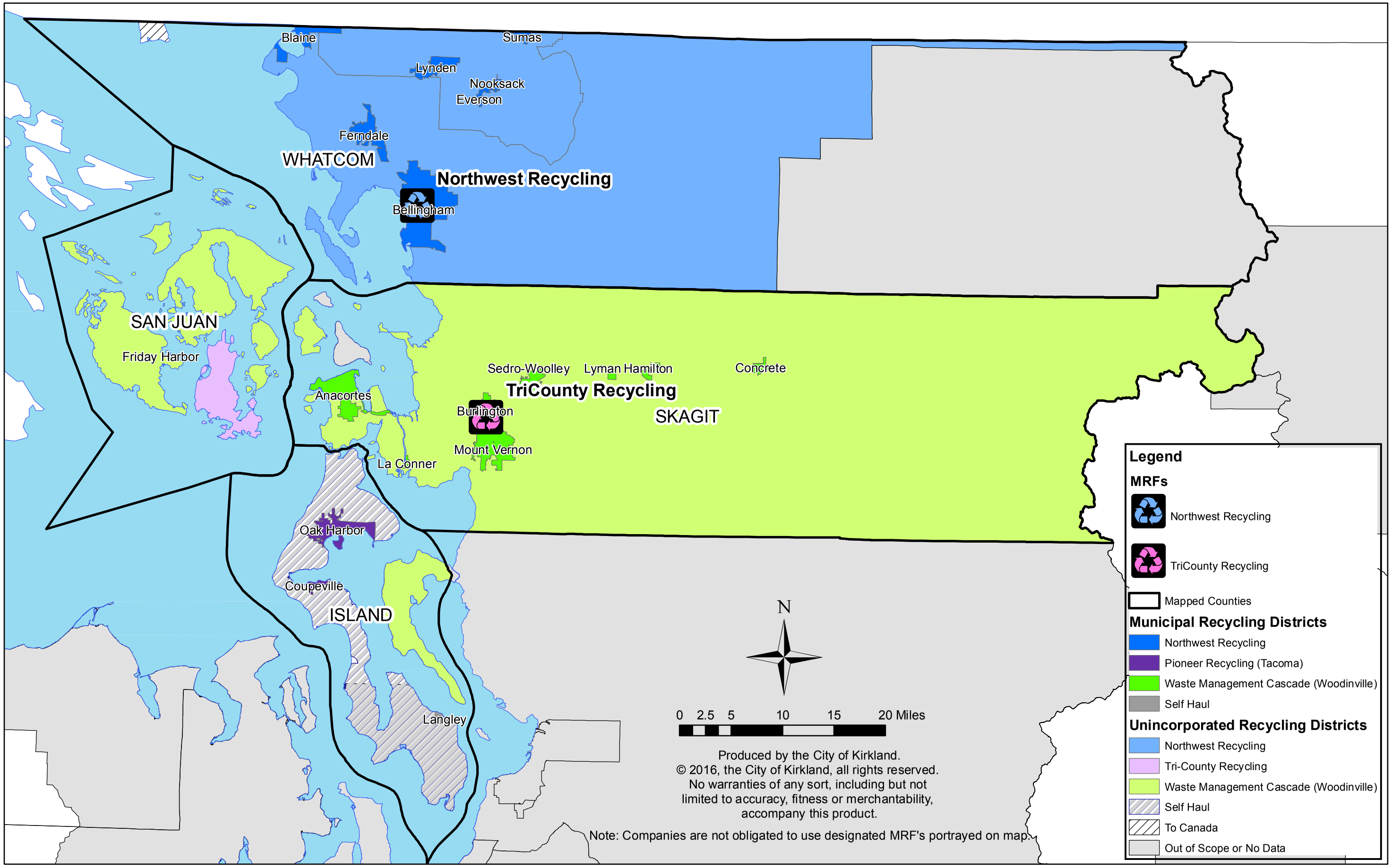
Please contact:

Waste 2 Resources Publication Coordinator
W2Rpublications@ecy.wa.gov
360-407-6900

