

Fibre Optical Sorting System Niagara Region

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1. INTRODUCTION

1.1 Introduction

The Regional Municipality of Niagara (herein referred to as Niagara Region) installed a new Fibre Optical Sorting System (FOSS) at its Materials Recycling Facility (MRF). The FOSS was procured through competitive process and was designed, manufactured, supplied, installed and commissioned by Van Dyk Baler Corporation (Van Dyk). The FOSS was commissioned in December 2015.

1.2 Project Goals and Objectives

The FOSS was installed in the MRF to increase the recovery of old corrugated cardboard (OCC) and boxboard (OBB) from the newsprint stream and to reduce the level of contamination in the newsprint stream. Specifically, the FOSS will enable Niagara Region to increase the resale value of newsprint.

2. BACKGROUND

2.1 Community Profile

Known world-wide as both the home of Niagara Falls and as a wine producing region, Niagara Region is comprised of twelve local municipalities: Fort Erie, Grimsby, Lincoln, Niagara-on-the-Lake, Niagara Falls, Pelham, Port Colborne, St. Catharines, Thorold, Wainfleet, Welland and West Lincoln.

Geographically, Niagara Region has a total area of 1,852 km² and is situated on the Niagara Peninsula, bordered on the north by Lake Ontario, on the south by Lake Erie, on the east by New York State and the Niagara River, and to the west by the City of Hamilton and Haldimand County. The population of Niagara Region, according to the 2014 Statistics Canada population estimate, is 446,192.



Niagara Region reported to Resource Productivity & Recovery Authority (RPRA) in 2015 that Blue Box recycling included 163,930 single-family residences and apartments with two (2) to six (6) units, and 31,521 multi-residential units with seven (7) or more units. At that time, Niagara Region reported that 37,375 tonnes of residential Blue Box recyclables were marketed.

2.2 Waste Management System

Niagara Region provides all waste collection, processing and disposal services for the residential sector and eligible Industrial, Commercial and Institutional (IC&I) sector for its member municipalities, including:

- A weekly, two-stream recycling collection and processing program. Curbside collection services are contracted out to Emterra Environmental; processing services are contracted out to Niagara Recycling;
- Weekly organics (Green Bin/Cart) diversion program;
- Weekly garbage collection with a one (1) bag garbage limit for low density residential units and a limit of 12 bags/cans per week for high rise residential properties; with varying limits for the Industrial, Commercial, Institutional and Mixed Use properties;
- Bulky/white goods and leaf & yard waste collection;
- Three permanent Household Hazardous Waste (HHW) Depots located in Welland, Thorold and Grimsby, and one partial HHW Depot located in Fort Erie;

Four landfill/drop-off depot locations, including a privately owned site at Walker Environmental Group, are available to serve the public as recycling centres, where the following residential materials are accepted:

Tipping Fees apply to:	Accepted, at no charge:
Household Waste	Leaf and Yard Waste
Scrap Metal	Blue and Grey Box Recyclables
Construction and Demolition Materials	Tires
Appliances containing CFC's	Electronics
Shingles	HHW materials

Niagara Region is also responsible for by-law enforcement, public education and promotion of all their programs offered.

2.3 Current Waste Management Performance

Based on posted RPRA Generally Accepted Principles (GAP) data, Niagara Region's 2015 diversion rate exceeded 50% of waste generated. Less than 20% of Niagara Region's 2015 residential waste stream was recycled through the Blue Box program. The performance information is summarized in Table 1.

Table 1: Niagara Region's Waste Management System Overview (2015 RPRA GAP)

Total Residential Waste Generated		Total Residential Waste Diverted		Total Residential Waste Disposed		Residential Recyclables Diverted	Total Residential Diversion Rate	Total Residential Disposal Rate
Tonnes	Kg/Cap	Tonnes	Kg/Cap	Tonnes	Kg/Cap	%	%	%
195,149	434.53	104,564	232.83	90,585	201.70	19.15%	53.58%	46.42%

2.4 Program Challenges

With pressure from local end markets to produce higher quality newsprint, and the lack of markets for loose newsprint, in 2013 Niagara Region began investigating the option to improve the quality of its newsprint in order to gain a higher per tonne price as well as increase the capture of OBB/OCC from the newsprint stream.

Niagara Region processes approximately 50,000 tonnes of fibre annually which includes approximately 25,000 tonnes of fibre from the Region of Waterloo's curbside collection program. The fibre mix over the past few years had changed drastically with newsprint volumes dropping as a result of increased use of electronic devices. Achieving end market specifications were more challenging to meet using traditional manual sorting.

At the time, Niagara Region was shipping its processed newsprint to Resolute Forest Products (Resolute), a local mill, at contamination levels over 20%, resulting in monthly downgrades averaging \$10 per metric tonne. Downgrades were applied to loads of newsprint with a contamination rate of over 9%; in 2014, the downgrades totaled \$240,488.

In May 2014, Niagara Region applied for Continuous Improvement Fund (CIF) funding to purchase and install a FOSS at its MRF. The main motivation for the installation was to increase separation efficiencies and produce higher revenues from curbside collected mixed fibres produced at the MRF. Specifically, the FOSS would enable the Region to increase the resale value of newsprint and increase the volume of OBB/OCC sold to end markets.

3. APPROACH

3.1 Set Up and Implementation

An RFP was issued for the design, manufacture, ship, supply, install and commission of a FOSS. The vendor selected was Van Dyk. Table 2 below provides a summary of the budgeted and actual procurement and installation dates for the FOSS.

Table 2: Procurement and Installation Process of the FOSS			
#	Item	Budgeted Date	Actual Date
1	Procurement process begins	January 2014	January 2014
2	Vendor selected	March 2014	March 18, 2014
3	Purchase order issued	March 2014	June 12, 2014
4	2015-RFP-05 agreement term effective	June 3, 2015	June 5, 2015
5	Delivery of all equipment	Award date + 4 months	November 2015
6	Completion of installation	Within 4 weeks of delivery	December 2015
7	Start up and initial commissioning	Within 2 weeks of installation	December 7, 2015
8	Performance testing start date	Within 2 weeks of start-up	February 10-11, 2016
9	Amending agreement start date	June 15, 2016	June 15, 2016
10	Provisions of plans and spec	14 days following start date	July 28, 2016
11	Completion of installation	September 2016	September 27, 2016
12	Acceptance testing audits	October 2016	September 28-30, 2016

The FOSS is required to optically remove contamination from the newsprint stream, which includes newspapers, magazines, catalogues, telephone books, soft cover books, office paper and shredded paper. The FOSS has a maximum throughput capacity of 24 metric tonnes per hour.

Delivery of equipment took place in early November 2015, and installation took place over a five-week period. The FOSS was commissioned on December 7, 2015. The process flow of the equipment is as follows:

- 1) Prior to the FOSS, mixed fibre including OCC, OBB and newsprint, as well as plastic film, polycoat cartons, containers and residue travel along the pre-sort line and OCC screen. The smaller materials are sent to the FOSS where they are split into two equal streams and conveyed to a vibratory feeder. The feeder spreads the material evenly across the nine (9) foot width.
- 2) Material cascades onto an accelerator conveyor that is 9 feet wide and moving at a speed of about 500 feet per minute. This conveyor thinly distributes material to the optical sorters.
- 3) The two twin Titech optical sorters are programmed to recognize and eject OCC, OBB, polycoat cartons and plastics utilizing infrared technology. These high-resolution scanning units' sort by colour and the light reflective properties of the material.
- 4) The ejected material consisting primarily of OCC and OBB is transferred to an existing sorting line for further processing and baling.
- 5) The pass through material consisting of newspaper, magazines and office paper is transferred to existing sort lines for final sorting. The clean paper is then loaded and transported to end market.

The original target requirements for the FOSS were:

- Provide a throughput capacity of 24 metric tonnes per hour;
- Eject 85% of the OBB/OCC and 85% total of the PET, HDPE, PP, PS, film and polycoat cartons in the stream;
- Maintain cross contamination levels of newspaper to no more than 15%;
- Operate at a minimum resolution of 160,000 measure spots per second in a scan point size of 6 x 6 mm across the full width of the conveyor;
- Provide no more than 180 watts scan light intensity per metre machine scanning width, per optical unit, to minimize electrical costs;
- Function with a total belt width equal or greater than 5600 mm.

Niagara Region's Legal and Court Services Division established a holdback on the contract with Van Dyk. If Van Dyk had successfully demonstrated that the equipment met the Region's objectives, the holdback would have been released. As part of the contingency in the Original Agreement, if the equipment did not meet the expected targets, Van Dyk would be allowed to modify the equipment, as necessary, at its sole cost to ensure targets are met. Though Van Dyk was able to meet the technical requirements and throughput requirements, they did not achieve the ejection targets. As such, Van Dyk signed an amending agreement on June 15, 2016. As part of the amending agreement, Van Dyk constructed and installed a new sorting line, including all associated equipment required for its use at the Region's Recycling Centre.

The additional sort line provided better distribution of material with reduced burden depth which allowed the Region to commence ejection of film plastic and plastic containers. These materials are more easily removed by quality control staff, thus improving newsprint and OBB/OCC quality. New targets of OBB/OCC ejection rates greater than 70%, and plastic/polycoat carton ejection rates greater than 55% were established, in which Van Dyk was successful in achieving.

