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The Battle for Recycling

by Daniel Lantz & Clarissa Morawski

It's the decades-old fight in the world of recycling – single-stream vs. dual-stream collection of recyclables. Which is best for municipalities? Which is best for industry? Which is better for the environment?

Nate Silver, in his recent best-seller "The Signal and the Noise – Why so many predictions fail but some don't," in describing the cost to society of failed predictions due to a poor understanding of data writes, "The signal is the truth, the noise is what distracts us from the truth." Silver explains that we need to distinguish a right signal from our world of information overload. People make confident decisions, but often on the basis of poor predictions.

"Solutions require attitudinal change," writes Silver. "We must think more carefully about our ideas – and how to test them. We must become more comfortable with probability and uncertainty. We must think more carefully about assumptions and beliefs that we bring to a problem." We must understand the signal when choosing the best recycling system.

Where is the noise coming from?

The debate over how to collect consumer recyclables has been moving swiftly, delivering vast amounts of data and analysis to municipal and state decision makers. On one side of the debate, armed with compelling data, are the proponents of single-stream (or "commingled") recycling. These are generally those stakeholders whose interest (public or private) is better served by managing collection and processing of mixed material. On the other side of the debate are domestic mills and manufacturers that are unhappy with the reduced quality and/or quantity of material available to them from most single-stream programs. Many environmentalists support separate collection (dual-stream or more) in support of greater quality and potentially greater quantity recycling. In terms of quality, U.S. PET recycling industry expert Michael Schedler explains, "we are seeing more PET bales bought, but the actual production of usable (particularly bottle grade) clean flake has not increased relative to the increase in sales." Other material recyclers in the U.S. report similar findings, where their input tonnage is higher, but output (for re-sale) remains the same, with increased levels of residuals to manage.

This article is presented as an update to two articles previously published in *Resource Recycling*: "Mixed results" from December 2008 by Daniel Lantz and "Single-stream uncovered" from February 2010 by Clarissa Morawski. Here, we present a number of recent findings from North America, as well as cost comparisons of eight Ontario-based recycling programs (four single-stream and four dual-stream), which have been tracked since 2003. We will also briefly examine recycling in the EU and U.K., as well as offer considerations for recycling in the future. The article's purpose is to convey new information for consideration and to ultimately make it easier to pick up the right signal through the noise.

Making the shift – or not

As single-stream recycling moves into its third decade, it seems that it is gaining momentum as more North American municipalities see it as the low-cost, high-diversion answer to achieving diversion goals.

In the last year alone, dozens of large and small cities and counties, located all over the U.S., have introduced single-stream collec-

tion programs, most notably Orlando and Minneapolis. In Canada, six of Canada's seven largest cities now offer single-stream recycling.

But evidence of the real problems, such as the higher costs and risks associated with mixing all recyclables together during collection, has some communities bucking the trend, choosing not to make the shift to single-stream and, in some cases, even switching back to dual-stream. While these examples may be the minority, what is important to understand are the reasons behind their choice.

Ottawa, Canada's capital and fourth largest city, operates a dual-stream collection system. Considering the possibility of converting to a single-stream program, the city conducted a public survey to see what residents would prefer. The community supported maintaining the existing system, which collects containers and fibers separately on alternating weeks. By maintaining the separate collection system, and reducing garbage collection to once every two weeks, the city is expected to save taxpayers $9 million annually over the next six years and will preserve the life of their landfill.

Table 1 | Single-stream programs 2003-2011

Municipality	2003 Quantity Metric tons	2003 $/mT Net	2003 Households	2003 $/hh Net
Single-stream programs (Dual-stream in 2003)				
Program 1	82,231	$147.66	331,000	$36.68
Program 2	148,798	$126.46	959,000	$19.62
Program 3	33,988	$113.57	143,349	$26.93
Program 4	43,516	$141.59	253,700	$24.29
Average		$132.82		$24.29
Municipality	**2011 Quantity Metric tons**	**2011 $/mT Net**	**2011 Households**	**2011 $/hh Net**
Single-stream programs				
Program 1	92,934	$198.87	411,800	$44.88
Program 2	154,511	$150.33	882,268	$26.33
Program 3	43,776	$156.49	179,013	$38.27
Program 4	76,073	$121.11	325,831	$28.28
Average		$157.30		$32.12
Cost Increase 2003 to 2011 (1)		$1.67		$3.66
		1.1 percent		12.8 percent

