Process description

1. Introduction

Norterra Farms is bringing in-vessel composting to Kingston. This initiative will provide the services necessary to support programs which promote and encourage sustainable waste management and landfill diversion, particularly with regards to organics. While the composting process is not a complicated one, it can be optimized so as to ensure that as little odour is generated as possible, and the design throughput is processed within the shortest time period possible.

Norterra Farms has selected the Gore Cover System as its operating platform which is based on a membrane laminate technology similar to that of the Gore-Tex fabrics used for outerwear and footwear. This technology will not only meet the immediate needs for the City's in-vessel treatment of organics, but will also provide the most flexibility for expansion to accommodate the anticipated feedstock quantities available in the region for years to come. Installed in more than 170 plants in 26 countries world wide, the benefits of the Gore Cover System include odor reduction of up to 90-97%; Bio-aerosol Emissions reduction of greater than 99 percent; less than 1 KWH/ton Energy Requirement and a three square feet/ton space requirement.

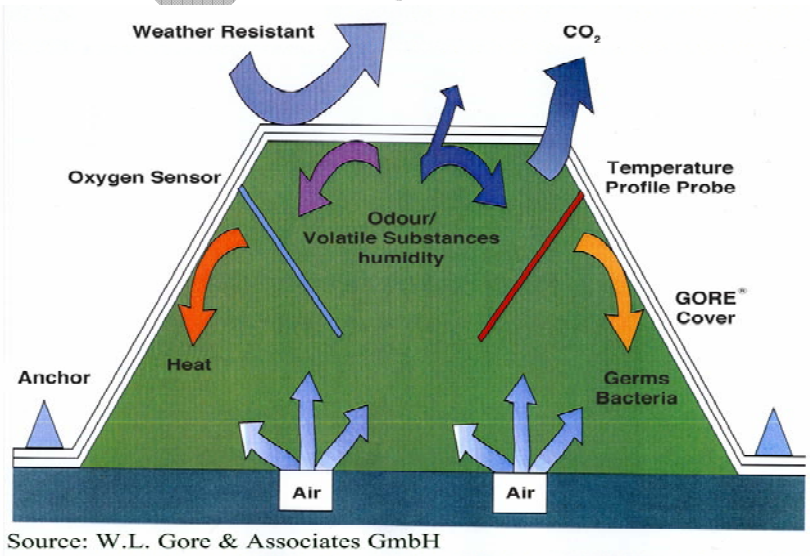


Figure #1: Cross Section of the Gore Cover System

One of the key considerations when selecting a process technology and by far the most important criteria for composting facility operation is odor control as this is the largest culprit responsible for facility closure in this industry. As this system allows the operator to use positive pressure air (whereby air is pushed through the material instead of sucked through to a bio-filter), operating costs are drastically reduced. This system is considered an in-vessel technology by regulatory authorities as the cover contains all of the process materials encapsulated and away from harmful vectors. This micro-porous GORE-TEX® membrane is also able to achieve more than 99% microbe reduction—a key criteria for regulatory approval. W.L. Gore and Associates have spent considerable time and effort in compiling data so that this system can be accurately gauged against traditional and competing technologies.