3.2 Monitoring and Measurement Methodology

In measuring the impact of the new technology, Niagara Region focused on basic measurements that supported the performance of the equipment: Post Sort Fibre Audits and FOSS positive/negative ejection audits (contamination levels pre and post installation, attached as Appendix A) and revenues.

3.2.1 MRF Audits

In order to effectively measure and monitor the performance of the FOSS, sales revenue reports for newsprint and OBB/OCC and pre-installation audits of the material passing through the processing system were used as base-line information. From there, the post-installation performance of the FOSS was measured and reported against. The true measurement of the FOSS performance will be the level of OBB/OCC recovery and the final quality of the newsprint marketed.

Niagara Region dedicated staff to developing and conducting composition studies. Over the years, Niagara Region has developed a comprehensive program designed to rigorously assess both feedstock and end product quality. In regards to the FOSS, Appendix B provides the auditing procedures used to determine the pre and post-installation performance of the FOSS.

Data in Appendix A shows a significant percentage decrease in both the outthrows and prohibitives categories when comparing pre and post-installation audits. Table 3 summarizes the audit results, pre- and post-installation of the FOSS. The outthrows category includes: OBB, OCC and notebook covers. The prohibitives category includes: containers, loose plastic film, bundled plastic film, garbage, and household hazardous waste (HHW).

Table 3: Niagara Region's Average % Contamination in the Newsprint

Auditing Period	Audit Date Range	Average % Outthrows	Average % Prohibitives	Average % Contamination
Pre FOSS and Additional Sort Line Installation Newsprint Quality After Quality Control (QC) - From Newsprint Storage Bunker	Jan-Dec 2015 (Post Sort Fibre Audits, Baseline Data)	22.7%	7.4%	30.1%
FOSS INSTALLED: DEC 2015				
Post FOSS Installation, Pre Additional Sort Line Newsprint Quality Before QC - From Negative Ejections	Feb and Sept 2016 (+/- Ejection Audits)	13.7%	8.8%	22.4%
Post FOSS Installation, Pre Additional Sort Line Installation Newsprint Quality After QC - From Newsprint Storage Bunker	Jan-Oct 2016 (Post Sort Fibre Audits)	13.1%	5.0%	18.1%
ADDITIONAL SORT LINE INSTALLED: END OF SEPT 2016				
Post FOSS and Additional Sort Line Installation Newsprint Quality After QC - From Newsprint Storage Bunker	Nov 2016-May 2017 (Post Sort Fibre Audits)	7.5%	3.5%	11%
% Change - Pre-Installation vs. Post-Installation of FOSS and QC Sort Line		15.2%	3.9%	19.1%

The percentage of outthrows and prohibitives in the pre-installation audits (2015 audit data) averaged 30.1%. After implementation of the FOSS, the percentage of outthrows and prohibitives present in the fibre stream decreased to an average of 11%. One should note that minor adjustments were made to the system between the end of September 2016 and November 2016. Therefore, the audit data for this adjustment period is included in the "Post FOSS Installation, Pre Additional Sort Line Installation Newsprint Quality After QC - From Newsprint Storage Bunker" audits. As a result, Niagara Region decreased the

contamination levels in its marketable newsprint from 30.1% to approximately 11.0%. **This represents a 63.5% improvement in quality compared to the pre-installation quality.**

3.2.2 Recovery and Revenue

Table 4 provides the tonnage and revenue performance, pre-installation (2015-Baseline), in comparison with and without installation of the FOSS (2016) at Niagara Region's MRF. As revenue comparisons are subject to commodity price fluctuations, of more significance is the impact in the outbound tonnes of newsprint and OCC/OBB. Figures are based on tonnes sold to end markets by Niagara Region and the sales revenues received.

Table 4: Niagara Region's Tonnage and Revenue Performance for Newsprint and OBB/OCC – Pre-Installation (2015) vs. Post-Installation (2016) of the FOSS

Pre-Installation of FOSS (Baseline) - Revenues and Tonnes (2015 Data)

#	Item	Gross Revenue	Tonnes	Rev / Tonne
1	ONP Revenues & Tonnes (Jan-Dec 2015)	\$2,624,548	38,038	\$69.00
2	OCC/OBB Revenues & Tonnes (Jan-Dec 2015)	\$1,545,601	14,325	\$107.89
3	Total:	\$4,170,148	52,363	\$79.64

Post-Installation of FOSS - Revenues and Tonnes (2016 Data)

#	Item	Gross Revenue	Tonnes	Rev / Tonne
1	ONP Revenues & Tonnes (Jan-Dec 2016)	\$2,667,188	27,676	\$96.37
2	OCC/OBB Revenues & Tonnes (Jan-Dec 2016)	\$2,735,534	22,875	\$119.59
3	Total:	\$5,402,722	50,551	\$106.88
4	Incremental Annual Revenue vs. Actual 2015 Data	\$1,232,574		
5	Incremental Annual Operating Savings vs. 2015 Baseline	\$66,731		
6	Incremental Annual Revenue vs. Actual 2015 Data	\$1,299,305		

With No Installation of FOSS - Revenues and Tonnes (2016 Data)

#	Item	Revenue	Tonnes	Rev / Tonne
1	ONP Revenues & Tonnes (Jan-Dec 2016)	\$3,298,815	36,722	\$89.83
2	OCC/OBB Revenues & Tonnes (Jan-Dec 2016)	\$1,629,439	13,829	\$117.82
3	Total:	\$4,928,254	50,551	\$97.49
4	Incremental Annual Revenue vs. Actual 2015 Data	\$758,106		
5	Incremental Annual Operating Expenses vs. 2015 Baseline	(-\$7,961)		
6	Incremental Annual Revenue vs. Actual 2015 Data	\$750,145		

With the installation of the FOSS, newsprint tonnes sold to end markets decreased from 2015 to 2016 by approximately 10,362 tonnes, or 27.2%. This is a result of a decrease in OCC/OBB in the marketed newsprint, in addition to an overall reduction in inbound newsprint tonnages based on factors such as online shopping and declining newspaper production trends. OCC/OBB tonnes sold to end markets increased from 2015 to 2016 by approximately 8,550 tonnes, or 59.7%. Newsprint sales revenue increased by approximately \$42,640, or 1.6%. OCC/OBB sales revenue increased by \$1,189,933, or 77%. In addition to improved commodity pricing received in 2016, another contributing factor to the increase in sales revenue was a result of fewer downgrades from the paper mill in 2016, directly related to the implementation of the FOSS.

If the FOSS had not been installed, newsprint tonnes would have decreased from 2015 to 2016 by 1,316 tonnes, or 3.5%; OCC/OBB tonnes would have decreased from 2015 to 2016 by 496 tonnes, or 3.5%. Newsprint sales revenue would have increased by approximately \$674,267, or 25.7%. OCC/OBB sales revenue increased by \$83,838, or 5.4%. Therefore, the overall financial effect attributable to the FOSS after all expenses and market adjustments is \$549,159 per year.

3.2.3 Monitoring Challenges, Limitations and Solutions

The main metrics for measurement of this project did not present any unusual challenges. Records for material recovery and sales are tracked as part of the day-to-day management of the facility, and readily available for year-to-year comparison. Systems are in place to manage and report this data annually to the Resource Productivity and Recovery Authority (RPRRA). The audit procedures are clear and replicable.

4. PROJECT RESULTS AND ANALYSIS

4.1 Project Results and Analysis

Niagara Region installed and commissioned the FOSS in December 2015, and this system is now an integral component of Niagara Region's MRF and recyclables processing system. In operation, the system has not met the original goal of reducing contamination levels in the newsprint product to 9% but has reduced contamination levels to approximately 11% representing a decrease of 63.5% from the pre-installation figure of 30.1%. However, the system has exceeded expectations for additional OBB/OCC tonnages recovered and associated revenues.

As previously noted, audits conducted post installation revealed that the FOSS reduced marketable newsprint contamination rates by 63.5% when compared to baseline audit data. In general, the installation of the FOSS has resulted in the following:

- Improved overall quality of newsprint
- Redirecting OCC and OBB from the newsprint end market (which ends up in the residue stream) to the OBB/OCC market;
- Higher revenue generation; and
- No requirement to hire additional sorters resulting in cost avoidance.

4.2 Lessons Learned and Next Steps

There are a number of lessons to be shared by Niagara Region's experience, particularly for those programs which might be considering incorporating fibre optical sorting technology into their MRF process.

4.2.1 System Throughput and Material Distribution

The maximum rated throughput of each optical unit was 12 tonnes per hour. Typical feed rates are at or above the 12 tonnes per hour system capacity. This results in reduced recovery rates and higher levels of collateral newsprint that is ejected with the OBB/OCC and plastics. Frequent surges in material flowing to the FOSS further impacts the recovery and purity rates. Material surging is an ongoing issue at the MRF due to the nature of the feedstock. The use of clear or blue bags for curbside storage of fibres and oversized OCC from curbside collection programs negatively impacts the flow of material through the sorting process. Installation of a bag breaker would address the bag issue, reduce surging and allow sorters to focus more on film and container recovery in the pre-sort area.