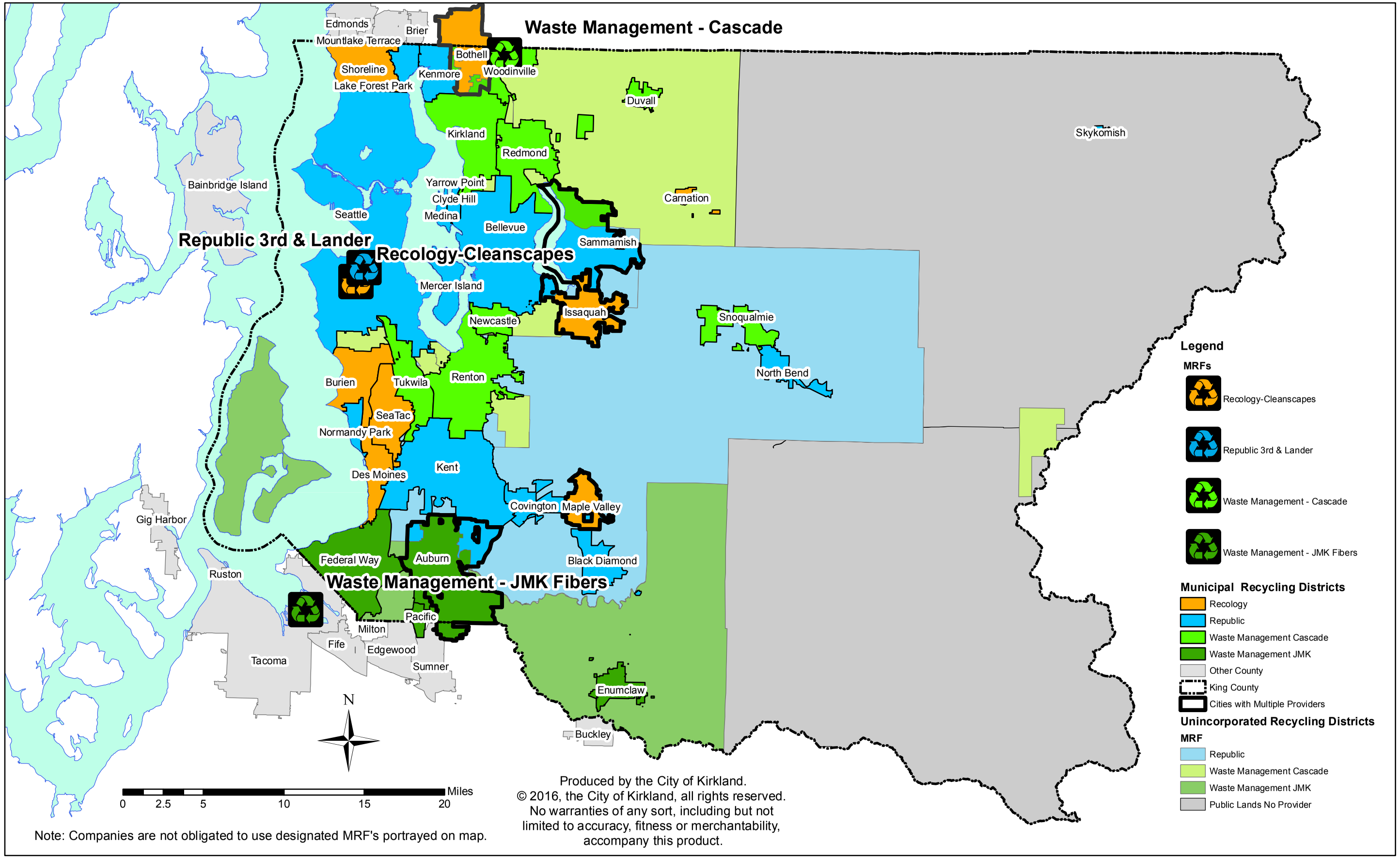
Snohomish County Recycling Facilities and Districts



Island, San Juan, Skagit, Whatcom Counties Recycling Facilities and Districts



King County Recycling Facilities and Districts



Note: Companies are not obligated to use designated MRF's portrayed on map.

Produced by the City of Kirkland.
© 2016, the City of Kirkland, all rights reserved.
No warranties of any sort, including but not limited to accuracy, fitness or merchantability, accompany this product.

APPENDIX D
Commodity Specifications

MATERIAL OVERVIEW

Standard specifications for commodities provide guidelines for buyers and sellers of processed scrap materials. Specifications allow a buyer and seller to know the specific qualities of an item they contract to buy or sell. Specifications make commodities fungible. Note that buyers and sellers can contract to sell non-spec bales or buyers may have their own purchasing specifications.

Listed here are widely used and widely published specifications for scrap materials. ISRI specifications receive an annual update if not more often. ISRI specifications are internationally accepted. Omissions include Bale size and weight specifications and specifications related to pricing. For full information on specifications, including grades not listed, consult the resource below each material group.

