Biosolids Compost Pilot Report
October 2018

Prepared by Michelle R. Paetkau, Senior Planning Engineer, P.Eng

Table of Contents

List of Figures:

List of Table:

Executive Summary

The City of Winnipeg piloted biosolids composting from 2015 to 2018 to evaluate composting as a beneficial reuse method for biosolids. The goals of the pilot were to evaluate composting as a beneficial reuse option with consideration to:

- Cost
- Ability to meet CCME guidelines
- Winter challenges
- Odour

The pilot was able to produce a low odour, nutrient rich compost with low (i.e. CCME Category B) metals content that was successfully used to grow vegetative cover at Brady Road Resource Management Facility (BRRMF). This protected the landfill from erosion, weathering elements, and saved capacity at BRRMF for future use. The compost program also provided an important reuse stream for wood waste at BRRMF, which is expected to increase with the arrival of the Emerald Ash Borer.

The upfront cost to compost biosolids, however, is more than landfilling and land application. While the compost generally met CCME's required pathogen reduction it was difficult to do so consistently. It also did not consistently meet the City's stricter standard for both *Salmonella* and Fecal coliform reductions until recent changes were made to operating procedures. It is anticipated that future composting samples will consistently meet the City's requirements with the modified operating procedures.

Based on the results of the pilot the City of Winnipeg recommends that biosolids composting continue on an as-needed basis to meet soil needs within the City's landfills. As those needs for BRRMF decrease the compost would be hauled to other City-owned landfills for top dressing and erosion control. In the future the enhanced operating and handling procedures should demonstrate that the City's pathogen reductions can be met. Once this is demonstrated the City may make an application to Manitoba Sustainable Development for approval to use the compost outside the City owned landfills.

Introduction

The City of Winnipeg's (City) Biosolids Master Plan initiated a two-year biosolids composting pilot to evaluate sustainably reusing biosolids. This complies with the Manitoba Water Protection Act which requires that "biosolids and wastewater sludge remaining after the treatment process must be reused" and that "nutrients that are removed must be recovered and recycled to the maximum extent possible through application of the best available technologies".

The purpose of the pilot was to test the feasibility of composting anaerobically digested biosolids. The goal was to compost 20% of the City's biosolids and achieve a Canadian Council of Ministers for the Environment (CCME) rating of Category A Unrestricted Use or Category B Restricted Use. The City also wanted to determine Winnipeg costs for composting biosolids and document challenges of composting in winter.

The pilot started May 4, 2015 and was originally scheduled to run until May 4, 2017. Manitoba Sustainable Development granted a one-year extension to the pilot so that additional operating procedures could be tested and evaluated. The pilot ended on May 4, 2018.

Pilot Compost Facility and Composting Process

Wastewater solids from the City's three sewage treatment plants are collected and treated at the North End Sewage Treatment Plant (NEWPCC). The solids are treated with mesophilic anaerobic digesters and dewatered to approximately 25-30% thickness. After digestion the biosolids are sent to the City's landfill, Brady Resource Recovery and Management Centre (BRRMF) where they are landfilled with municipal wastes.

The composting process is illustrated in Figure 1. Biosolids for the composting pilot are diverted from the landfill to the pilot compost facility, which is also located at BRRMF. The biosolids are mixed with woodchips in an enclosed mixing building after which they are transferred to aerated bunkers. The bunkers have negative aeration in which air is pulled through the compost piles and is then sent to a biofilter for odour treatment. Air from the mixing building is also sent to the biofilter for treatment.

Figure 1 Biosolids Composting Process

Mixing and receiving building

Biosolids, woodchips mixing

Receiving bunker

Process air to biofilter for odour treatment

Composting in bunkers

Process air

Two weeks curing, then screening

As the bacteria compost the biosolids and woodchip mixture heat is released which kills the pathogens contained within the biosolids. The mixture is composted in the bunkers for 2 – 4 weeks. Once composting is complete the compost is transferred to a curing pad where it ages for an additional 2-4 weeks. Then it is screened and applied as top cover dressing to the landfill. The screened woodchips are returned to the composting process and reused.

The final compost is sampled and tested for metals, pathogens, compost maturity, and checked for foreign particles. After sampling the compost is spread on the landfill as a final top cover, providing erosion control and growth medium for plants.