As a result of the challenges Niagara Region experienced with the system throughput, the vendor, Van Dyk has reduced its optical sorting capacity for these units from 12 tonnes per hour to 8 tonnes per hour in order to ensure that higher recovery rates can be achieved. This means that Niagara Region should optimally have three optical units to process its volume. The true advantage of installing a third unit would be further enhancement of end product quality. However, the end products marketed, under current conditions, well exceed quality standards. Furthermore, based on current operation and labour costs, the installation of additional optical units is still preferable when compared to an additional shift being scheduled on the MRF's fibre line.

The key consideration when installing any optical sorting system is material distribution. The design of the FOSS included a 30-inch wide conveyor feeding a 9-foot wide vibratory conveyor, which feeds the 9-foot wide optical accelerator conveyor. Surges in material cannot be efficiently distributed, resulting in greater inefficiencies as the material clumps together and the scanning units are unable to see all the targeted materials for ejection. Furthermore, the FOSS does not detect OCC/OBB that is white or grey. If the OBB/OCC is brown on one side and white/grey on the other it will have a 50% chance of being ejected based on its positioning when being detected at the scan point. However, other light shades and/or colours of OBB/OCC, such as yellow and orange, are correctly detected.

Weather is also a major factor that impacts the FOSS. Wet paper or snow/ice will cause greater clumping than under dry conditions. The air nozzle bar also clogs with snow/ice during the winter months resulting in more frequent cleaning activities and material jams. As a result, the feed rate must be reduced to process under wet and snow /ice conditions. These events are rare and do not significantly impact the operational efficiencies of the MRF's fibre line. Therefore, these events do not justify alternative operational plans such as adding an additional shift to the fibre line.

Another consideration is the vibratory feeders. Although the 9-foot wide feeders do spread out the material, improvements in equipment design are required. The feeders are operating at maximum capacity; larger or faster feeders are required to more effectively disperse the material. This would also reduce feed problems experienced during wet conditions. Singularization is critical to achieving the highest level of ejection.

4.2.2 Air Quality

The optical sorting units also generate a significant amount of airborne dust. Since there is no fines screen in the process, there are large quantities of loose shredded paper that further compounds the dust issue. In order to mitigate the dust issue, Niagara Recycling designed and installed custom hoods over the eject chamber with a series of curtains to guide the dust and shredded paper into containers below the ejection chamber. This has proven to be very successful.

4.2.3 Bale Storage

At Niagara Region's MRF, the installation of the FOSS was relatively seamless but did require a significant amount of floor area resulting in a loss of bale storage area. With the 59.7% increase in OBB/OCC tonnes recovered, storage and timely movement of baled product is an ongoing challenge that requires significant attention from the MRF operator, Niagara Recycling.

4.2.4 System Design

The FOSS is designed to eject OCC, OBB, polycoat cartons, and various plastics including PET, HDPE, PP, PS and film plastic. Initially, in December 2015, the positively ejected items were transferred to the OCC separator overs line. Due to the very high burden depth, sorting staff were unable to remove all the smaller plastics and film, resulting in unacceptable levels of contamination in the OBB/OCC stream. Due to end market quality concerns, the optical units were reprogrammed to eject only OCC, OBB and polycoat cartons. In late September 2016, as requested by Niagara Region, Van Dyk installed a new separate quality control sorting line to allow dedicated sorters to clean the positively ejected stream. This allowed the Region to commence positive ejection of all plastics as well as the OCC, OBB and polycoat cartons.

With full ejection of all targeted materials, the audit results as presented in Table 3 indicate a quality level of only 11%, which is a 63.5% change from the pre-installation audits. The post-installation audits reveal that 70% of the OBB/OCC and 58% of the plastic film, containers and polycoat cartons are being ejected. It is interesting to note that the optical units will eject virtually all the missed items if placed back on the accelerator conveyor. The reason why items are missed is due to the throughput level and material distribution. The detection capabilities of the Titech units are excellent.

One of the challenges with ejecting film and other plastic containers along with OCC, OBB and polycoat containers is the percentage of air ejects occurring in the optical chamber. The agreement with Van Dyk allowed for up to 15% newsprint and other papers to be ejected, however, the audit results indicate just

over 30%. The reason for this is the high amount of plastic film. Due to the size of the plastic film, it overlaps with the other items causing false ejections. Sorters on the quality control line do remove some newsprint but their primary objective is to remove film, plastics and polycoat cartons. The newsprint that remains in with the OBB/OCC has not been an issue with the fibre mills. The percentage of newsprint in the OBB/OCC is approximately 10% by weight.

5. PROJECT BUDGET

5.1 Project Budget

The budgeted vs. actual procurement and installation costs for the FOSS appear in Table 5.

Table 5: Budget vs. Actual Procurement/Installation Costs for the FOSS

Budgeted Procurement and Installation Costs

#	Item	Cost	Date
1	Design, Manufacture, Ship, Supply, Install and Commission Fibre Optical Sorting System	(\$2,239,669)	September 30, 2014
2	Supply and Install Air Compressors	(\$268,660)	
3	Total (includes Net HST):	(\$2,508,329)	

Fibre Optical Sorting System (FOSS) - Actual Procurement and Installation Costs

#	Item	Cost	Date
1	Upon Execution of Agreement by Successful Proponent - 5%	(\$110,725)	June 5, 2015
2	Upon Completion of Detailed Engineering, including submission of final plan & drawings - 10%	(\$221,450)	August 6, 2015
3	Upon Delivery of all Equipment - 25%	(\$553,626)	July 6, 2015
4	Upon Completion of Installation - 45%	(\$996,527)	September 18, 2015
5	Upon Successful Acceptance Testing - 15%	(\$332,176)	October 3, 2016
6	5% GST for FOSS (Reflects Net HST Portion Only)	(\$1,949)	September 18, 2015
7	Air Compressor (Pneu Air)	(\$297,183)	March 29, 2016
8	Electrical Supply (Golden Horseshoe Electrical)	(\$32,684)	November 13, 2015
9	Electrical Supply (Hallex Engineering)	(\$4,783)	August 25, 2015
10	Install Column, Platform & Staircase (Colbey Fabricating)	(\$9,869)	January 14, 2016
11	Total (includes Net HST):	(\$2,560,973)	

Difference between Budgeted vs. Actual Procurement and Installation Costs

#	Item	Difference
1	Upon Execution of Agreement by Successful Proponent - 5%	
2	Upon Completion of Detailed Engineering, including submission of final plan & drawings - 10%	\$23,216

3	Upon Delivery of all Equipment - 25%	
4	Upon Completion of Installation - 45%	
5	Upon Successful Acceptance Testing - 15%	
6	5% GST for FOSS (Reflects Net HST Portion Only)	
7	Air Compressor (Pneu Air)	(\$28,524)
8	Electrical Supply (Golden Horseshoe Electrical)	(\$32,684)
9	Electrical Supply (Hallex Engineering)	(\$4,783)
10	Install Column, Platform & Staircase (Colbey Fabricating)	(\$9,869)
11	Total (includes Net HST):	(\$52,644)

5.2 Payback Period

Table 6 provides a breakdown of the payback calculation for the FOSS. These results are based on the total capital and installation cost, with and without CIF funding, divided by the difference in revenue between the pre-installation (2015-Baseline), post-installation (2016) and with no installation of the FOSS.

Table 6: Payback Calculation for the Fibre Optical Sorting System

Pre-Installation of FOSS (Baseline) Revenues (2015 Data)

#	Item	Revenue
1	Newsprint Revenues (January-December 2015)	\$2,624,548
2	OBB/OCC Revenues (January-December 2015)	\$1,545,601
3	Total Revenues:	\$4,170,148

Post-Installation of FOSS Revenues (2016 Data)

#	Item	Revenue
1	Newsprint Revenues (January-December 2016)	\$2,667,188
2	OBB/OCC Revenues (January-December 2016)	\$2,735,534
3	Total Revenues:	\$5,402,722
4	Incremental Annual Revenue vs. Actual 2015 Data	\$1,232,574
5	Incremental Annual Operating Savings vs. Baseline	\$66,731
6	Incremental Annual Revenue vs. Actual 2015 Data	\$1,299,305

With No Installation of FOSS Revenues (2016 Data)

#	Item	Revenue
1	Newsprint Revenues (January-December 2016)	\$3,298,815
2	OBB/OCC Revenues (January-December 2016)	\$1,629,439
3	Total Revenues:	\$4,928,254
4	Incremental Annual Revenue vs. Actual 2015 Data	\$758,106
5	Incremental Annual Operating Expenses vs. Baseline	(\$7,961)
6	Incremental Annual Revenue vs. Actual 2015 Data	\$750,145

FOSS - Payback Period

#	Item	Cost and Revenue
1	Capital and Installation Cost without CIF Funding	(\$2,560,973)
2	ONP/OBB/OCC Revenue - No Installation of FOSS	\$750,145
3	ONP/OBB/OCC Revenue - With Installation of FOSS	\$1,299,305

4	Incremental Revenue with Installation of FOSS	\$549,159
5	Capital Payback Period (months) without CIF Funding	56
6	CIF Funding for Purchase of FOSS (includes Net HST)	\$1,017,600
7	Capital and Installation Cost, with CIF Funding	(\$1,543,373)
8	Capital Payback Period (months), with CIF Funding	34

Based on the above payback calculations, the FOSS would pay for itself in approximately 4.67 years, or 56 months, without the CIF funding. If the CIF funding is applied to the Capital and Installation Cost, the Capital Payback Period decreases to approximately 2.8 years, or 34 months.