CARDBOARD (OCC)

ISRI Specifications

OCC: An acronym for old corrugated containers, OCC contains a rippled middle layer that is sandwiched between two layers of linerboard. Mills use old corrugated containers to make new recycled-content shipping boxes, as well as recycled paperboard for product packaging

(11) Old Corrugated Containers (OCC)

Consists of corrugated containers having liners of either test liner or kraft.

Prohibitive Materials may not exceed 1%

Outthrows plus prohibitives may not exceed 5%

(12) Double-Sorted Old Corrugated (DS O CC)

Double-sorted old corrugated consists of double-sorted corrugated containers, generated from supermarkets and/or industrial or commercial facilities. The material has liners of test liner or kraft. Sorted material is free of boxboard, offshore corrugated, plastic, and wax.

Prohibitive Materials may not exceed 1/2 of 1%

Outthrows plus prohibitives may not exceed 2%

MOISTURE CONTENT

All paper stock must be packed air dry. Air-dry is a moisture content of 12% as a definition.

Where excess moisture is present in the shipment, the Buyer has the right to request an adjustment. Whenever possible, the average air-dry basis determines successful adjustment.

OUTTHROWS

The term "Outthrows" as used throughout this section. Outthrows definition is "all papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified."

PROHIBITIVE MATERIALS

The term "Prohibitive Materials" is used throughout this section. The definition of prohibitive materials is:

a. Any materials, which by their presence in a packing of paper stock, in excess of the amount allowed, will make the pack unusable as the grade specified.

b. Equipment damaging materials.

GLASS CONTAINERS

ISRI Specifications

Scrap Glass Definitions:

CONTAINER GLASS CULLET

Crushed or whole scrap soda-lime-silica-container glass.

UNPROCESSED CONTAINER GLASS CULLET

Broken or whole scrap glass containers that comply with the proper ISRI glass specifications.

ORGANIC MATTER

Consists of organic materials that are non-container glass items; for example, paper labels should not exceed 0.2%.

FERROUS MATERIALS

Magnetic metals, i.e. steel, iron, etc. Ferrous materials are removed during scrap glass processing.

NON-FERROUS MATERIALS

Non-magnetic metals, i.e. aluminum, lead, copper, etc. Non-ferrous materials are removed during glass processing.

Unprocessed flint container glass cullet specifications

Cullet Colors Segregation: Flint Cullet

Flint 95-100%

Amber 0-5%

Green 0-5%

Other Colors 0-5%

Cullet Colors Segregation: Amber Cullet

Amber 90-100%

Flint 0-5%

Green 0-5%

Other Colors 0-5%

Cullet Colors Segregation: Green Cullet

Green 90-100%

Flint 0-10%

Amber 0-10%

Other Colors 0-5%

Composition

Soda-lime-silica beverage or food container glass.

Size

Cullet may be broken but not pulverized.

Moisture

Cullet should be free of excess moisture.

Contaminant Listings

Outthrow Materials: Normal container labels; ring and metal closures where processing capabilities permit.

Prohibitive Materials: Non-acceptable items include non-container glass (vision ware, light bulbs, crystal, windows, mirrors, drinking glasses, ceramic, milk glass, etc.) metals, ores, minerals, bricks, clay, grinding and refractory materials, rocks, clay, and ceramic closures.

General

The quality of the unprocessed container glass cullet must be such that after beneficiation with a conventional container glass cullet processor it will be suitable for the production of glass containers.

METAL

ISRI Specifications

Aluminum

POST-CONSUMER ALUMINUM CAN SCRAP (TALC)

Shall consist of old aluminum food and/or beverage cans. The material is to be free of other scrap metals, foil, tin cans, plastic bottles, paper, glass, and other non-metallic items.

BALED ALUMINUM USED BEVERAGE CAN (UBC) SCRAP (TALDON)

Material needs magnetically separated to ensure removal of steel, lead, bottle caps, plastic cans and other plastic, glass, wood, dirt, grease, trash, and other foreign substances. Any free lead is basis for rejection. Any and all aluminum items, other than used beverage cans, are not acceptable.

POST CONSUMER ALUMINUM FOIL (TESLA)

Shall consist of baled old household aluminum foil and formed foil containers of uncoated 1000, 3000 and 8000 series aluminum alloy. Material may be anodized and contain a maximum of 5% organic residue. Material must be free from radar chaff foil, chemically etched foil, laminated foils, iron, paper, plastic, and other non-metallic contaminants.