(1) Accounting for 2 percent inflation per year, compounded from 2003 to 2011.
Source: Cascades Recovery, 2013

In 2006, the City of London, Ontario undertook a comprehensive review of their recycling system, with key goals being to reduce program cost, increase the capture of recyclable materials and the addition of new materials. London had a dual-stream system where fibers were kept separate from containers. The analysis concluded that a dual-stream collection system, rather than single-stream collection, would be the most appropriate for the City of London, as it would reduce processing costs, produce better-quality material for final markets, capture more recyclables (i.e., less recyclables going to residue or wrong materials mixed into end products) and have minimal impacts on collection. Limited savings were expected from single-stream collection and these savings were more than offset by the expected increase in the cost of processing single-stream materials.

The new state-of-art dual-stream MRF has been operating for 17 months. The program has reduced London's processing costs by about 10 percent compared to their last contract. The city's facility processes materials from a number of the surrounding municipalities who pay a processing fee and share in the revenues. The resulting quality has helped the city receive 15 percent higher prices for their materials than the averages reported in Ontario in the StewardEdge Price Sheet (http://stewardedge.ca/pricesheet/), which the city then shares with the other municipalities.

In California – the state often considered "ground zero" for single-stream recycling – Berkeley has opted to retain their dual-stream recycling system and use modern split carts for its residents after reviewing the performance of neighboring cities that adopted single-stream recycling.

Roseville, Minnesota conducted an exhaustive study of the pros and cons of switching to a single-stream collection system but eventually decided to continue with the existing dual-stream program.

Auburn, Maine switched to a single-stream recycling system because the city wanted to increase tonnage recycled and decrease tonnage landfilled. Due to concerns regarding the marketability of materials collected in their single-stream program, the town elected to switch back to dual-stream. Dom Casavant, chair of the city's Solid Waste Subcommittee stated, "The problem with a single-stream program is that it renders most of the commodities recycled practically worthless."

Low cost?

But what about this notion of cost savings for municipalities that move to single-stream? For the past six years, the largest Ontario-based single-stream and dual-stream recycling programs have been closely analyzed. During this timeframe, single-stream has always been more expensive, and the results for 2011 (the latest available) show nothing different.

The analysis includes only curbside collection and processing costs, subtracting total revenues for the program. After accounting for approximately 2 percent inflation per year, overall, the average program net cost for single-stream has increased by $1.67 (1.1 percent) per metric ton or $3.66 (12.8 percent) per household (Table 1). [Editor's

Table 2 | Dual-stream programs 2003-2011

Municipality	2003 Quantity Metric tons	2003 $/mT Net	2003 Households	2003 $/hh Net
Dual-stream programs				
Program 5	30,780	$162.53	194,200	$25.76
Program 6	26,977	$91.57	170,500	$14.49
Program 7	38,491	$90.10	177,700	$19.52
Program 8	66,798	$138.74	321,700	$28.81
Average		$123.94		$23.39
Municipality	**2011 Quantity Metric tons**	**2011 $/mT Net**	**2011 Households**	**2011 $/hh Net**
Dual-stream programs				
Program 5	39,841	$149.14	211,921	$28.04
Program 6	40,429	$148.87	185,181	$32.50
Program 7	45,743	$148.70	207,660	$32.76
Program 8	62,961	$109.61	382,873	$18.03
Average		$135.81		$25.99
Cost Increase 2003 to 2011 (1)		$ -9.41		$ -1.42
		-6.5 percent		-5.2 percent

(1) Accounting for 2 percent inflation per year, compounded from 2003 to 2011.
Source: Cascades Recovery, 2013

note: All figures in the story are in Canadian dollars, which are equivalent to U.S. dollars at press time.]

However, again after accounting for inflation, the average dual-stream program actually decreased in net cost by $9.41 per metric ton (-6.5 percent) or $1.42 (-5.2 percent) per household (Table 2).

So the difference in net cost between single-stream compared to dual-stream is a $21.49 per metric ton and $6.13 per household premium (Table 3).