6. CONCLUSIONS

The installation of the FOSS has been a tremendous success for Niagara Region, resulting in higher recovery rates of OBB/OCC, less contamination in the newsprint sent to market, both resulting in significantly higher revenues. Other MRFs contemplating the installation of a FOSS can learn from Niagara Region's experience in a number of ways:

- 1) In order to ensure efficient material distribution the optical sorter feed rates should be in the range of 8 to 10 tonnes per hour. A better vibratory feeder system in conjunction with reduced throughput would allow MRFs to achieve positive ejection rates of OCC and OBB in the 80 to 90% range, compared to Niagara's 70% ejection rate.
- 2) Ejecting plastic film and other plastic containers plus polycoat, OCC and OBB will result in higher levels of collateral newsprint being ejected. Depending on end market specifications, this extra newsprint could devalue the OBB/OCC sold to board mills, although this has had no impact for Niagara Region. Removal of film and containers prior to the FOSS is recommended, when possible. Alternatively, installing another optical sorter for plastics downstream is worth consideration. Another option would be to install ONP screens and have the overs go to an optical sorter to eject OCC and OBB only and the unders to an optical sorter to remove all fibre including ONP from the plastic containers, film and polycoat cartons. The ONP screens would be wide enough to feed the optical accelerator conveyors directly, thus eliminating the need for vibratory feeders.
- 3) A dedicated sort line should be installed to QC the positively ejected materials from the optical sorter. Due to the nature of the fibre stream, purity rates will be lower than compared to, for example, a PET single eject optical sorter which has purity rates of well over 90%. By addressing the concerns noted in section 4.2, the ejected fibre stream should have purity rates in the 80% to 85% range. Niagara's purity rates are close to 70% due to feed rates, material distribution and ejection of plastic film and plastic containers.
- 4) In order to reduce dust levels and winter related issues with the nozzle bar, consideration should be given to installing a fine screen upstream that would remove shredded paper, glass and snow and ice. This would reduce nozzle bar issues, dust generation and extra cleaning requirements.
- 5) Compressed air consisting of high quality and sufficient quantity is key with any optical sorter system. Consideration should be given to building in 100% system redundancy. If one unit is down for preventative maintenance or breakdowns, a second unit should be available to keep fibre line processing while second unit is being repaired.
- 6) This project has demonstrated that the Titech optical sorting equipment supplied by Van Dyk has the capability of accurately distinguish OCC and OBB from ONP at a high throughput level utilizing near infrared and visual spectrometry sensor technology.
- 7) With the changing composition of the fibre stream and tighter specifications on the export market, producing an acceptable Sorted Residential Paper (56) grade utilizing a combination of OCC and ONP

screens and manual labour will be difficult. Optical sorting technology provides the necessary tools for MRF's to produce this grade and open other marketing opportunities to supply newsprint to mills that produce moulded pulp products and fibre insulation domestically. In addition, with the forecasted growth in containerboard packaging due to online shopping, demand for OBB/OCC is growing and the market price will continue to reflect this change. Therefore, recovering as much OCC and OBB from the ONP stream will increase revenues at Ontario MRFs.

In Niagara Region, the objective was to improve the quality of newsprint by ejecting all possible items from the fibre stream. It was determined that by removing the film and plastic containers optically, in addition to the OCC, OBB and polycoat cartons, the remaining missed items could be more easily removed on the two existing negative sort final quality control lines. This approach has allowed Niagara Region to achieve its 11% ONP quality and become a leader in MRF ONP quality in Ontario.

PHOTOS OF FIBRE OPTICAL SORTING SYSTEM



Figure 1: Vibratory feeder before FOSS

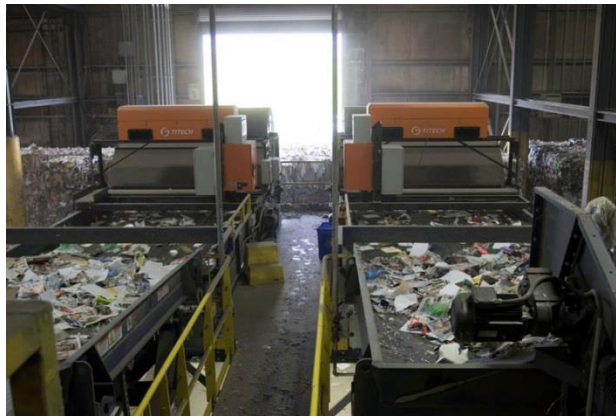


Figure 2: Two twin Titech optical sorters



Figure 3: Conveyer moving negatives to additional sort line



Figure 4: Additional conveyer leading to sort line



Figure 5: Post FOSS additional sort line



Figure 6: Newsprint storage bunker

APPENDIX A

Quarterly Composition Audits of Residue Stream - Pre- and Post-Installation of FOSS

Pre FOSS and Additional Sort Line Installation Newsprint Quality After QC - From Newsprint Storage Bunker

Date	Newsprint (lbs)	%	Outthrows (lbs)	%	Prohibitives (lbs)	%	Total Weight (lbs.)	%
2015 Q1 Audit Dates:								
February 6, 2015	167.50	75%	38.50	17%	17.50	8%	223.5	100%
February 11, 2015	190.00	71%	49.50	19%	26.50	10%	266	100%
February 20, 2015	190.00	70%	59.00	22%	21.00	8%	270	100%
March 3, 2015	185.00	71%	50.50	19%	26.00	10%	261.5	100%
March 13, 2015	202.00	79%	40.00	16%	12.50	5%	254.5	100%
March 17, 2015	160.50	72%	50.00	22%	12.50	6%	223	100%
2015 Q1 Average:	182.50	73%	47.92	19%	19.33	8%	249.75	100%
2015 Q2 Audit Dates:								
April 1, 2015	202.00	74%	47.00	17%	24.50	9%	273.5	100%
April 17, 2015	180.50	70%	56.00	22%	22.50	9%	259	100%
May 11, 2015	187.70	54%	125.00	36%	35.50	10%	348.2	100%
May 26, 2015	157.50	64%	67.00	27%	20.00	8%	244.5	100%
2015 Q2 Average:	181.93	65%	73.75	26%	25.63	9%	281.30	100%
2015 Q3 Audit Dates:								
July 29, 2015	166.50	54%	100.50	33%	39.50	13%	306.5	100%
August 3, 2015	142.50	49%	124.50	43%	24.50	8%	291.5	100%
August 18, 2015	147.50	52%	113.00	40%	22.50	8%	283	100%
August 24, 2015	171.00	63%	62.50	23%	38.00	14%	271.5	100%
August 31, 2015	189.00	71%	59.50	22%	19.00	7%	267.5	100%
September 1, 2015	189.00	71%	59.50	22%	19.00	7%	267.5	100%
September 8, 2015	190.00	73%	62.50	24%	8.50	3%	261	100%
September 18, 2015	183.50	74%	54.00	22%	11.00	4%	248.5	100%
September 22, 2015	155.00	75%	44.50	21%	8.00	4%	207.5	100%
September 30, 2015	190.00	73%	62.00	24%	10.00	4%	262	100%
2015 Q3 Average:	172.40	65%	74.25	27%	20.00	7%	266.65	100%
2015 Q4 Audit Dates:								
October 8, 2015	190.00	66%	70.50	25%	26.50	9%	287.00	100%
November 6, 2015	200.00	73%	60.50	22%	13.00	5%	273.50	100%
October 14, 2015	183.00	63%	77.00	27%	30.00	10%	290.00	100%
November 18, 2015	215.00	73%	65.00	22%	16.50	6%	296.50	100%
November 25, 2015	189.50	75%	50.50	20%	13.00	5%	253.00	100%
December 1, 2015	245.50	79%	51.50	17%	13.00	4%	310.00	100%
December 10, 2015	317.50	88%	33.50	9%	8.50	2%	359.50	100%
December 18, 2015	231.50	83%	36.50	13%	10.00	4%	278.00	100%

December 22, 2015	242.50	82%	40.50	14%	12.00	4%	295.00	100%
2015 Q4 Average:	223.83	76%	53.94	19%	15.83	5%	293.61	100%
Average- All Audits	191.77	70%	62.43	23%	19.34	7%	273.54	100%

Audit Category Definitions

Newsprint: Old Newsprint, Fine Paper, Magazines, Molded Paper and Unsortable Material. Unsortable material was deemed appropriate for this category based on the fact that the majority of unsortable material found in these audits consisted of small pieces of shredded paper.

