Reclay StewardEdge
Product Stewardship Solutions

Optimizing Material Recovery Facilities

Measuring and Maximizing Sorting Efficiencies

A&WMA and ONEIA 2015 Waste Conference

By: Neil Menezes, *Reclay StewardEdge Inc.*

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- Our principals have over 20 years of experience in the sustainability and recycling field
- Instrumental in the design and implementation of the Blue Box recycling program, in Ontario and worldwide
- We help our clients make bold and strategic decisions to positively impact circular material flows and be at the forefront of change
- Work with municipal and private sector to realize their goals for operating an efficient recycling systems

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The Changing Recycling Market

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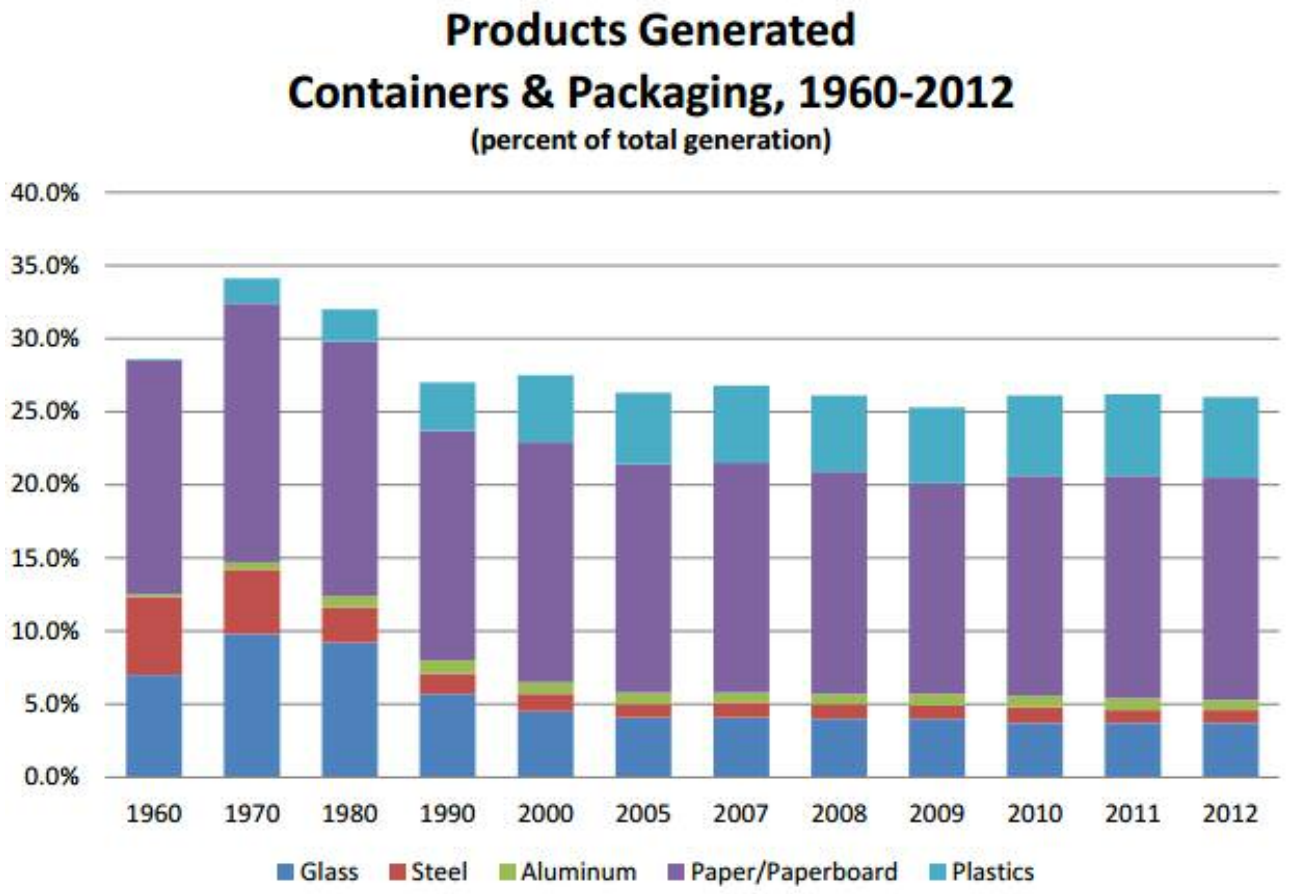
Changes in Container Recycling Mix