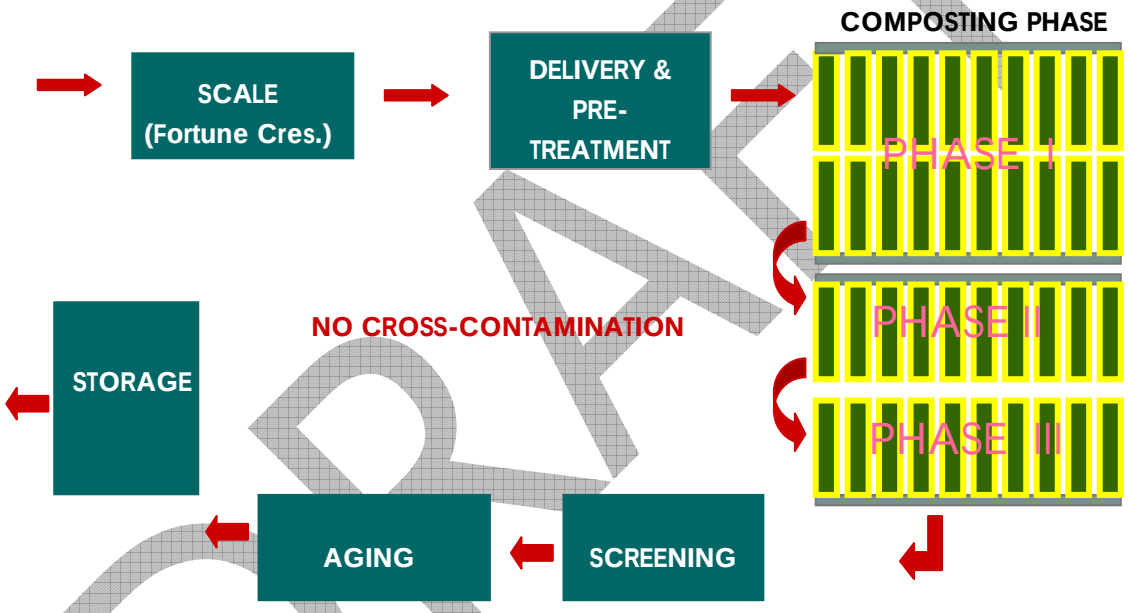


Figure #2: Material Movement Diagram for the Norterra Facility. *Organic material spends six weeks under the GORE™ Covers. The six week process is broken up into two phases. Phase I is four weeks under the GORE™ Cover. In Phase II, the material is moved to another heap for two more weeks under the GORE™ Cover followed by an additional two weeks of curing on the aerated pad. After the eight weeks of composting, the material is ready to be screened and stockpiled for further aging, and ready for sale. Maturity index testing can insure regulatory requirements and determine if additional treatment is required.*

2. Input Material Receipt (Scale) and Initial Mixing Phase

So as to minimize the potential for on site operational / public interactions (and the associated safety concerns which would accompany such a scenario), the Norterra Model allows for the convenience of in-town delivery of organics to the Fortune Crescent transfer station location. This location is also conveniently located within central Kingston which minimizes highway traffic, and optimizes the weight load per trip. At this site, material will be weighed, and mixed to the appropriate C:N ratio prior to its delivery on site. Mixing of materials using a loader will help to dewater incoming food waste, and allow the staff to add bulking agent if necessary prior to delivery to site. Vacuum trucks or sealed box liners will be used to transport the feedstock to the facility so as to ensure that no liquid is spilled on the way to the Norterra Facility.

* Depending on the quantity and quality of feedstock direct delivery to the Norterra compost facility may also be an option.

3. Supreme Mixer Feedstock Preparation Unit

Once the material arrives to the Norterra Facility a Mixing Unit will be used in order to get the feedstock mix correct, with the addition of any wood waste amendment necessary. Compost which does not pass through the 3/8" screen on the back end of the process is also added to the mix, lowering the need for additional amendment while providing a necessary kick start of inoculant bacteria into the process. It will also serve to contain leachate should moisture need to be added during the composting process. Models such as the Supreme Enviro Processor (or similar) can also serve to cut and breakdown the material.

Twin rotating auger screws cut and shred the material, working well on green waste up to 4 inches in diameter. There is a downloadable scale which allows the operators to meter how much of each mixing ingredient is added to the mix so as to ensure the feedstock moisture content is consistent and will optimize the composting process. As the material will be considerably more uniform in size, the surface area exposed to the decomposition process will also increase resulting in a higher percentage of throughput at the back end of the facility.

The density of the material is expected to be in the neighborhood of 700 kg/cubic meter once it has gone through some processing in the mixer. While there are a variety of Enviro-processors available to choose from, a truck mounted unit (shown right) allows for the hauling of multiple bucket loads worth of material to the heap location at one time. This can increase the functionality, as material is loaded and transferred in bulk from one phase to another on the Site.

4. General Description of Operating a GORE™ Cover System

The typical components and equipment utilized in the GORE™ Cover System facilities is as follows.