Outthrows: All papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified including any of the following: OCC; OBB; Unbleached bags; Manila file folders; Boxboard; Post-it Notes; Brown Kraft Envelopes; Chipboard; Hard Cover Books

Prohibitives: Any materials which by their presence in a packing of paper stock, in excess of the amount allowed will make the packaging unusable as the grade specified; or any materials that may be damaging to mill equipment and shall include all non-paper items including but not limited to: Wood; Metal; Plastics; Tapes; Foil Laminated Papers; Asphalt Treated Papers; Spiral or Plastic-Bound; Electrocardiograms; Food Waste; Beater Dyed Papers; Glass; Rubber; Polystyrene; Photographs; UV Coated Papers; Carbon Paper; X-Rays; Wet strength Paper; Blueprints.

Post FOSS Installation, Pre Additional Sort Line Newsprint Quality Before QC - From Negative Ejections

Date	Newsprint (lbs)	%	Outthrows (lbs)	%	Prohibitives (lbs)	%	Total Weight (lbs.)	%
2016 Q1 Audit Dates:								
February 10, 2016	160.50	66%	48.00	20%	33.00	14%	241.50	100%
February 10, 2016	104.50	67%	39.50	25%	13.00	8%	157.00	100%
February 10, 2016	192.50	72%	54.00	20%	20.00	8%	266.50	100%
February 10, 2016	196.50	78%	40.00	16%	17.00	7%	253.50	100%
February 11, 2016	151.00	76%	29.50	15%	17.50	9%	198.00	100%
February 11, 2016	74.00	72%	16.00	16%	13.00	13%	103.00	100%
February 11, 2016	132.50	73%	27.00	15%	21.50	12%	181.00	100%
February 11, 2016	180.50	81%	28.00	13%	15.50	7%	224.00	100%
2016 Q1 Average:	149.00	73%	35.25	17%	18.81	10%	203.06	100%
2016 Q4 Audit Dates:								
September 28, 2016	214.50	82%	27.00	10%	19.50	7%	261.00	100%
September 28, 2016	199.50	85%	22.50	10%	14.00	6%	236.00	100%
September 29, 2016	200.50	81%	21.50	9%	24.50	10%	246.50	100%
September 29, 2016	217.00	82%	25.00	9%	23.00	9%	265.00	100%
September 30, 2016	180.00	79%	25.00	11%	22.00	10%	227.00	100%
September 30, 2016	172.50	83%	22.50	11%	13.00	6%	208.00	100%
2016 Q4 Average:	197.33	82%	23.92	10%	19.33	8%	240.58	100%
Average- All Audits	169.71	77%	30.39	14%	19.04	9%	219.14	100%

Audit Category Definitions

Newsprint: Old Newsprint, Fine Paper, Magazines, Molded Paper and Unsortable Material. Unsortable material was deemed appropriate for this category based on the fact that the majority of unsortable material found in these audits consisted of small pieces of shredded paper.

Outthrows: All papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified including any of the following: OCC; OBB; Unbleached bags; Manila file folders; Boxboard; Post-it Notes; Brown Kraft Envelopes; Chipboard; Hard Cover Books

Prohibitives: Any materials which by their presence in a packing of paper stock, in excess of the amount allowed will make the packaging unusable as the grade specified; or any materials that may be damaging to mill equipment and shall include all non-paper items including but not limited to: Wood; Metal; Plastics; Tapes; Foil Laminated Papers; Asphalt Treated Papers; Spiral or Plastic-Bound; Electrocardiograms; Food Waste; Beater Dyed Papers; Glass; Rubber; Polystyrene; Photographs; UV Coated Papers; Carbon Paper; X-Rays; Wet strength Paper; Blueprints.

Post FOSS Installation, Pre Additional Sort Line Installation Newsprint Quality After QC - From Newsprint Storage Bunker

Date	Newsprint (lbs)	%	Outthrows (lbs)	%	Prohibitives (lbs)	%	Total Weight (lbs.)	%
2016 Q1 Audit Dates:								
January 6, 2016	250.50	85%	27.00	9%	15.50	5%	293	100%
January 7, 2016	243.00	77%	48.50	15%	24.50	8%	316	100%
January 13, 2016	243.00	80%	40.00	13%	19.50	6%	302.5	100%
January 21, 2016	200.50	78%	37.50	15%	19.50	8%	257.5	100%
January 28, 2016	236.50	82%	42.00	15%	11.00	4%	289.5	100%
February 4, 2016	197.00	78%	41.50	16%	14.50	6%	253	100%
February 11, 2016	222.50	79%	45.50	16%	14.00	5%	282	100%
February 16, 2016	246.00	81%	38.50	13%	20.00	7%	304.5	100%
February 19, 2016	219.00	81%	40.50	15%	11.00	4%	270.5	100%
February 24, 2016	261.00	84%	39.50	13%	9.00	3%	309.5	100%
March 1, 2016	213.50	82%	33.00	13%	15.00	6%	261.5	100%
March 8, 2016	209.50	78%	45.00	17%	15.50	6%	270	100%
March 17, 2016	216.50	82%	31.50	12%	16.50	6%	264.5	100%
March 24, 2016	231.50	81%	45.00	16%	11.00	4%	287.5	100%
March 29, 2016	217.00	79%	46.00	17%	13.00	5%	276	100%
2016 Q1 Average:	227.13	80%	40.07	14%	15.30	5%	282.50	100%
2016 Q2 Audit Dates:								
April 7, 2016	235.50	80%	44.50	15%	14.50	5%	294.5	100%
April 14, 2016	311.00	86%	36.00	10%	14.00	4%	361	100%
April 20, 2016	305.50	87%	32.00	9%	14.50	4%	352	100%
April 26, 2016	273.50	85%	38.00	12%	11.00	3%	322.5	100%
May 5, 2016	270.00	86%	27.00	9%	16.50	5%	313.5	100%
May 9, 2016	298.00	86%	36.00	10%	14.00	4%	348	100%
May 18, 2016	224.50	77%	44.00	15%	21.50	7%	290	100%
May 25, 2016	234.50	83%	34.00	12%	13.00	5%	281.5	100%
June 2, 2016	241.00	82%	39.00	13%	13.00	4%	293	100%
June 9, 2016	232.00	76%	52.50	17%	22.00	7%	306.5	100%
June 16, 2016	241.50	78%	54.50	18%	13.50	4%	309.5	100%
June 23, 2016	218.00	77%	39.50	14%	24.50	9%	282	100%
June 28, 2016	224.00	74%	57.00	19%	20.00	7%	301	100%
2016 Q2 Average:	254.54	81%	41.08	13%	16.31	5%	311.92	100%
2016 Q3 Audit Dates:								
July 8, 2016	225.00	79%	41.00	14%	20.00	7%	286	100%
July 15, 2016	207.00	80%	42.00	16%	9.00	3%	258	100%

July 22, 2016	243.50	85%	26.00	9%	16.50	6%	286	100%
July 27, 2016	214.00	84%	30.50	12%	10.50	4%	255	100%
August 5, 2016	213.00	83%	32.50	13%	10.00	4%	255.5	100%
August 12, 2016	242.50	82%	36.50	12%	15.50	5%	294.5	100%
August 15, 2016	243.00	83%	29.50	10%	22.00	7%	294.5	100%
August 22, 2016	250.50	88%	26.50	9%	8.50	3%	285.5	100%
August 29, 2016	227.00	86%	22.00	8%	14.50	6%	263.5	100%
September 6, 2016	230.50	82%	41.00	15%	8.50	3%	280	100%
September 15, 2016	218.00	81%	30.00	11%	22.00	8%	270	100%
September 22, 2016	222.00	80%	45.50	16%	9.50	3%	277	100%
2016 Q3 Average:	228.00	83%	33.58	12%	13.88	5%	275.46	100%
2016 Q4 Audit Dates:								
October 6, 2016	256.00	82%	43.50	14%	12.00	4%	311.5	100%
October 11, 2016	198.50	83%	26.50	11%	11.50	5%	238	99%
October 17, 2016	204.00	87%	20.50	9%	10.00	4%	233.5	100%
October 25, 2016	203.00	79%	40.50	16%	13.50	5%	258	100%
November 3, 2016	222.00	83%	39.00	15%	8.50	3%	267.5	101%
2016 Q4 Average:	216.70	83%	34.00	13%	11.10	4%	261.70	100%
Average- All Audits	234.12	82%	37.96	13%	14.74	5%	286.81	100%

Audit Category Definitions

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Outthrows: All papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified including any of the following: OCC; OBB; Unbleached bags; Manila file folders; Boxboard; Post-it Notes; Brown Kraft Envelopes; Chipboard; Hard Cover Books

Prohibitives: Any materials which by their presence in a packing of paper stock, in excess of the amount allowed will make the packaging unusable as the grade specified; or any materials that may be damaging to mill equipment and shall include all non-paper items including but not limited to: Wood; Metal; Plastics; Tapes; Foil Laminated Papers; Asphalt Treated Papers; Spiral or Plastic-Bound; Electrocardiograms; Food Waste; Beater Dyed Papers; Glass; Rubber; Polystyrene; Photographs; UV Coated Papers; Carbon Paper; X-Rays; Wet strength Paper; Blueprints.