Runoff from the composting bunkers and mixing building is collected in a leachate tank and hauled to the North End Sewage Treatment Plant for treatment. Land drainage from the curing pads are collected in a retention pond and then discharged to surface water drainage.

The facility was constructed under Bid Opportunity 839-2012 at a cost of approximately $6.6 million.

Results

Use of the Compost

Figures 2 and 3 show the before and after photos of the landfill areas that received biosolids compost. The landfill benefited from the compost, which provided a soil growth medium for grasses and plants. This will protect the landfill from erosion caused by water and wind.

Figure 2 - Area of BRRMF before receiving biosolids compost; landfill gas flare is in centre of photo for reference

Figure 3 - Area of BRRMF after application of biosolids compost; landfill gas flare is in left side of photo for reference.

Growth and water uptake will reduce percolation and leachate production and the plants provide a more aesthetic appearance to the landfill. By using the biosolids compost the City was able to make use of onsite wood waste and offset soil purchases. The compost also proved resilient to drought and maintained green cover during periods of low rainfall.

Compost Quality: Metals and Pathogen Reduction

Samples of finished compost were taken throughout the piloting period. The biosolids were tested to determine if they met CCME Category A or B quality for metals content and pathogen reduction.

Table 1 shows the average metal concentration of the samples and their standard deviation. The finished compost can be categorized as having low metals, with all tested samples meeting the Category B restricted use requirement. Of the 75 samples, approximately 44% met the CCME Category A, unrestricted use category for metals content.

Table 1 - Compost metals results from the 2015 – 2018 compost pilot, *n = 75 samples*

Metals	CCME Category A (mg/L)	CCME Category B (mg/L)	Pilot Compost Average (mg/L)	Standard Deviation (mg/L)
Arsenic	13	75	5.6	6.7
Cadmium	3	20	1.8	0.6
Cobalt	34	150	2.5	0.7
Chromium	210	-	62.6	30.7
Copper	400	-	195.1	56.1
Mercury	0.8	5	0.4	0.1
Molybdenum	5	20	4.4	1.4
Nickel	62	180	17.4	8.1
Lead	150	500	34.4	29.3
Selenium	2	14	2.2	0.8
Zinc	500	1850	456.1	196.8

Figure 4 shows the percentage of samples that were above each Category A metal parameter. The compost is characterized as having very low levels of mercury, copper, chromium, nickel, and cobalt. Selenium, zinc, and molybdenum were the metals most often above Category A, though all met the CCME guidelines for Category B restricted use.