Steel

213 STEEL CAN BUNDLES

Steel can scrap compressed to charging box size and weighing not less than 75 pounds per cubic foot. Cans may be baled without removal of paper labels, but free of other non-metallics. May include up to 5-gallon tin-coated containers.

MIXED WASTE PAPER – MWP

ISRI Specifications

Mixed paper is a broad category that often includes items such as discarded mail, telephone books, paperboard, magazines, and catalogs.

(1) Residential Mixed Paper

Consists of a mixture of various qualities of paper not limited as to type of fiber content, normally generated from residential, multi-material collection programs.

Prohibitive Materials may not exceed 2%

Outthrows plus prohibitives may not exceed 5%

(52) Aseptic Packaging and Gable-Top Cartons

Consists of liquid packaging board containers including empty, used, polyethylene (PE)-coated, printed one-side aseptic and gable-top cartons containing no less than 70% bleached chemical fiber and may contain up to 6% aluminum foil and 24% PE film.

Prohibitive Materials may not exceed 2%

Outthrows plus prohibitives may not exceed 5%

Moisture Content

All paper stock must be packed air dry. A moisture content of 12% is deemed to be air dry.

Where excess moisture is present in the shipment, the Buyer has the right to request an adjustment. Whenever possible, such adjustment shall be made on an average air dry basis.

Outthrows

The term "Outthrows" as used throughout this section is defined as "all papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified."

Prohibitive Materials

The term "Prohibitive Materials" as used throughout this section is defined as:

a. Any materials which by their presence in a packing of paper stock, in excess of the amount allowed, will make the pack unusable as the grade specified.

b. Any materials that may be damaging to equipment.

NEWSPAPER – ONP

ISRI Specifications

(6) Old Newspaper

Consists of sorted newspapers and other acceptable papers as typically generated by voluntary collection and curbside collection programs.

Prohibitive Materials may not exceed 2%

Outthrows plus prohibitives may not exceed 4%

Other acceptable papers may not exceed 30%

Moisture Content

All paper stock must be packed air dry. A moisture content of 12% is deemed to be air dry.

Where excess moisture is present in the shipment, the Buyer has the right to request an adjustment. Whenever possible, such adjustment shall be made on an average air dry basis.

OUTTHROWS

The term "Outthrows" as used throughout this section is defined as "all papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified."

PROHIBITIVE MATERIALS

The term "Prohibitive Materials" as used throughout this section is defined as:

a. Any materials which by their presence in a packing of paper stock, in excess of the amount allowed, will make the pack unusable as the grade specified.

b. Any materials that may be damaging to equipment.

PLASTICS

APR Model Bale Specifications

They include:

Rigid Plastic Model Bale Specifications
PET Bottles with Gradings
Bale Audit with Test Methods
PET Thermoforms

Natural Graded HDPE Bottles Testing Protocol
Natural Graded HDPE Bottles
Pigmented Graded HDPE Bottles Testing Protocol
Pigmented Graded Bottles HDPE

Polypropylene (PP)
Tubs and Lids (Thin Wall Packaging)
HDPE Injection Grade Bulky Rigids
Mixed Bulky Rigids
All Rigid Plastic (also known as 1-7 Bottles and Small Rigid Plastic, and 1-7 All Rigid Plastic)
Pre-Picked (also known as 3-7 Bottles & All Small Rigid Plastic, and 3-7 Bottles & All Other Rigid Plastic)

Film Model Bale Specifications
HD and LD Retail Bags
MRF Mix Film
PE Ag Film Including Mulch
PE Ag Film Not Including Mulch PE
Clear Film

PE Retail Bag and Film
LDPE Colored Film LDPE
Furniture Mix Film LLDPE
Clear Film Grade A

Appendix E
Energy Savings from Recycling Glass

Glass is heavy and there is a perception that it is not worth transporting long distances for recycling. However, the following information from Oregon Department of Environmental Quality indicates that there are net energy savings from recycling glass even when it is transported long distances.

The following table illustrates energy use per ton of production.