Post FOSS and Additional Sort Line Installation Newsprint Quality After QC - From Newsprint Storage Bunker

Date	Newsprint (lbs)	%	Outthrows (lbs)	%	Prohibitives (lbs)	%	Total Weight (lbs.)	%
2016 Q4 Audit Dates:								
November 24, 2016	230.00	91%	16.00	6%	6.00	2%	252	100%
December 1, 2016	235.50	86%	25.00	9%	13.00	5%	273.5	100%
December 15, 2016	237.00	96%	7.50	3%	3.00	1%	247.5	100%
December 19, 2016	252.00	90%	20.00	7%	7.00	3%	279	100%
2016 Q4 Average:	238.63	91%	17.13	6%	7.25	3%	263.00	100%
2017 Q1 Audit Dates:								
January 24, 2017	238.50	88%	22.00	8%	9.00	3%	269.5	100%
February 7, 2017	233.50	87%	25.50	9%	10.00	4%	269	100%
March 23, 2017	229.00	92%	14.50	6%	8.00	3%	251.5	101%
2017 Q1 Average:	233.67	89%	20.67	8%	9.00	3%	263.33	100%
2017 Q2 Audit Dates:								
April 25, 2017	223.50	83%	30.50	11%	14.50	5%	263.50	100%
May 18, 2017	259.50	91%	15.00	5%	10.00	4%	284.5	100%
2017 Q2 Average:	241.50	87%	22.75	8%	12.25	4%	274.00	100%
Average- All Audits	237.61	89%	19.56	7%	8.94	3%	265.56	100%

Audit Category Definitions

Newsprint: Old Newsprint, Fine Paper, Magazines, Molded Paper and Unsortable Material. Unsortable material was deemed appropriate for this category based on the fact that the majority of unsortable material found in these audits consisted of small pieces of shredded paper.

Outthrows: All papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified including any of the following: OCC; OBB; Unbleached bags; Manila file folders; Boxboard; Post-it Notes; Brown Kraft Envelopes; Chipboard; Hard Cover Books

Prohibitives: Any materials which by their presence in a packing of paper stock, in excess of the amount allowed will make the packaging unusable as the grade specified; or any materials that may be damaging to mill equipment and shall include all non-paper items including but not limited to: Wood; Metal; Plastics; Tapes; Foil Laminated Papers; Asphalt Treated Papers; Spiral or Plastic-Bound; Electrocardiograms; Food Waste; Beater Dyed Papers; Glass; Rubber; Polystyrene; Photographs; UV Coated Papers; Carbon Paper; X-Rays; Wet strength Paper; Blueprints.

APPENDIX B
Auditing Procedures

Niagara Region – Waste Management Services	Effective Date: September 11, 2014
Post Sort Paper Audit Procedure	Number: # 2014-001
Revised by: C. Burt	Revision date: September 10, 2014
Approved by: C. Burt	Approved date: September 11, 2014
<p>1. Rationale/Background:</p> <p>The post sort fibre audits are required to monitor the composition and contamination levels of the loads that go to Resolute Forest Products (Resolute). Resolute strives to receive newsprint that is high in quality and free from outthrows and prohibitives. This audit will also be used to determine the composition of newsprint before and after the QC upon installation of the FOSS.</p> <p>Resolute has established targets for Niagara Region based on the Region's individual quality from previous years. Niagara Region and Resolute will perform individual sample testing to report on performance. A fibre price adjustment system will be implemented based on the quality of the newsprint sent to Resolute from Niagara Region; and the volume of outthrows and prohibitives in the mix.</p> <p>Outthrows: All papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified including any of the following: OCC; OBB; Unbleached bags; Manila file folders; Boxboard; Post-it Notes; Brown Kraft Envelopes; Chipboard; Hard Cover Books</p> <p>Prohibitives: Any materials which by their presence in a packing of paper stock, in excess of the amount allowed will make the packaging unusable as the grade specified; or any materials that may be damaging to mill equipment and shall include all non-paper items including but not limited to: Wood; Metal; Plastics; Tapes; Foil Laminated Papers; Asphalt Treated Papers; Spiral or Plastic-Bound; Electrocardiograms; Food Waste; Beater Dyed Papers; Glass; Rubber; Polystyrene; Photographs; UV Coated Papers; Carbon Paper; X-Rays; Wet strength Paper; Blueprints.</p> <p>2. Purpose:</p> <p>The purpose of this procedure is to provide the information required for Waste Management Interns (WMIs) to conduct the post sort paper audits and to document the results.</p> <p>3. When to use this Procedure:</p> <p>This procedure is to be used when conducting post sort paper audits. Post sort paper audits are to be completed as required. Upon installation of the FOSS, composition audits of the #8 news will be conducted quarterly before and after the QC. Direction will be given to the WMIs by the Contract Manager.</p>	

4. Roles and Responsibilities:

The Waste Management Interns are responsible for the implementation and maintenance of this procedure.

5. Tools:

The tools required to conduct the audits are:

- Audit Form
- Pen
- Broom
- Label Tags (optional)
- Clipboard
- Protective Clothing (includes: safety glasses, safety boots, vests, gloves and face mask)
- Totes/Boxes
- Scale
- Link to all the audit information L:\2007 Beyond\E09 Waste Diversion\Recycling Centre\Audits

6. Training:

New Waste Management Interns shall review the procedure for the post sort paper audits prior to conducting a post sort paper audit.

7. Procedure:

a) Audit Preparation

- The Waste Management Intern primarily responsible for audits shall schedule the audits in the Intern Schedule based on the availability of the other interns. The student schedule can be found at the following file path:
L:\2007 Beyond\zStudents\1Student Schedule
- Each Monday, the Waste Management Intern primarily responsible for audits shall post a schedule of the required audits that must be completed that week on the Niagara Recycling Controller's office door. The list may include a post sort paper audit. The list will let Niagara Recycling staff know the type of audit(s) required, the date and approximate time the audit samples must be ready by. Once the audit sample has been collected and dumped onto the audit table, Niagara Recycling staff will complete the form with the audit weight, the line speed, and the number of sorters. A blank copy of the 'Weekly Audit Schedule' can be found at the following path:
L:\2007 Beyond\E09 Waste Diversion\Recycling Centre\Audits\2012\Weekly Audit Schedule
- On the day of the requested audit, the WMIs shall check the audit table (located in Bay 1) to make sure the audit sample has been dumped. If the audit sample has not been dumped, the Intern shall follow up with the Niagara Recycling CEO or Controller to prepare the audit sample.

- The WMI shall obtain a blank post sort paper audit form and bring it to Bay 1. Blank forms can be obtained from the WMI primarily responsible for the post sort paper audits or on the L drive at the following file path:
L:\2007 Beyond\E09 Waste Diversion\Recycling Centre\Audits\2011\Paper\Post Sort Paper\Blank Post Sort
- The WMI shall wear the personal protective equipment listed in section 5, 'Tools', prior to entering the Bay 1 audit area of the Recycling Centre.

b) Conducting the Audit

- Once in the Bay 1 audit area, WMIs shall collect empty totes and boxes to separate the audit material. When conducting a post sort paper audit, approximately 8 totes and 3 blue boxes are required. The carts and boxes required are located alongside the auditing table. These carts are chained together using a cable and each end of the cable is locked together. Before putting carts in place for sorting the cable must be unlocked using the combination 1, 3, 5 (aligned in side window of lock). Once unlocked the lock should be locked back onto the end of the cable and the cable must be removed from the cart handles. Lock and cable must be placed back in the office area.
- WMIS shall ensure that all the totes and boxes are empty. All of the audit totes should have a tare weight recorded on the outer lip of the cart lid in black permanent marker. If there is no tare weight recorded and no other totes that can be used, weigh the tote using the scale at the north end of Bay 1. The WMIs shall record the tare weight of each box or tote on the post sort audit sheet. If there are not enough available totes or boxes to conduct the audit, speak to the Niagara Recycling Controller or Leadhand for assistance. **To ensure safety, WMIs are not permitted to travel beyond Bay 1.**
- WMIs shall separate the audit material into the totes/boxes using the following categories below. It is important to review the post sort paper audit categories to ensure the audit is being sorted correctly.

Post Sort Paper Audit Categories

Paper: Fine paper, phone books, soft cover books, spiral wound notebooks; softcover notebooks; shredded paper, manila envelopes, file folders

Newspaper (ONP): Newspaper, non-glossy flyers

OCC (Cardboard): Cardboard- shipping and pizza boxes

As required, staff may be asked to sort out **small** and **large OCC** (anything larger than a pizza box is considered large)

OBB (Boxboard): Boxboard including; cereal, cookie, cracker, detergent, pop, tissue, greeting cards, shoe and gift boxes

As required, staff may be asked to sort out **small** and **large OBB** (anything larger than a

cereal box is considered large)

Prohibitives: Blue Box material, containers, steel, etc.

Magazines: Magazines, calendars, glossy flyers

Hard Cover Books: Hard cover books

Plastic Film: Plastic bags and stretchy recyclable film

Garbage: Gift bags, frozen food boxes, napkins, Green Bin materials including construction paper; paper egg cartons and take-out drink trays, scraps, anything laminated, Bristol board, anything that is not recyclable, etc.