Source: Making Sense of the Mix: Analysis and Implications of the Changing Curbside Recycling Stream
Prepared for: American Chemistry Council
Submitted by: Green Spectrum Consulting, LLC and Resource Recycling, Inc.
February 2015

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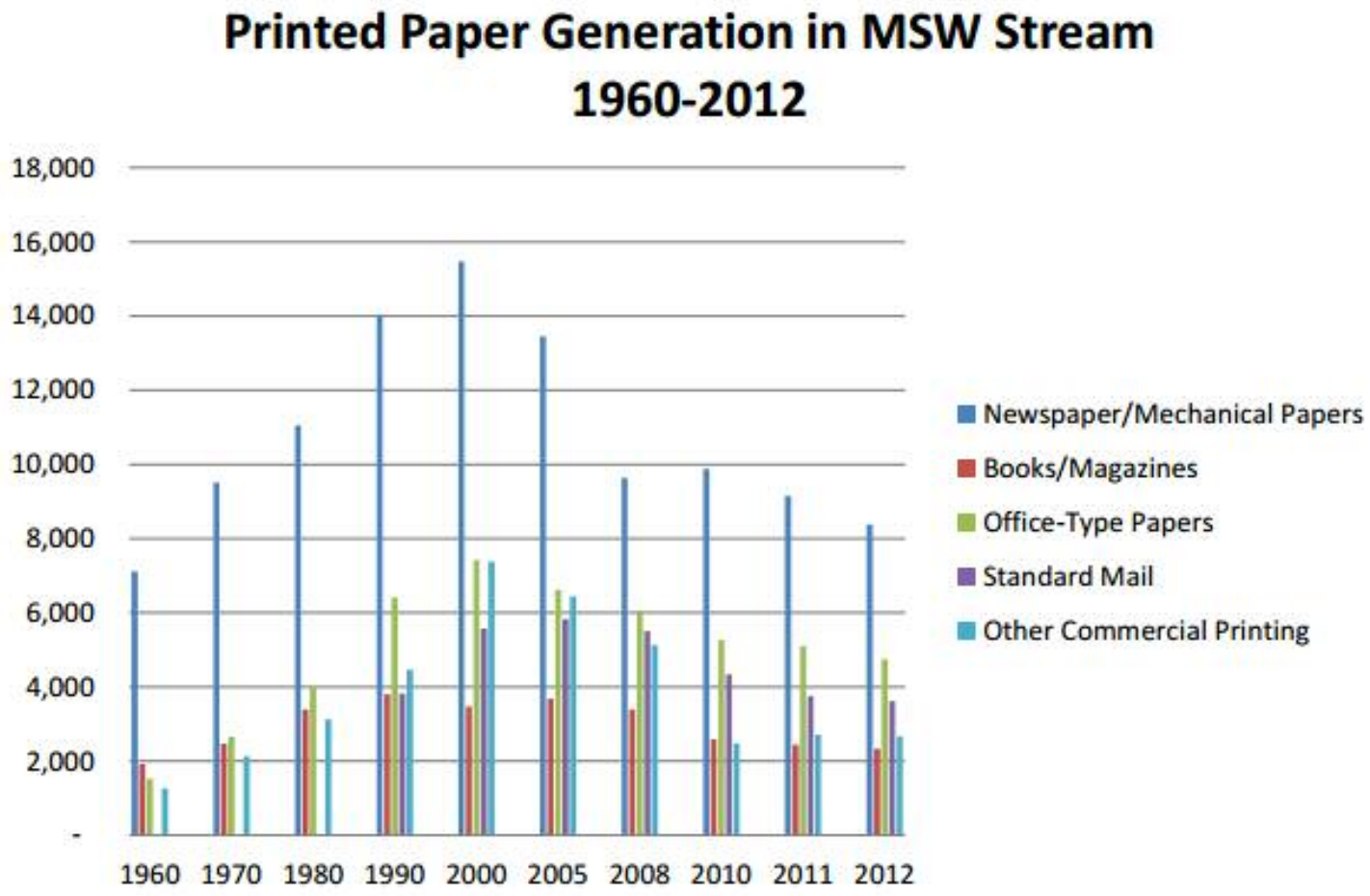
Changes in Paper Recycling Mix