The single premium escalates after accounting for economies of scale, maintenance and the paper fiber premium provided to two of the single-stream programs. The "fiber premium" is the net increase in average revenue paid by the end-market and is approximately $5.25 to $6.25 per metric ton to those programs. This premium does not relate to the program type, rather to the economy of scale of newspaper available from those programs.

Three of the single-stream programs operate over two shifts per day while the dual-stream programs only operate over one. The ability to operate the facility two shifts per day means that the equipment is monetized over the larger number of metric tons, providing an economy of scale.

Economies of scale would provide a decrease in cost of between $4.50 and $7.50 per metric ton for dual-stream programs. Adding the extra maintenance would increase dual-stream costs by $2.25 to $3.00 per metric ton (see Table 4 for adjusted costs on page 17).

With these adjustments, the cost differential widens to between $28 and $33 per metric ton in favor of dual-stream recycling. Comparing all costs, including collection, processing and administration, single-stream recycling is approximately 22 percent to 26.5 percent higher in cost than dual-stream programs. On top of all of the added costs, single-stream programs even show a $13 per metric ton lower average basket of goods revenue. If you include "extraneous costs" associated with operating depots, transferring and administration, the cost differential between single-stream and dual-stream is even more pronounced, with single-stream costs 60 percent higher than dual-stream.

Single-stream collects more?

Advocates of single-stream regularly argue that offering a more convenient collection option to residents will result in higher rates of diversion. But this too, may not be so.

By including all municipalities in both program types, single-stream programs captured approximately 204 kilograms per household (kg/hh) in 2011, while dual-stream programs captured approximately 191 kg/hh (6.3 percent less). Note that the data show two municipalities with a substantial decrease in recovered quantities per household. By removing these outliers, the data show that dual-stream programs recovered about 10 kg/hh more than single-stream (see Table 5 for a comparison of quantities recovered).

It should also be noted that single-stream programs capture approximately 22 kg/hh more newspaper than dual-stream programs. This is not unreasonable considering the size and number of newspapers available in these municipalities. Bear in mind that quantities recovered per household also does not provide information on recovery rates. For that, quantities generated would have to be made available. Therefore, no real conclusions that one type of program is better than the other can be drawn from the available data. The list of materials managed is not identical in all municipalities but, for the most part, matches up reasonably well, meaning it does not favor single-stream or dual-stream programs.

Table 3 | Base comparison of single-stream and dual-stream program costs

	Net $/mT	Net $/hh
Single-stream premium	$21.49	$6.13
	15.8 percent	23.6 percent

Source: Cascades Recovery, 2013

What's the word out of Europe and the U.K.?

Single-stream recycling is, for the most part, non-existent in European Union countries and is not moving in that direction in the future. Recycling under the European Directive 2008/98/EC states that, "to facilitate or improve recovery, waste shall be collected separately if technically, environmentally and economically practicable and shall not be mixed with other waste or other material with different properties (Article 10(2)). " The directive goes on to state that "by 2015, separate collection shall be set up for at least the following: paper, metal, plastic and glass (Article 11(1))."

"End-of-waste" provisions are being introduced for numerous recyclable materials that carry very tight end-market specifications, which, if met, allow producers to avoid paying waste levies. Programs must either sort at the curb or through a combination of curbside and depot systems in order to meet legal requirements and dictated end market specifications. Single-stream is simply not an option.

Earlier this year, a new report from the U.K. entitled "Procurement Outcomes for Waste Collection Systems in the U.K. Market April 2008-February 2012," by 4R Environmental Ltd. analyzed the results of more than 65 recycling collection tenders (contracts). The report identifies that of the those tenders between 2008 and 2012, 51 percent of all procurement for a recycling collection services resulted in curbside sort, with 28 percent awarded to single-stream commingling and 21 percent resulting in dual-stream systems.

However, more notable was that 29 requests for bids did not prescribe the type of collection system, but left it open to the competitive marketplace. Interestingly, 90 percent offered curbside sort or dual-stream collection, while only 10 percent offered single-stream collection. For example, Cheshire West, Chester, and Northampton recently decided to "un-mingle" household recycling into separate streams.

Commenting on the findings, Andy Bond, author of the report, said, "senior managers at local authorities who are considering their procurement options might be surprised by these findings and that they will almost certainly benefit from allowing the most open procurement system rather than prescribing this at the outset."