The WMIs shall:

- Sweep the audit area prior to the sample being dumped on the table to ensure that the area is free of material from a prior audit. Any remaining material from a previous audit will alter the results of the next audit as it will be sorted and weighed with the new audit material. To prevent this from occurring, the audit area shall be cleared of old audit scraps.
- Place the weighed empty totes/boxes beside the sample. Paper, Newspaper, OCC, OBB, and Magazines are to be sorted into totes as the audit sample will have large volumes of these materials. Prohibitives, Plastic Film, and garbage will be sorted into Blue Boxes. If there are any hard cover books, they are to be placed to the side and weighed separately.
- Begin to sort the sample by placing each type of material into appropriate totes/boxes.
- Sort as much of the sample as possible including small scraps and small pieces of paper. The entire sample shall be sorted into proper categories, within reason. The original audit sample weight shall be as close as possible to the combined weight of all the separated audit categories.
- Ensure that all material that has fallen onto the floor during the audit is swept/picked up and sorted to ensure that as much of the sample is being sorted as possible. This will ensure that the pre-audit sample weight is as close as possible to the post-audit sample weights of all separated categories.
- Clean the audit table of any leftover small scraps of material from the audit that could not be sorted. This material shall only consist of very small scraps of paper, or in the case of any cross-contamination, only small shards of glass/small plastic fragments that cannot be sorted. The leftover unsortable material can be placed in a tote and lined up with the other totes to be weighed.
- Once the audit is complete, all the totes and boxes shall be weighed separately on the scale. Tare weights and final weights shall be documented on the audit form. *Note: If*

more than one tote/box exists per category, each weight shall be documented separately and then added together.

- Make a comment on the Post Sort Audit sheet below the results table of any material that could not be sorted. For example: small pieces of glass, garbage or, fine pieces of paper. The weight of this material shall be noted in the comment, but not included with any stream in the results table. Please note this material must only consist of very fine, unsortable material.
- Consolidate all the material into totes (keep any Blue Box, Grey Box, and garbage materials from this audit as well as any previous audits separated) and line up the totes to the side of the scale in Bay 1, with the lids open. This will indicate to Niagara Recycling staff that the audit is complete and the tote may be emptied.
Note: Do not block the path to the fire hose located beside the scale with any totes.
- Sweep the floor around the audit table after each audit to ensure that material from one audit does not get mixed with a new sample.
- The audit carts must be relocked after the audit is completed and the carts have been emptied by Niagara Recycling. This may take time depending on the Niagara Recycling staff's availability. The WMIs are responsible for checking the audit area before the end of the auditing day to lock up carts. If carts are not emptied by the end of the day the carts must be locked the following morning. To lock carts the cable must be wrapped on one end around the audit table leg and woven through the handle bars of each cart. The other end must then be brought back to the start and locked through the opposite looped end. The number dial on the combination lock must be turned away from the combination alignment in order to lock.
Note: Depending on the number of available interns and the size of the audit, it takes approximately 4 interns and 1.5 hours to complete one post sort paper audit.

c) Recording the Results

The WMIs primarily responsible for audits shall:

- Input the audit results on the Post Sort Paper Audit form into the excel spreadsheets found at the following file path: L:\2007 Beyond\E09 Waste Diversion and Recycling\+E0902 Plants\Recycling Centre\Audit\YEAR\Paper Audit\Paper Audit Results YEAR.xlsx
- Create a new tab after the previous audit, and rename it with the audit date. The previous tab will have Excel formulas in the boxes which makes it easier than starting from a blank form. Copy and paste the last audit results into the new tab, space everything accordingly and input the new data.

- Fill out the top portion of the form, condition of material, line speed, number of sorters and sample weight.
- Calculate the weights for each category by subtracting the final weight from the starting weight. The percentages will change in the spreadsheet as the new numbers are inputted.
- Make sure the total percentages add to a total of 100%, with the exception of the unsortable materials weight which should be minimal. (If not, the WMI shall re-check their work)
- Develop a pie chart to show the results from the current audit.
- Save the work.
- Send the file to the Contract Manager.

8. Contacts:

Controller – Niagara Recycling
905-356-4141 ext.2524

CEO, Niagara Recycling
905-356-4141 ext. 2522

Contract Manager
905-356-4141 ext. 2538

Niagara Region Waste Management Services	Effective Date: September 27, 2016
Fibre Optical Sorting System Audit	Number: #2016-002
Approved by: Allison Tyldesley	Revision date: N/A
<p>1. Background/Purpose</p> <p>The Fibre Optical Sorting System audits are required to determine the efficiency and effectiveness of the optical sorter installed on the fibre line in the 4th quarter of 2015.</p> <p>Niagara Region has established targets that are based on machine efficiency and contractual obligations. Region staff will audit samples from the fibre sort line to monitor whether targets have been met.</p> <p>The purpose of this procedure is to provide the information required for Waste Management Interns (WMIs) to conduct the optical sorter fibre audits and to document the results.</p> <p>2. Roles and Responsibilities:</p> <p>The CEO of Niagara Recycling shall determine when the Fibre Optical Sorting audits are needed, and shall communicate this to the Collection and Diversion Program Manager.</p> <p>The WMIs are responsible for the implementation and maintenance of this procedure.</p> <p>3. Tools:</p> <p>The tools required to conduct the audits are:</p> <ul style="list-style-type: none"> • Audit Form • Pen • Broom • Label Tags (optional) • Clipboard • Personal Protective Equipment (includes: safety glasses, safety boots, vests, gloves and face mask) • Carts/Boxes • Scale • Camera • Posters detailing the categories <p>Link to all the audit information: L:\2007 Beyond\E09 Waste Diversion and Recycling\Recycling Centre\Audits\2016\Optical Sorter Audit</p>	

4. Training:

New WMIs shall review the procedure for the Optical Sorter Fibre audits prior to conducting an audit.

All WMIs shall review the Niagara Region Syringe/Sharp Program and Response Policy. Section 5 b) of this procedure includes syringe and sharp safety methods relating directly to the auditing procedure.

WMIs shall also refer to the Low Bay Safety Procedure and receive training prior to being allowed in the Low Bay area.

5. Procedure:

a) Audit Preparation

- As required, the CEO of Niagara Recycling shall contact the Collection and Diversion Program Manager to communicate when audits are needed. The Manager in turn shall then contact the WMI primarily responsible for audits. These parties shall schedule interns on the required dates.
- On the day of the requested audit(s), the Recycling Plant Manager and the CEO of Niagara Recycling shall collect the sample from the fibre line using sample collection methodology acceptable by the Associate Director of Collection & Diversion Operations. Each sample set collected from the fibre line will include two separate samples, each weighing approximately 100lbs. One sample shall be a positive eject sample, and the other will be a negative eject sample, which will make up the sample set.
- The WMIs shall wear the personal protective equipment listed in section 3, 'Tools', prior to entering the Low Bay area of the Recycling Centre.
- WMIs shall go to the audit area with the CEO of Niagara Recycling (located in the Low Bay) to ensure the audit sample is a representative sample. If the audit appears to have a skewed composition, as determined by the CEO of Niagara Recycling, a new sample shall be collected.
- The WMI shall use the proper blank Optical Sorter forms (Positive and Negative samples), which can be found on the L Drive at the following file paths:
L:\2007 Beyond\E09 Waste Diversion and Recycling\Recycling Centre\Audits\2016\Fibre Optical Sorter Audit\Optical Sort Audit Sheet-POSITIVE.xlsx

L:\2007 Beyond\E09 Waste Diversion and Recycling\Recycling Centre\Audits\2016\Fibre Optical Sorter Audit\Optical Sort Audit Sheet-NEGATIVE.xlsx

b) Syringe/Sharp Safety

- All Waste Management Interns shall be prepared with syringe and sharp safety equipment, in addition to all other personal protective equipment, prior to

conducting the audit. Safety equipment shall include durable gloves, an impervious safe sharps container such as a labeled detergent container and retrieval tool such as tongs or pliers. The Safety Equipment kit will be stored on the hangers behind the auditing table.

- In order to avoid contact with syringes or sharps while auditing, WMIs shall inspect the audit material prior to beginning the sort. Once sorting starts WMIs shall avoid quickly brushing hands over the material or quickly grabbing at the material. Although syringes and sharps are found only on rare occasions, WMIs shall stay alert and mindful for the possibility of syringes and sharps in the audit material.
- If a syringe or sharp is found during the audit the following procedure applies:
 - Place sharps container on ground near syringe or sharp.
 - Carefully pick up the syringe/sharp using a retrieval tool such as tongs or pliers. Always keep the needle pointed downwards and away from the body to avoid any contact with the needle.
 - Deposit the syringe/sharp into the disposal container needle end first.
 - Close the sharps container securely and return the container immediately to the CEO of Niagara Recycling.
 - Clean retrieval tools in 1:10 bleach solution for a minimum of 30 seconds. Cleaning solution is located in the safety kit, hanging on the wall behind the auditing table.
 - In the event of a needle stick injury or penetrating wound:
 - Remove contaminated clothes.
 - Allow immediate bleeding of the wound.
 - Wash the injured area well with soap and water then apply antiseptic which is found in first aid kit located on the wall behind the audit table, next to the broom hanger.
 - If in eye, nose, or mouth are involved, flush well with a large amount of water.
 - Do not promote bleeding of injuries by cutting, scratching, squeezing, or puncturing the skin. This may damage tissues and increase the uptake of any pathogen(s).
 - Immediately report incident/injury to your supervisor or manager to ensure that an Employee Incident Report is completed and submitted to Employee Health Services within 24 hours of receiving the report.
 - Seek medical attention immediately to treat injury and obtain medical advice regarding the possible transmission of communicable diseases.
 - *Note: After removal of gloves, always thoroughly wash hands.*

c) Fibre Optical Sorter System Audit Categories and Definitions:

A sample set in a fibre optical sorter system audit consists of two samples; a positive eject sample and a negative eject sample. These two separate samples are considered to be one large sample, and indicate the effectiveness of the optical sorter ejecting items that are not

meant to be in the fibre stream. WMIs shall separate the audit material into carts/boxes using the following categories below. It is important to review both the Positive and Negative Fibre Optical Sorter system audit categories to ensure the audit is being sorted correctly.

i. **Positive Eject Sample**

This sample, known as a “positive sample” or “positive eject sample” are all the objects that have been positively ejected from the optical sorter. The target is to contain a high proportion of OBB/OCC, garbage and residue, as well as all Blue Box recycling items, while containing a low proportion of ONP. A target set by Niagara Region is a positive sample containing >55% of the containers in each sample set and >70% of the OBB/OCC in each sample set.