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Lightweighting of Packaging

Replace original package with lighter weight alternative (e.g. from glass to plastics)

Cut the amount of material used (e.g. thinning of PET bottles and aluminum cans)

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Example of Lightweighting – Evolution of Laundry Detergent

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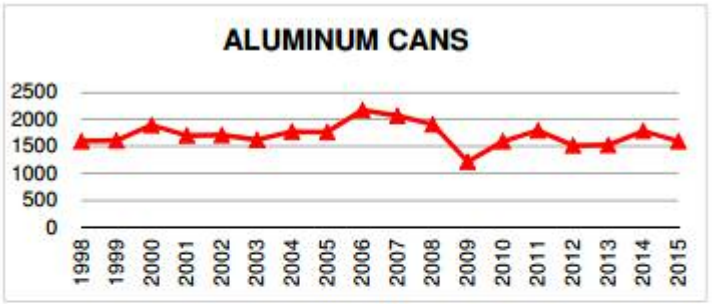
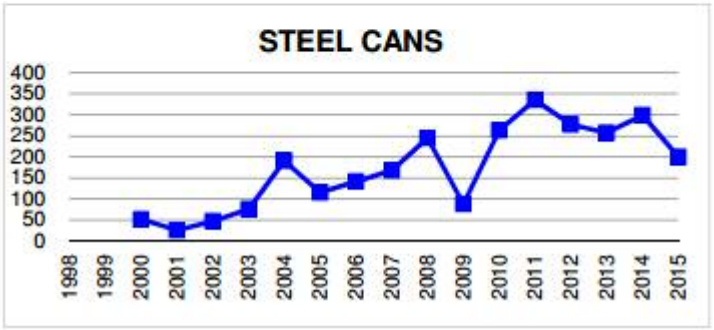
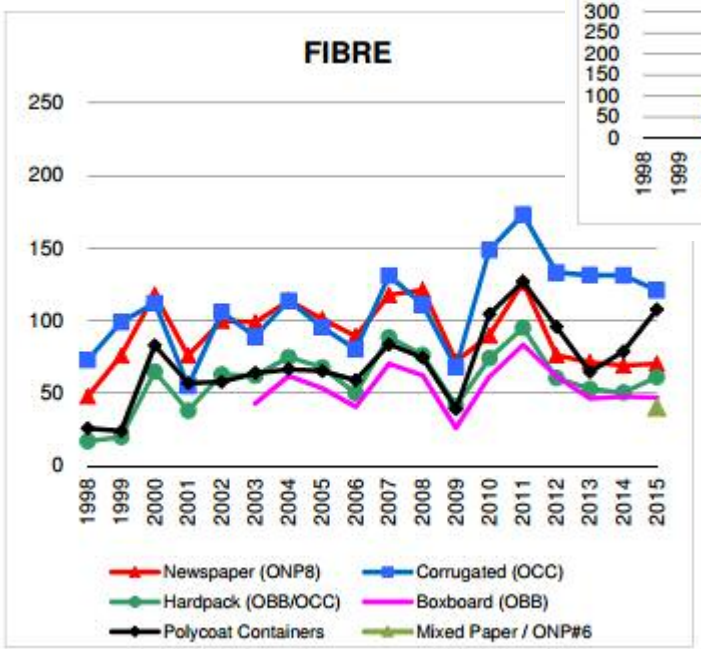
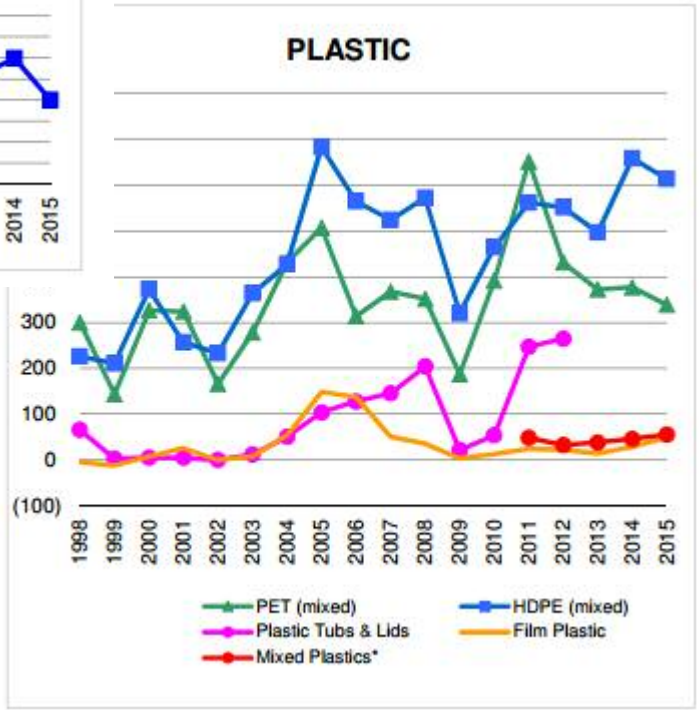
Declining Commodity Prices