1. GORE™ Covers

2. Aeration System:
    a. In-floor aeration trenches serving to deliver air and remove leachate from the heap (typically 2 per 8 m wide heap)
    b. Water Traps to separate the aeration system from the leachate collection and transport system (typically 2 per 8m wide heap)
    c. Aeration Trench Covers
    d. Aeration Blower (1 per heap)

3. Control System:

    a) Oxygen and Temperature Sensors

    b) Control Units

    c) Computer and Software

4. GORE™ Cover Handling Machine (Winder)

The GORE™ Cover System, manufactured by W. L. Gore & Associates (Gore), utilizes positive aeration and a specially designed cover to create an enclosed system that optimizes the composting process, controls odors and micro-organisms, separates leachate from storm water and creates a consistent process unaffected by outside environmental conditions. Medium-pressure ventilators connect to in-floor aeration trenches. Stainless steel probes inserted into the pile monitor oxygen and temperature parameters. The data is relayed to and stored in a computer. This data controls the ventilator to keep the heap conditions consistent.

Typical Operating model:

After a pile is constructed, the GORE™ Cover, a specially developed membrane laminated between two polyester layers, is pulled over the pile. The cover protects the pile from weather conditions, but allows the release of $CO_2$and the water vapor. These controlled conditions allow a consistent product to be produced without the risk of damp pockets, eliminating the possibility for anaerobic conditions and thus mitigating odors.

The GORE™ Cover System typical operating model is to produce stabilized compost in 8 weeks. During that time period the material is moved through 3 phases of operations, in which the process is optimized through the GORE™ Cover Technology resulting in the appropriate temperatures as required to meet regulatory requirements.

Feedstocks that will be composted in the GORE™ Cover System are prepared as they would be to enter any other composting system. This includes setting the feedstock's initial moisture content, carbon-to-nitrogen ratio, particle size and porosity (as

described earlier). The prepared feedstock is then delivered to the desired heap position and placed over the aeration trenches with a front end loader or with the mixing unit outlined earlier.

After heap formation is completed, the GORE™ Cover is pulled over the heap automatically and secured to the ground. Oxygen and temperature sensors are inserted through the GORE™ Cover and their signals processed by an automatic computer control.

For the next four weeks, the heap undergoes intensive composting. The composting process continues naturally under the cover. The composted material is then moved and formed into a second heap for Phase II treatment for maturation under cover and oxygen controlled aeration for an additional two weeks. Thereafter the material is uncovered and moved again to form the Phase III heap for an aerated finishing period of 2 weeks. Depending on environmental conditions and feedstock material this Phase III is covered or uncovered.

Odor retention:

The GORE™ Cover composting system's emission reduction efficiency is achieved by the well-balanced interaction of all the system elements, not by a single component.

The GORE™ Cover - as the critical component - allows for effective emission reduction by three means:

1. Pathogen retention by the microporous structure of the Gore ePTFE membrane:

   Germ reduction of > 99% has been proved in several microbiological tests. Occupational safety as well as the safety of area residents is thus ensured. Thanks to the thermal insulation of the GORE ™ Cover enclosure and the temperature-distribution within the system, the temperature required for material hygienization can be ensured throughout the pile even during winter. PFRP is achieved and any pathogens which exist in the compost feedstock are safely destroyed.

2. Direct retention of odorous compounds under the GORE™ Cover:

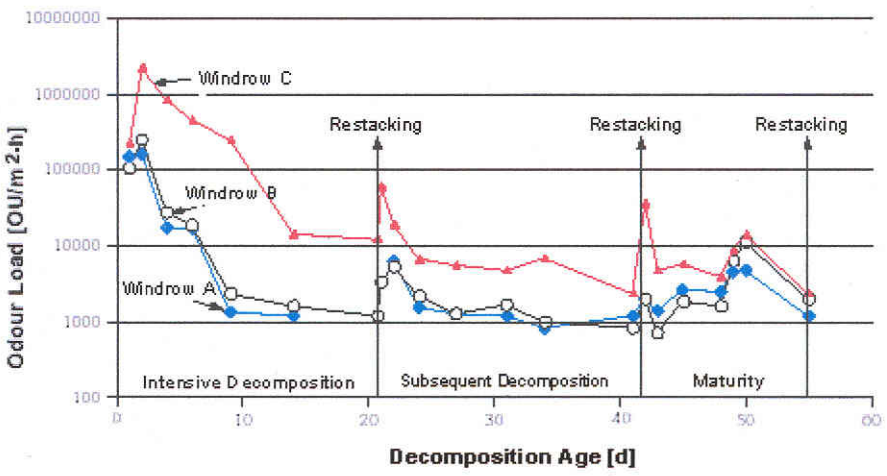
   The GORE™ Cover laminate retains gaseous substances beneath it and prevents them from escaping through the formation of a diffusion barrier. A fine film of condensate is formed on the inner side of the GORE™ Cover during composting that retains odors and other gaseous substances. These gases dissolve in the water film and drip back into the pile, and continue to be

broken down by the composting process. This results in a reduction of the overall emission flux.