Table 4 | Factor adjusted dual-stream program costs

	Average quantity (mT)	Net cost (Average)	
		Low	High
Single-stream program costs (from Table 1)	91,824	$157.30	$157.30
Dual-stream program costs (from Table 2)	47,243	$135.81	$135.81
Adjustment for premium fiber revenues		-$6.25	-$5.25
Adjustment for economies of scale		-$7.50	-$4.50
Adjustment for increased maintenance		$2.25	$3.00
Adjusted dual-stream program costs		$124.31	$129.06
Single-stream premium		$32.99	$28.24
		26.5 percent	21.9 percent
Source: Cascades Recovery, 2013			

Table 5 | Diversion performance for single-stream and dual-stream programs

All single-stream programs					
Municipality	**Households**		**Quantity/HH (kg)**		
	2003	**2011**	**2003**	**2011**	**Increase/decrease**
Program 1	331,000	411,800	248.4	225.7	-9.2 percent
Program 2	959,000	882,268	155.2	175.1	12.9 percent
Program 3	149,339	179,013	237.1	244.5	3.1 percent
Program 4	253,700	325,831	171.5	233.5	36.1 percent
Weighted avg			183.1	204.2	11.5 percent
All dual-stream programs					
Municipality	**Households**		**Quantity/HH**		
	2003	**2011**	**2003**	**2011**	**Increase/decrease**
Program 5	194,200	211,921	158.5	188.0	18.6 percent
Program 6	170,500	185,181	158.2	218.3	38.0 percent
Program 7	177,700	207,660	216.6	220.3	1.7 percent
Program 8	321,700	382,873	207.6	164.4	-20.8 percent
Weighted avg			188.7	191.3	1.4 percent
Single-stream programs (minus negative growth municipality)					
Weighted avg			167.2	197.8	18.3 percent
Dual-stream programs (minus negative growth municipality)					
Weighted avg			177.4	208.4	17.4 percent
Source: Cascades Recovery, 2013					

Their decisions are bearing fruit. Previously single-stream, the town of Torbay was recycling at a rate of approximately 36 percent in September 2010 when they decided to abandon their single-stream program for curbside sorting instead. Results were immediate. The town recycles over 40 percent and expects to reach 50 percent before or during the 2013 year.

Considerations for the future

The cost differential between the two systems not only continues to favor dual-stream recycling, but it can be suggested it is getting even more pronounced and the premium comes without any real diversion or revenue benefits. Looking at Toronto, Canada's largest city, the latest processing tender results shows single-stream recycling is will increase this disparity. With an ever-increasing list of materials to be managed in the future (see Table 6 for the list of current 126 different paper and packaging materials on page 19), it is easy to see that single-stream approaches will not be able to control costs when compared to dual-stream.

Having to separate fibers and containers from a single, mixed stream of materials is reasonably possible. Add in flexible packaging and the task becomes more than challenging. Flexibles (e.g., pouches, films, etc.) act similar in air to sheets of fiber and create operational challenges when using rotating screens, which are common to single-stream facilities for the separation of fibers and containers. In dual-stream programs, the flexibles can be added to container stream and removed with a combination of trommels and air, leaving the rigids to be processed with magnets, eddy currents and optical sorters.

Consider the changing fiber stream and the dramatic decrease in newspaper in the mix to less than half that generated 10 years ago. This means there will be less and less processing of fibers. MRFs will simply remove old corrugated cardboard (OCC) using an inexpensive OCC screen and bale the rest. To illustrate, the last City of Toronto and Region of Durham requests for proposals required only OCC and mixed paper to be generated. Old newspaper pulp (ONP) is no longer a recognized marketable commodity.

So why "force" the sorting of 100 percent of the recyclables, when only the container stream now requires any significant infrastructure? A recycling system where fibers and containers are separated at the curb means much less overall infrastructure and, ultimately, much lower overall costs. Alternating weekly collection of fibers and containers or split carts for those looking for cart collection

Table 6 | Materials

Printed Paper
Newspaper
Newspaper inserts
Magazines
Catalogues
Telephone directories
Hardcover books
Paperback books
Other printed media
Residential paper
Miscellaneous papers