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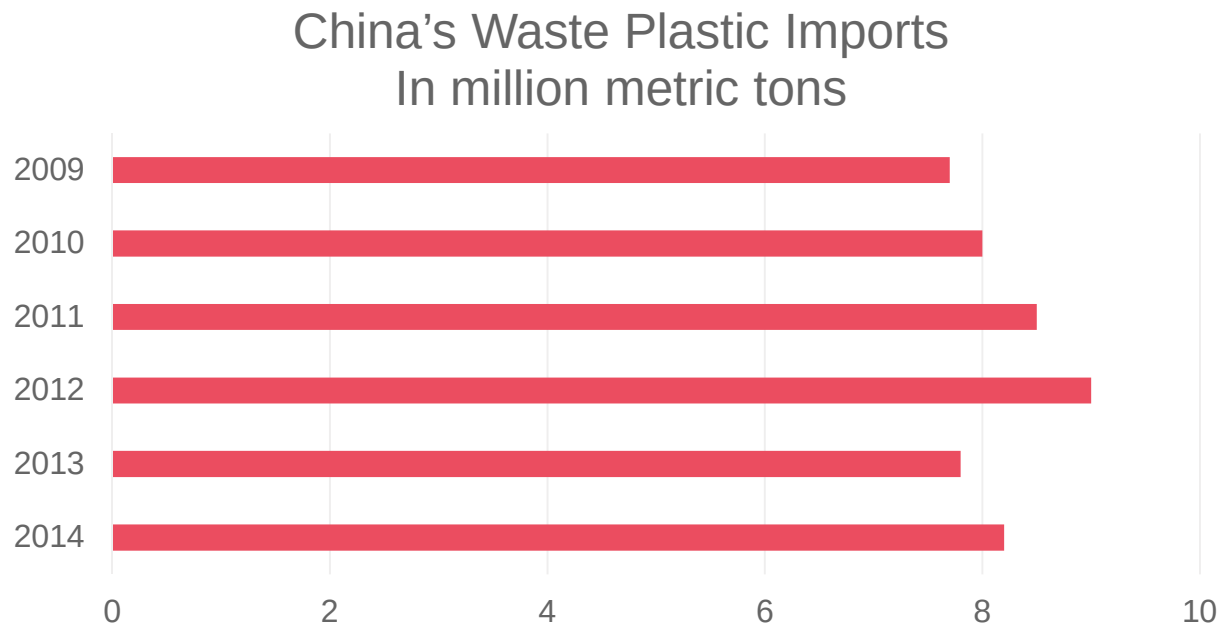
Green Fence

- Difficult to move loads with slightly higher contamination rates
- Municipalities forced to hire additional sort staff and/or invest in equipment to meet China's new commodity specifications



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Evolving with Recycling Market Changes