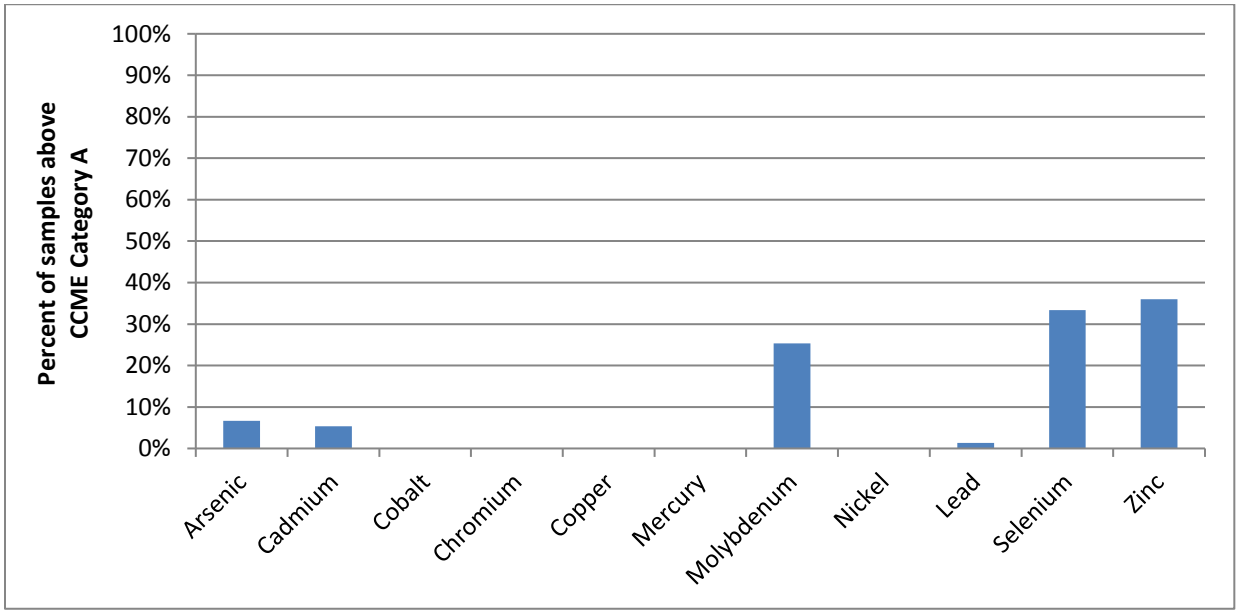

Figure 4 Percentage of samples that exceeded CCME Category A Unrestricted Use metal guidelines. All samples passed the metal guidelines for CCME Category B Restricted Use

During the pilot the compost was tested for fecal coliform, *Salmonella* sp. and *E. coli*. CCME states that compost containing biosolids should have a fecal coliform level of less than 1000 MPN (most probable number) per gram of sample, **or** a no *Salmonella* sp. reading with a detection level of less than 3 MPN per four grams of solids. CCME does not have a requirement for testing *E.coli*.

Using the CCME guideline 68% (n=51) of the compost samples would have passed the pathogen reduction guidelines. However, the City has decided to have a stricter requirement in which the compost has to pass both the fecal **and** *Salmonella* reduction guidelines. Using this standard, 36% (n = 27) of the compost samples passed the pathogen requirement.

The samples did not meet the City's pathogen reduction requirement because of cross contamination during sampling, and incomplete mixing of biosolids with woodchips. Adjustments were made to operating procedures to improve pathogen reduction, including better mixing and modified sampling techniques. This has resulted in improved pathogen reduction, with the last 10 samples consistently meeting all of the City's pathogen reduction requirements.

Quantity of Biosolids Beneficially Reused

The goal of the compost pilot was to compost 20% of total biosolids production. During the three year piloting period approximately 10,820 wet tonnes of biosolids were composted. This represents approximately 7% of all biosolids that were produced during this time.

Figure 5 shows the relative diversion rates of total biosolids production during the composting project. Diversion rates went down in winter and early spring. The pilot did not reach its 20% goal for several reasons, including:

- The bunkers were not filled to capacity so that the bunker walls could act as a fall barrier for operators who worked on top of the compost piles
- Winter challenges meant that composting was not achievable when temperatures dropped below -10C.
- Mechanical failure of aeration fans during the winter 2015/2016 winter halted composting
- Movement of a bunker wall in September 2016 reduced operating capacity by 25%; future work for the bunker is planned