Paper Packaging
Old corrugated containers (OCC)
Waxed OCC
Old boxboard
Wet strength boxboard
Moulded pulp
Kraft paper
Paper cup (hot) (polycoated liner)
Paper cup (hot) (biodegradable liner)
Paper cup (cold) (waxed)
Paper cup (cold) (two-side polycoated)
Multi-laminated paper packaging
Other paper packaging

Multi-layer (Composite packaging paper as primary component)
Polycoated milk cartons
Aseptic containers
Polycoated boxboard
Multi-laminated paper-based pkg

Glass
Clear liquor glass
Colored liquor glass
Clear beer glass
Colored beer glass
Refillable beer glass
Clear food grade bottles and jars
Colored food grade bottles and jars
Ceramic bottles and jars
Pyrex/Corelle type glass

Metals
Steel cans
Steel (all) paint cans
Steel aerosol cans
Spiral wound cans (steel ends)
Steel gas cylinders
Aluminum beverage cans
Aluminum cans
Aluminum aerosol cans
Aluminum foil and foil containers
Bi-metal containers/aerosols

Plastics
PET (No. 1)
PET bottles
PET jars
PET clamshells
PET trays
PET tubs and lids
PET sealed packaging
PET cold drink cups
PET films
PET strapping
PET-G (all)
PET-N (all)

HDPE (No. 2
HDPE bottles
HDPE Jars
HDPE pails
HDPE trays
HDPE tubs and lids
HDPE planter pots
HDPE films
LDPE cushion packaging

PVC (No. 3)
PVC bottles
PVC jars
PVC tubs and lids
PVC sealed packaging
PVC films

LDPE (No. 4)
LDPE bottles
LDPE jars
LDPE tubs and lids
LDPE/LLDPE films

PP (No. 5
PP bottles
PP jars
PP clamshells
PP trays
PP tubs and lids
PP sealed packaging
PP cold drink cups
PP planter pots
PP cushion packaging
PP films
PP strapping

PS (No. 6)
PS bottles
PS clamshells (rigid)
PS clamshells (XPS)
PS trays (rigid)
PS trays/plates (XPS)
PS meat trays (XPS)
PS tubs and lids (rigid)
PS tubs and lids (HIPS)
PS sealed packaging
PS cold drink cups (rigid)
PS hot drink cups (EPS)
PS planter pots
PS cushion packaging (EPS)
PS films

Other – Known (No. 7
PLA bottles
PLA clamshells
PLA cold drink cups
PHA bottles
EVA films
EVOH films

Other – Generic (No. 7)
Other bottles
Other jars
Other clamshells
Other trays
Other tubs and Lids
Other sealed packaging
Other cold drink cups
Other planter pots
Other cushion packaging
Other films
Other strapping
Other plastics – undefined

Multi-layer (Composite packaging plastic as primary component)
Multi-laminated plastic-based pkg (50+ combinations)
Multi-laminated juice/drink pouches
Multi-plastic plastic-based pkg

Other Packaging
Textile packaging
Wood packaging
Other strapping
Plastic/metal tubing
Other blended packaging
Degradable shopping bags
Degradable containers

Source: Cascades Recovery, 2013

can ensure collection costs are on par with single-stream.

The dangers of uncertainly

"The Signal and the Noise" clearly differentiates between risk, which you can at least attempt to quantify and uncertainty, which is like measuring the unknown and much harder to quantify.

This is perfectly illustrated in the fiscal crash of late 2008. Commodity prices dropped dramatically during the crash consistent with a lack of manufacturing. Supply outstripped demand as companies reduced capacities. When times are tight, buyers of recyclables always gravitate to the highest-quality materials knowing they have more control over their costs. Some single-stream facilities at this time had to work harder to move their materials as quality became more of an issue, and MRFs and municipalities gave up material revenues. Thankfully, however, the market has recovered, but the experience serves as a valuable lesson.

Uncertainties relating to single-stream recycling are numerous and have the potential to significantly impact recycling and its potential environmental and social benefits in the future. These include the costs of extensive equipment upgrades and technological improvements to process the increasing array of continually-evolving packaging types (if they are even added at all in a single-stream system for fear of impacts on core materials). It also includes the risk of material values decreasing as more higher-quality materials become available under end-of-waste provisions and mandated source separation programs.

With these uncertainties, the signals clearly point to dual-stream as the system that offers lower costs, similar diversion and more flexibility to add more materials in a more cost-effective manner. RR

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