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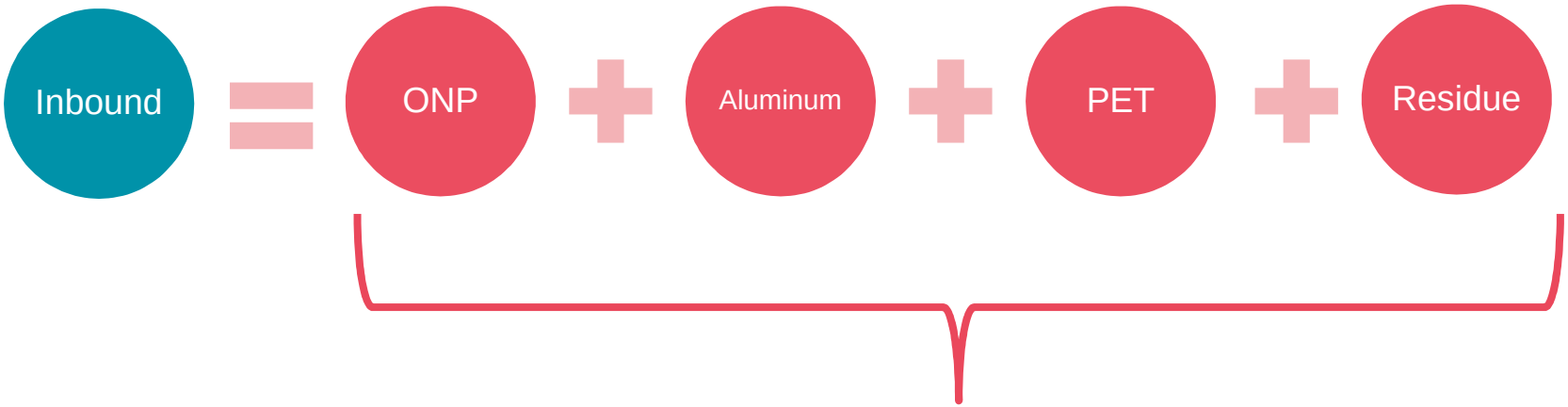
Current MRF Performance Measure



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MRF Optimization

- Optimization study evaluates the performance of the entire line, including all equipment and manual sort stations.
- Includes analysis of:
  - Tip floor composition
  - Bunker composition
  - Residue rates
  - Efficiency rates
  - Purity rates

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Benefits of MRF Optimization

- ✓ Maximize capture rates by pinpointing areas of improvement
- ✓ Optimize operating costs and revenues
- ✓ Validate the composition of incoming/outgoing materials

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Case Study: City of Hamilton MRF Optimization

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City of Hamilton MRF Optimization Study

- Dual Stream facility processing 45,000 tonnes annually; analysis of container line only
- Project Team consisted of Reclay StewardEdge and Stantec
- Objectives:
  - Evaluate performance of container line
  - Evaluate performance of glass clean-up system
  - Determine value of materials within the post-optical residue
  - Provide recommendations on cost and improvement options to enhance efficiency and effectiveness of container line