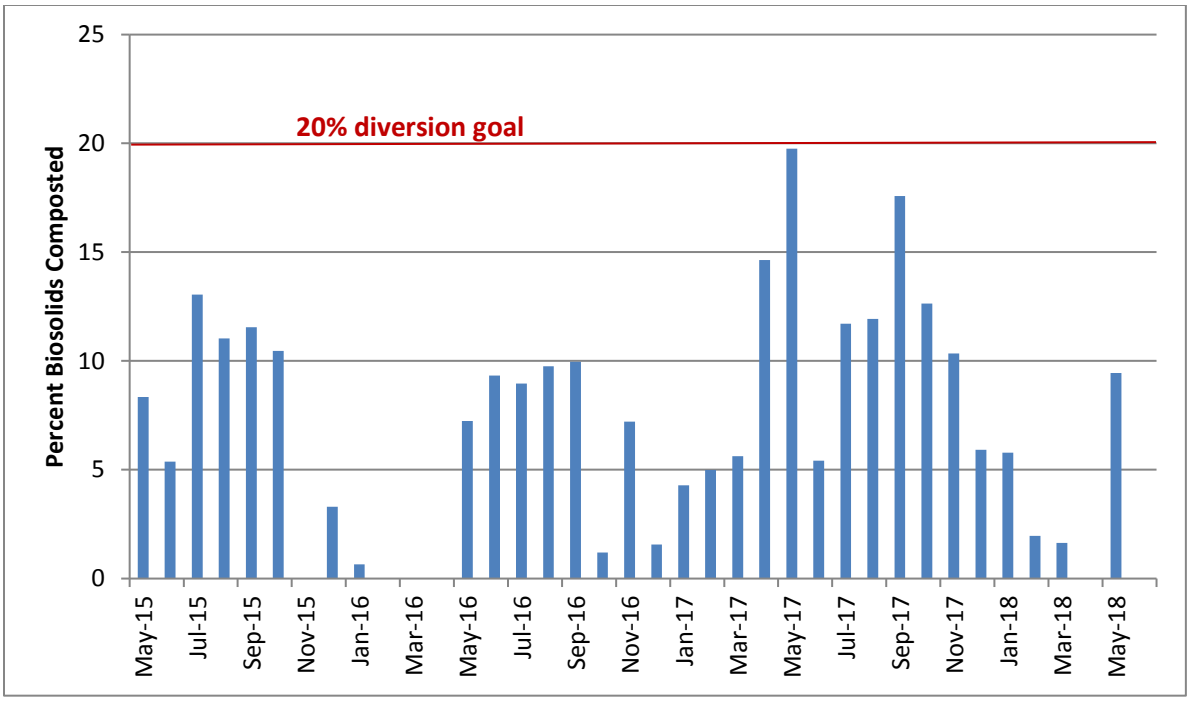

Figure 5 - Monthly percentage of biosolids composted during three year pilot.

On February 6, 2017 Manitoba Sustainable Development approved a one-year extension to the pilot so that the City could review alternative ways to increase composting production. The City altered its composting procedure in May 2017 by composting the biosolids in the bunkers for two weeks, instead of four weeks.

This resulted in approximately 10% of biosolids being composted during the May 2017 – May 2018 period, compared to the overall three-year average of 7%. The pathogen kill was not negatively impacted by the reduced composting period.

Odour

Odour is monitored as part of BRRMF's operating licence. The City did not receive any odour complaints regarding the biosolids compost pilot. General odour complaints for Brady during the pilot did not change compared to pre-composting baseline.

Winter Challenges

The original intent of the pilot was to compost year round to understand the challenges associated with cold weather composting. As seen in Figure 5 the volumes of compost in winter were reduced because of the cold weather. Operating in winter was difficult because the moist mixture of biosolids and woodchips would freeze to the mixer, conveyor, and loader buckets leading to shutdowns and repairs.

Operating between 0C and -10C was possible because the warmth associated with the biosolids was able to prevent freezing. The facility was, however, unable to operate below -10C because of the increased labour and repair associated with de-icing the conveyors, ventilation equipment, loader buckets, and aeration equipment. At these colder temperatures the operators spent the majority amount of time maintaining, repairing, and de-icing the facility, instead of mixing.

For winter operation the facility would run in temperatures warmer than -10C. When the temperature went below -10C the material in the bunker would be left until a warm spell allowed the operators to mix and move material. The biological activity of the composting process was able to be maintained year round. If the biosolids and woodchips were mixed and placed in the bunkers then the bacteria were able to compost during the colder (i.e. colder than -10C) weather. Pathogen reduction during winter composting was not different compared to warmer temperatures.

Compost Costs

The relative costs for composting biosolids were tracked to determine how economical composting would be compared to other disposal methods, such as land application and landfilling. Costs included labour, maintenance and repair, woodchip purchase, and final disposal. Capital costs were not included in the analysis below in Figure 6, which are shown for comparison purposes only.