WMIs will set aside a category named “50/50 OBB/OCC” throughout the audit. The items, as defined below, are items that the optical sorter may see as either a positive or negative eject, depending on how the item is positioned on the fibre line. The target is that the optical sorter will place these items into the positive sample 50% of the time.

- **ONP:** Newspaper, magazines, calendars, white/high grade paper, unsortables/shredded paper, books, manila envelopes, yellow file folders
- **Plastic Containers:** Plastic containers(#1-7), polycoat
- **Plastic Film:** Plastic bags and film
- **Residue:** All white/black OBB/OCC, regular garbage items, glass, steel, aluminum products, OBB that has been stuffed with ONP, OBB/OCC <2'x2', Green Bin items, regular garbage items.
- **OBB/OCC:** Regular coloured cardboard and boxboard products, moulded paper
- **“50/50” OBB/OCC:** OBB/OCC with white/grey/black on one side, and the opposite side is brown/coloured

ii. **Negative Eject Sample**

This sample, known as a “negative sample” or “negative eject sample” are all the objects that the optical sorter has not ejected and has sorted as being ONP, with little to no OBB/OCC, garbage, residue, and Blue Box recycling items. A target set by Niagara Region is a negative sample containing <45% of the containers in each sample set and <30% of the OBB/OCC in each sample set.

WMIs will set aside a category named “50/50 OBB/OCC” throughout the audit. The items, as defined below, are items that the optical sorter may see as either a positive or negative eject, depending on how the item is positioned on the fibre line. The target is that the optical sorter will place these items into the negative sample 50% of the time.

- **ONP:** Newspaper, magazines, calendars, white/high grade paper, unsortables/shredded paper, books, manila envelopes, yellow file folders

- **Plastic Containers:** Plastic containers(#1-7), polycoat
- **Plastic Film:** Plastic bags and film
- **Residue:** All white/black OBB/OCC, regular garbage items, glass, steel, aluminum products, OBB that has been stuffed with ONP, OBB/OCC <2'x2', Green Bin items, regular garbage items.
- **OBB/OCC:** Regular coloured cardboard and boxboard products, moulded paper
- **"50/50" OBB/OCC:** OBB/OCC with white/grey/black on one side, and the opposite side is brown/coloured
- **OCC White/Brown:** OCC that is white on one side, and brown on the other

d) Conducting the Audit:

- Once in the Low Bay area, WMIs shall sweep the audit area prior to the sample being dumped on the table to ensure that the area is free of material from a prior audit. Any remaining material from a previous audit will alter the results of the next audit as it will be sorted and weighed with the new audit material. To prevent this from occurring, the audit area shall be cleared of old audit scraps.
- The WMI responsible for leading the audit shall then communicate with the fork lift operator to weigh the audit sample. The WMI shall record the weight of the audit container/sample, and then ask the operator to dump the first sample of the sample set on to the audit table (either the positive eject or negative eject sample). The WMI shall then ask the operator to weigh the empty audit container in order to obtain a tare weight. This will allow for the accurate calculation of the sample weight. The weight of both the Positive and Negative samples should be approximately 100 lbs. each, adding to a sample set weight of approximately 200 lbs.
- WMIs shall line up the empty carts and Blue Boxes in front of the audit table. When conducting the Positive eject sample, approximately two carts and 12 Blue Boxes are required to collect and weigh each audit category. When conducting the Negative eject sample, approximately four carts and 16 Blue Boxes are required. These numbers include Blue Boxes that shall be used around the audit table to separate audit material and dump into their designated audit carts or boxes. The carts and boxes required are located alongside the auditing table.
- WMIs shall ensure that all the carts and boxes are empty. All of the audit carts should have a tare weight recorded on the outer lip of the cart lid in black permanent marker. If there is no tare weight recorded and no other carts that can be used, weigh the cart using the scale in the audit area prior to the audit, and record the weight on the cart. Periodically WMIs shall reweigh the carts and Blue Boxes to ensure proper tare weights. The WMIs shall record the tare weight of each box or cart on the post sort audit sheet.
- Sort as much of the sample as possible including small scraps and small pieces of

paper until nothing further can be sorted efficiently. The entire sample shall be sorted into proper categories, within reason. The original audit sample weight shall be as close as possible to the combined weight of all the separated audit categories.

- Ensure that all material that has fallen onto the floor during the audit is swept/picked up and sorted to ensure that as much of the sample is being sorted as possible. This will ensure that the pre-audit sample weight is as close as possible to the post-audit sample weights of all separated categories.
- Clean the audit table of any leftover small scraps of material from the audit that could not be sorted. This material shall only consist of very small scraps of paper, or in the case of any cross-contamination, only small shards of glass/small plastic fragments that cannot be sorted. The leftover unsortable material can be placed with ONP.
- Prior to weighing the carts and boxes, WMIs shall go through the “50/50 OBB/OCC” boxes with the CEO of Niagara Recycling and the employees of the company servicing the Fibre Optical Sorter (if available). The parties will then determine if it is in the right category, or if it should be placed in another OBB/OCC category based on the colours present.
- Once the audit is complete, all the carts and boxes shall be weighed separately on the scale. Tare weights and final weights shall be documented on the audit form.
Note: If more than one cart/box exists per category, each weight shall be documented separately and then added together.
- Take pictures using the WMI camera of each sorted category in its cart/box.
- Consolidate all the material into carts (keep any Blue Box, Grey Box, and garbage materials from this audit as well as any previous audits separated) and line up the carts to the side of audit table in the Low Bay, with the lids open. This will indicate to Niagara Recycling staff that the audit is complete and the carts may be emptied.
Note: Do not block any throughways or exits with any of the carts.
- Sweep the floor around the audit table after each audit to ensure that material from one audit does not get mixed with a new sample.
- Following the completion of one sample set (either positive eject or negative eject), WMIs will indicate to the forklift operator that the corresponding sample can now be dumped on the audit table.
- To ensure safety, WMIs are not permitted to travel outside of the designated walking areas in the Recycling Plant.

e) Recording the Results

The WMIs primarily responsible for audits shall:

- Input the audit results on the Fibre Optical Sorter System Audit form into the excel spreadsheets found at the following file path: L:\2007 Beyond\E09 Waste Diversion and Recycling\Recycling Centre\Audits\2016\Fibre Optical Sorter Audit\Fiber Optical Sorter Audit Summary September.xlsx
- Create a new tab after the previous audit, and rename it with the audit date. The previous tab will have Excel formulas in the boxes which makes it easier than starting from a blank form. Copy and paste the last audit results into the new tab, space everything accordingly and input the new data.
- Fill out the top portion of the form: date sample was obtained and audited, and sample weight.
- Calculate the weights for each category by subtracting the final weight from the starting weight. The percentages will change in the spreadsheet as the new numbers are inputted.
- Make sure the total percentages add to a total of 100% (If not, the WMI shall re-check their work).
- Ensure that the “summary”, “summary averages” pages are completed and have accurate data, and percentages add to a total of 100% where applicable.
- Save the work.
- Send the file to the CEO of Niagara Recycling and Waste Management Program Manager.

6. Contact Information:

CEO of Niagara Recycling
905-356-4141 ext. 2522

Waste Management Program Manager
905-685-4225 ext. 3558

7. Associated Documents:

Positive Sample Sheet

L:\2007 Beyond\E09 Waste Diversion and Recycling\Recycling Centre\Audits\2016\Fibre Optical Sorter Audit\Optical Sort Audit Sheet- POSITIVE.xlsx

Negative Sample Sheet

L:\2007 Beyond\E09 Waste Diversion and Recycling\Recycling Centre\Audits\2016\Fibre Optical Sorter Audit\Optical Sort Audit Sheet- NEGATIVE.xlsx

Audit Summary

L:\2007 Beyond\E09 Waste Diversion and Recycling\Recycling Centre\Audits\2016\Fibre Optical Sorter Audit\Fiber Optical Sorter Audit Summary September.xlsx

8. Revision History:

N/A