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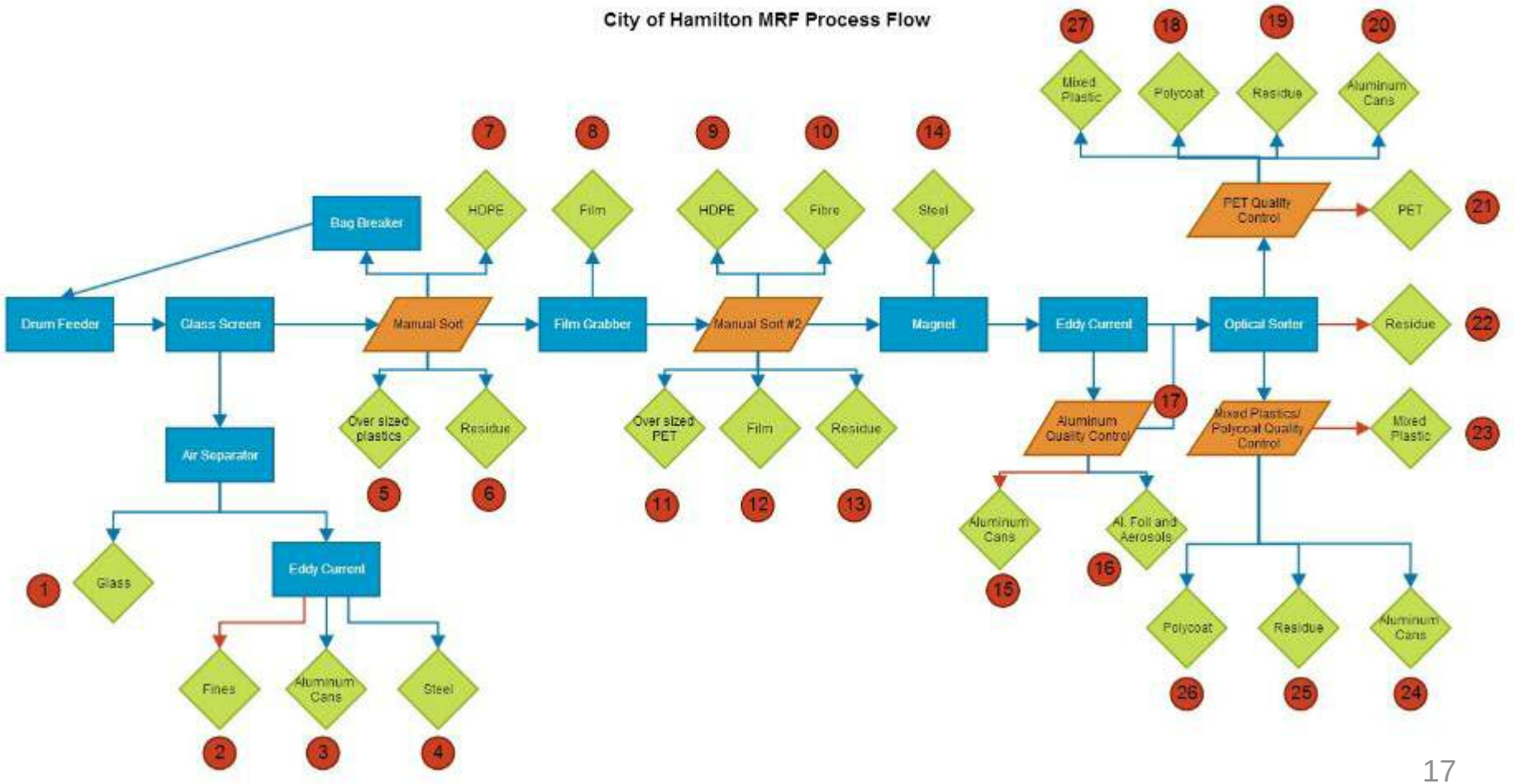
Methodology

Walkthrough of facility



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Methodology Continued

Collecting and weighing tip floor samples

Loading the infeed

Clearing lines before tests

Emptying bunkers before tests

Tarp to capture glass

Bags to capture material flow

Observation point during tests

Sorting material

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Efficiency Rate

- Efficiency rate: ability of a piece of equipment to correctly identify and sort the material it is intended to sort
- Project Team identified the expected efficiency rate based on manufacturers' specification and evaluated it against the actual efficiency rate

$$\text{Efficiency Rate} = \frac{\text{Amount of material effectively sorted}}{\text{Total amount of material sorted in system}}$$

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Purity Rate

- Purity Rate: amount of targeted materials sorted/ejected divided by the total amount of materials sorted/ejected by the equipment
- Equipment with high purity rates that meet market specifications do not need further QC; equipment that does not meet market specifications requires additional QC/sorting prior to being sent to market

$$\text{Purity Rate} = \frac{\text{Amount of material targeted for ejection}}{\text{Total amount of material ejected by equipment}}$$

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Inbound Composition (by weight)