Table 1. Table 2 Energy Use for 1 Ton of Glass Materials[1]

Product	Energy per ton (Million BTUs)
Production of 1 ton of container glass from virgin materials[2]	6.49
Production of 1 ton container glass from cullet (recycled glass)[3]	4.32
Production of 1 ton of aggregate (crushing)[3]	0.05
Transport by dump truck 100 miles[4]	0.623
Transport of 1 ton of cullet by tractor/trailer 100 miles[4]	0.14
Transport 1 ton of cullet by rail 100 miles[4]	0.033
Transport 1 ton of cullet by freighter (ship) 100 miles[4]	0.026

To translate the above table into energy use savings depending on the end-use of the glass, the following example and illustration Figure 1: Energy Use for 1 Ton of Glass Materials is provided by David Allaway, Oregon Department of Environmental Quality:

If one ton of glass cullet were collected in eastern Oregon and used locally for aggregate, there would be a net energy savings of ~0.2 million BTUs per ton of cullet.

[1] Because of material losses in manufacturing, slightly more than 1 ton of cullet is required to produce 1 ton of container glass.

[2] Transport of virgin feedstocks not included (estimated at an additional 0.58 MMBTU/ton)

[3] Collection transportation not included.

[4] Includes the energy used to make the fuel (called pre-combustion energy) and combustion energy (Allaway, 2015)

If that cullet was transported by truck to Portland, instead, and used for glass bottle production, there would be a net energy savings of ~2.1 million BTUs per ton of cullet.

If that cullet was trucked to Portland and then shipped to California by rail and used to produce fiberglass, there would be a net energy savings of ~2.1 – 3.2 million BTUs per ton of cullet.

Overall, the ultimate end-use of the glass is far more important from an energy-savings standpoint, than the energy used in transportation to get it into production.

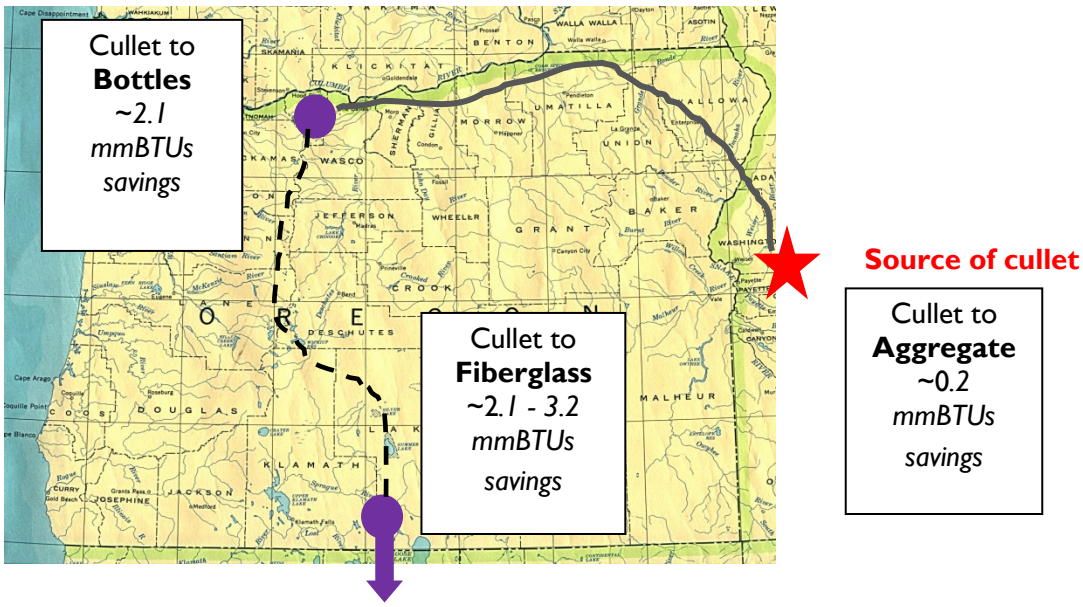


Figure 1. Energy Use for 1 Ton of Glass Materials

Source: Presentation by Peter Spendelow, Oregon DEQ, 2009

Appendix F
NORPAC Study on Effects of Glass at Paper Mill (2009)

The following information comes from *Beyond the Curb - Tracking the Commingled Residential Recyclables from Southwest WA* (Washington State Department of Ecology, 2010, pp. 19-21.

Glass is the single most damaging commodity for the recovered paper industry. For example, NORPAC newsprint mill averaged 37 tons of glass per month during May 1 – October 28, 2009 (based on material from six suppliers). Table 1 shows the differences in quantities of glass received based on whether the supplier's source had commingled glass (*Glass In*). Table 1 shows glass collected separately at the curb (*Glass on Side*). It also shows whether the supply came from a bottle bill state. Bottle bill states do not collect glass at curbside and there is an incentive to return the bottle to claim the deposit (*Bottle Bill*). Photo 1and Photo 2 show the size of glass and its impact in the paper stream.