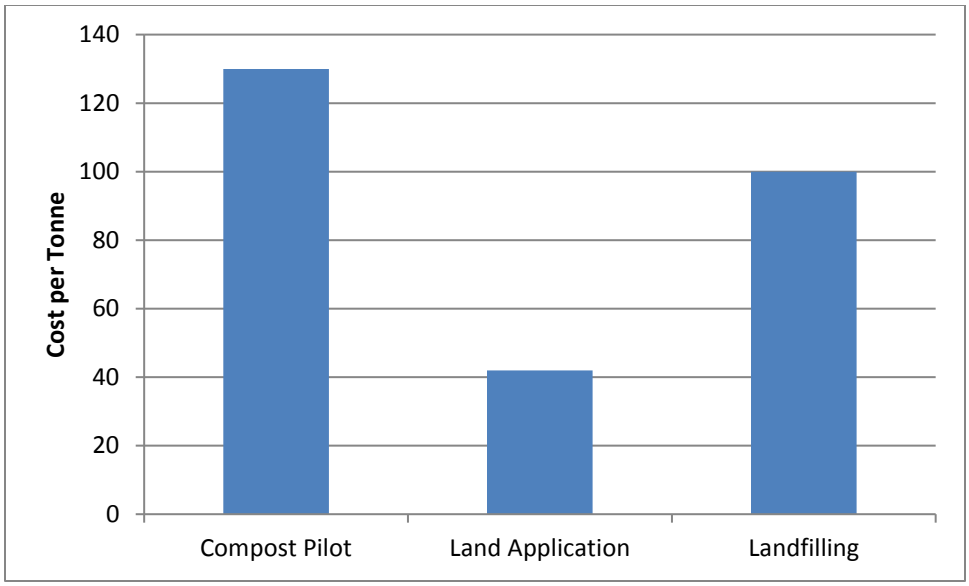

Figure 6 - Comparison of biosolids disposal costs

Composting was the most expensive disposal method, at $130/tonne compared to land application and landfilling. The majority of this cost was for the purchase of woodchips amendment and labour costs for mixing, moving, and screening the material.

Woodchips were purchased from a local vendor during the first year of the pilot. During the second year of the pilot the City started to trial woodchips that were sourced from within the landfill. Wood waste is received from trees that were felled due to storms, age, Dutch Elm Disease and the Emerald Ash Borer. To prevent cross contamination the wood was treated to the required specifications before it was used in the composting process. This included stripping bark and/or grinding and shredding the wood to specific size requirements. By the third year of the pilot the composting process used internal wood waste exclusively, which provided a valuable and beneficial reuse for both wood and biosolids. The costs in Figure 6 reflect an average between purchased wood chips and internally sourced wood waste.

While biosolids composting carries the highest operational costs for biosolids disposal these costs could be offset by future savings. By taking biosolids out of the landfill capacity is saved for future use; the compost also offsets soil requirements for Brady.

The compost also provides a use for wood waste, which is expected to increase at BRRMF with the spread of Dutch Elm Disease and the Emerald Ash Borer. It should also be noted that while the costs for land application are low, the quantity of biosolids that can be land applied is limited. This is because of seasonal restrictions, lower application rates and storage requirements. With all this in consideration composting is still a viable beneficial reuse strategy.

Recommendation

Composting represents a method of beneficial reuse for biosolids. The pilot was able to produce a low odour, nutrient rich compost with low (i.e. CCME Category B) metals content that was used to grow vegetative cover at BRRMF. This protects the landfill from erosion, the weathering elements, and saved capacity at BRRMF for future use. The compost program also provided a reuse stream for wood waste at BRRMF, which is expected to increase in the near future.

The upfront cost to compost the biosolids, however, are more than landfilling and land application. While the finished compost generally met CCME's required pathogen reduction it was difficult to meet it consistently. More recently the facility is able to meet the City's stricter standard for both *Salmonella* and Fecal coliform reductions due to changes that were made to operating procedures. It is anticipated that in the future the City will consistently produce compost that meets both CCME's and the City's required pathogen reduction requirements.

For these reasons the City of Winnipeg recommends that biosolids composting continue on an as-needed basis during warmer weather (e.g. greater than -10C). As soil needs for BRRMF decrease the compost would be hauled to other City-owned landfills for top dressing and erosion control. Over time the new operating and handling procedures should demonstrate that the City's pathogen reduction can be met. The City may then, with the approval of Manitoba Sustainable Development, reconsider other uses for the biosolids compost. Until such time, all compost is recommended to stay within the City's landfills.

References

Canadian Council of Ministers of the Environment (CCME) Guidelines for Compost Quality, 2005 https://www.ccme.ca/files/Resources/waste/organics/compostgdlns_1340_e.pdf

Manitoba Water Protection Act: https://web2.gov.mb.ca/laws/statutes/ccsm/w065e.php