Commodity	Material Category	Composition (%)
Paper Packaging	Gable top cartons	2.0%
	Aseptic cartons	0.5%
	Paper cups	0.6%
	Ice cream containers	0.1%
	Composite cans	0.2%
	Other laminated packaging	0.1%
Plastics	#1 PET bottles, jugs and jars	14.8%
	#1 PET thermoforms	5.2%
	#2 HDPE bottles, jugs and jars	7.0%
	#3 PVC bottles and jars	0.0%
	LDPE/HDPE film	7.8%
	#4, #5, #6, and #7 rigid plastic packaging	9.0%
	#6 Expanded polystyrene	1.3%
	Plastic laminates	1.3%
	Large HDPE & PP pails and lids	0.9%
	Other plastics - non-packaging/durable goods	1.0%
Metals	Aluminum food and beverage cans	4.4%
	Aluminum foil, trays and aerosols	0.6%
	Steel and other metals food and beverage cans	8.9%
	Steel aerosols containers	0.5%
Glass	Glass < 3/8" in size	6.9%
	Glass > 3/8" in size	14.9%
Other	Other recyclables (fibres)	3.4%
	Other non-recyclables	8.4%
TOTAL		100%

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Bunker Compositions

	Bunkers										
Commodity	Glass	HDPE	Film	Steel	Al. Prime	Al. B-Grade	PET	Mixed Plastics	Cartons	Residue (Pre-OS)	Residue (Post-OS)
Glass	**92.0%**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.3%	3.0%
HDPE	0.0%	**88.5%**	0.2%	0.0%	0.1%	0.0%	0.1%	11.4%	0.0%	0.2%	2.2%
Film	0.0%	0.1%	**85.3%**	0.3%	0.1%	0.0%	1.3%	6.4%	0.1%	27.3%	5.8%
Steel	0.4%	0.0%	2.1%	**83.4%**	0.2%	0.0%	0.4%	0.1%	0.1%	3.4%	0.4%
Al. Food and Bev. Cans	0.0%	0.1%	0.0%	0.3%	**97.0%**	**81.7%**[6]	0.3%	0.9%	0.1%	1.3%	2.6%
Al. Foil and Aerosol	0.0%	0.0%	0.5%	0.0%	0.2%		0.0%	0.0%	0.0%	0.3%	1.2%
PET	0.0%	1.4%	4.7%	1.5%	0.2%	0.4%	**93.9%**	12.5%	0.1%	5.8%	21.1%
Mixed Plastics	3.6%	9.8%	1.2%	0.7%	0.4%	0.0%	1.7%	**51.7%**	1.2%	7.7%	18.9%
Cartons	0.0%	0.0%	0.4%	0.1%	0.1%	0.0%	0.1%	3.6%	**93.2%**	0.3%	2.2%
Residue	4.0%	0.0%	4.6%	13.1%	0.9%	17.9%	1.6%	11.5%	4.0%	**44.4%**	30.0%
Other Recyclables	0.0%	0.0%	1.1%	0.4%	0.9%	0.0%	0.4%	1.9%	0.6%	9.1%	**12.6%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

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Material Capture Rates

Material Type	Capture Rate (%)
Glass	97.9%
HDPE	81.2%
Film	55.1%
Steel	93.9%
Aluminum food and beverage cans	84.3%
Aluminum foil, trays and aerosols	62.6%
PET	73.1%
Mixed Plastics	43.1%
Cartons	73.6%
Residue	64.0%

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City of Hamilton's Equipment Performance

Equipment	Description/Purpose	Expected Efficiency (%)	Actual Efficiency (%)	Actual Purity (%)
Fine Screen	Separates glass from inbound material before it reaches main sort line	N/A	98%	85%
ORSE Screen	Separates glass from all other light-weight materials	98%		
Glass			100%	92%
Other non-glass materials			56%	100%
Eddy Current (Aluminum Station 3)	Removes non-ferrous, aluminum containers from the glass/fines	98%	71%	100%
Bag Breaker Large bags	Rips bags of sealed recyclables to be reintroduced into the sort line	95% of all bags	99%	N/A
Bag Breaker Small bags			55%	N/A
Film Grabber	Removes plastic film from main sort line	30%	0%	0%
Magnet (steel) Food and beverage cans	Removes ferrous metals from main sort line	98%	98%	83%
Magnet (steel) Aerosols containers			100%	
Eddy Current: Food and beverage cans	Removes non-ferrous, aluminum containers from the sort line	98%	86%	88%
Eddy Current: Foil, trays and aerosols			68%	
Optical Sorter				
#1 PET bottles, jugs and jars	Dual-eject optical sorter; first eject on PET containers; second eject on mixed plastics & polycoat	90-98%	77%	91%
#1 PET thermoforms			84%	
Gable top cartons			89%	57%
Aseptic cartons			85%	
Ice cream containers			79%	
#3 PVC bottles and jars			39%	
#4, #5, #6, and #7 rigid plastic packaging			63%	