The costs of dealing with glass in the fiber stream are significant especially considering the percent of the glass in the paper by weight (.3%). Because glass is abrasive, a small amount can do a lot of damage to equipment. Annual fiber replacement costs and maintenance costs directly attributable to the increased wear and tear by glass on the NORPAC mill machinery total an estimated $306,000 a year and include:

- ~ $60,000 for replacing valves (see Photo 3)
- $80,000 improved metallurgy/components (see description below)
- $100,000 for replacement of piping, conveyors, pulper, and pumps
- $66,000 for fiber replacement costs

Additional costs for improving metallurgy are due to equipment suppliers changing the metals they typically use in manufacturing products to supply to paper mills. The pulp and paper industry uses stainless steel in almost all equipment that is in contact with pulp slurry and certain chemicals. The pulp slurry is so abrasive with glass in it. The slurry erodes the stainless steel parts much more quickly (see Photo 3).

Equipment that typically requires replacement every 15 to 20 years now requires replacement within the first year. NORPAC has tried different grades of stainless steel which are more expensive, but with only slightly improved life. They have also worked with the equipment manufacture to add different levels of other metals, which has improved its susceptibility to glass, but is more prone to cracking from vibration, reducing its life as well. They have not

found a solution and are continuing to trial different metallurgy in each of the high wear areas in the process caused by the glass.

Additional impacts from glass in the fiber stream include:

- Employee safety impacts such as airborne glass dust during daily cleanup
- Unplanned shutdowns due to mechanical failures
- Replacing plugged equipment (i.e. screens plugged with glass shards).
- Reduced quality of the final paper product due to poor performing equipment

Recently, NORPAC has increased the level of intermittent shutdowns for cleaning due to the level of glass and customer requirements for cleaner paper, and so the full cost of glass is higher than reported above.

Photo 1. Glass in the Paper Bales – Sample Rejected after Drum-Pulper Pulping Process
Source: NORPAC 2009

Photo 2. Glass in the Paper Bales – Sample Rejected by Sand Cleaner
Source: NORPAC 2009

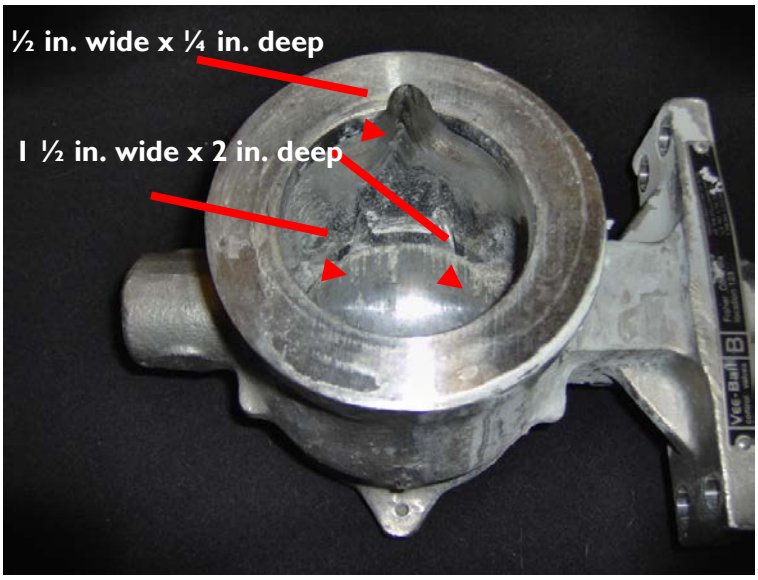


Photo 3. Wear on Stainless Steel Valve Due to Glass

Source: NORPAC 2009 (valve), S. McClelland (photo)

Table 1. Glass Quantity by Supplier of Fiber to NORPAC Mill in Longview, WA (May 1 – October 28, 2009)

Source of Fiber/ Type of Collection System	Average % Glass Content	% of Total Volume of ONP supplied	Approximate Tons Glass (per month)
1. Glass In	1.5%	13%	20
2. Glass In	0.66%	5%	3
3. Glass on Side	.14%	30%	4
4. Glass In	.78%	5%	4
5. Bottle Bill	.08%	8%	0.6
6. Glass In	.35%	15%	5
TOTAL	.46%	76% [1]	37 Tons

1. Approximately 75-79% of NORPACs recovered fiber supply comes from commingled suppliers
Source: NORPAC, 2009