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City of Hamilton's Manual Sorting Performance

Sort Station/Target Material	Description	Efficiency Rate
Manual Sort #1	Positive manual sorts on targeted materials	
Oversized plastics (5)		N/A
Residue (6)		1.4%
HDPE (7 & 9)		81.3%
Manual Sort #2	Positive manual sorts on targeted materials	
Fibre (10)		16.9%
Oversized PET (11)		100%
Film (12)		55.8%
Residue (13)		33.7%
Manual Sort Aluminum Quality Control		
Aluminum foil, trays and aerosols (16)	Positive manual sort on "B" grade aluminum	97.7%
Anything but aluminum (17)	Positive manual sort on non-aluminum materials	55.2%
Manual Sort Optical Sorter PET Quality Control	Positive manual sorts on targeted materials	
Polycoat (18)		
Gable top cartons		55.0%
Aseptic cartons		31.1%
Ice cream containers		66.5%
Residue (19)		24.8%
Aluminum cans (20)		41.9%
Mixed Plastics (27)		17.7%
Manual Sort Optical Sorter Mixed Plastics/Polycoat Quality Control	Positive manual sorts on targeted materials	
Aluminum cans (24)		21.8%
Residue (25)		35.9%
Polycoat (26)		
Gable top cartons		91.9%
Aseptic cartons		61.9%
Ice cream containers		56.0%

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Key Findings – Areas for Improvement

Handling of Plastic Film

- Film is a common problem in MRFs
  - Wraps around other materials
  - Impedes the ability of manual and mechanical sort stations to complete their duties efficiently
- This has created a spin-off project to review cost implications for sorting film through the curbside program as well as alternative collection methods

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Key Findings – Areas for Improvement

Missed Capture of HDPE Containers

- HDPE is manually sorted at first two manual sorting stations, remaining HDPE ends up in mixed plastics or post-optical residue
- Manual sorters at these stations are also responsible for sorting film
- Approximately 20% of HDPE were being missed due to large amounts of plastic film
- It is estimated a loss of **$50,000 - $55,000** annually from missed capture of HDPE

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Key Findings – Areas for Improvement

Missed Capture of Aluminum Containers

- Majority of materials passing through eddy current are plastics
- High burden depth and volumes of material pose a challenge for eddy current to effectively remove aluminum cans
- Estimated loss of **$155,000 - $165,000** in revenue from missed aluminum

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Key Findings – Areas for Improvement

Optical Sorter Configuration

- Optical sorter is over-worked as it is required to sort more than optimal amount of material that passes through it
- Dual-eject optical sorters generally have lower efficiency rates as materials ejected by the second valve are 1/3 as effective as the first valve.
- Estimated loss of **$150,000** for missed PET, mixed plastics & polycoat

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Key Findings – Areas for Improvement

Optical Sorter Residue

- Study determined actual residue accounts for about 30% of the post-optical residue stream
- Almost 9% aluminum cans, 21% PET containers, 27% mixed plastics
- If the City were to capture these materials, it could achieve a net benefit of **$53,000**

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Recommendations

- Evaluate Alternative Methods for Managing Plastic Film
  - Recommended the City conduct a cost-benefit analysis of collecting plastic film from curbside program vs. other collection alternatives
- Repurpose Existing Optical Sorter and Add Second Optical
  - Second optical sorter will alleviate some of the burden at the front-end manual stations (e.g.: HDPE)

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Summary

- Inbound materials have changed drastically since many MRFs have been constructed
- Depending on the age of the facility, it may be difficult to retrofit buildings
- Conducting a mass balance of only tip-floor audits and outbound tonnages provide good information, but don't show the full picture
- MRF Optimization studies can be used to:
  - Improve efficiencies
  - Lower operational costs
  - Increase revenue
  - Reduce supply chain risk

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Thank you!

Neil Menezes
26 Wellington Street East, Ste. 601,
Toronto, ON M5E 1S2
Phone: 416-644-8349
E-Mail nmenezes@reclaystewardedge.com