3. Minimization of odor formation by achieving optimal process conditions:

   The choice of membrane influences the moisture discharged during the composting process. Excessive moisture would result in odor forming anaerobic zones; lack of moisture would stop adequate decomposition of biogenic materials, especially in arid zones. The membrane also confines air permeation leading to even air distribution throughout the heap and avoids channeling effects otherwise creating dry and wet zones within the stock.

A research project funded in 2000 by the German Federal Foundation for the Environment (DBU) revealed that the use of a sealed cover enclosure with ventilation (heap A+B) in high rate composting as compared to open windrow composting (windrow C) leads to a **90 % reduction in the odor emissions**.



Windrow C: Open windrow composting

Heap A+B: Composting with membrane covers

Re-stacking: Move and form into another heap

Intensive decomposition: Phase I (intensive rot)

Subsequent decomposition: Phase II (maturation)

Maturity: Phase III (finishing)

Decomposition age [d]: Number of composting days

Odor load [OU/m²h]: Odor flux [OU/m²h]

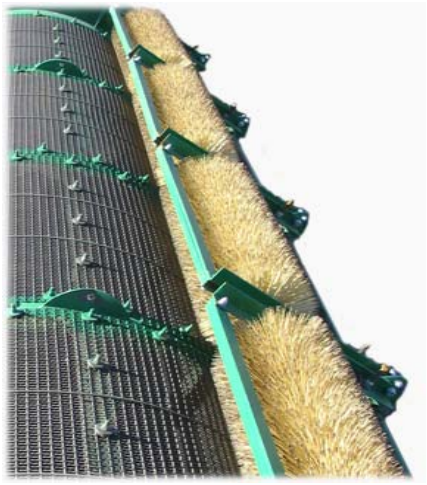
5. Water Management

The site will require a leachate containment and recirculation system so as to operate efficiently. While it is understood that the region experiences relatively low levels of rainfall, site designs need to consider variable weather patterns and the 100yr storm event. The Gore™ system is designed to handle complex feed stocks and minimize leachate production by providing an impermeable slab (which prevents groundwater contamination) and the use of the Gore™ impermeable covers (which prevents mixing with stormwater). Aeration trenches which are cast into the slab and located beneath each of the heaps double as leachate collection channels. These channels help to remove any excess water through gravity drainage serving to keep the base of the pile aerobic and all of the material biologically active. Leachate collected and introduced at the start of the composting process provides an additional jump start to the system by provided a jolt of inoculant bacteria beneficial to the decomposition process.

6. Curing, Screening & Storage

All materials removed from the Gore Cover composting system will require some degree of external curing. Initially this will include two weeks on the aerated pad, however long term curing will be completed in large storage piles which have completed the composting process. This material which is stabilizing should not need to have any water added to it as it will be in the process of drying out as the biological reaction slows.

The screening of compost occurs after curing demonstrates a stable product and successful bio-assays. Typically a 3/8" product size (3/8" screen) is the most demanded by nurseries who then take this material and blend it with sand and soil to create a box mix. Traditionally *flat screens* are not well suited to processing higher moisture content materials because the mesh tends to blind. For this reason a flat screen is likely not the best selection for the screening of bio-solids compost. If a flat screen is desired or already in place, then a ball decks can aid in the process as they bounce against the screen causing vibration.



Star screens are extremely effective but are also more complicated than simple trommel screens and often clog when presented with contamination. As the Norterra facility is planning to accept a significant degree of food waste with the potential to expand the program in the future, this could result in substantial and regular cleaning of the screen which will consume the operating budget. Trommel screen drum cleaning brushes provide a simple, yet vital, component for a screening plant. Equipment which has stiff brushes and a high bristle count will ensure that the trommel remains clear under difficult operations keeping production rates high.

Should there be a high degree of plastic film in the waste it is also relatively easy to retrofit the conveyor out feed belt of the screen with an Airlift separator (made by Hawker Corporation). The assembly sits on a 4x4 foot skid and can remove about 95% of plastic in the compost or mulch on the first pass. It also takes out plastic bottles and aluminum cans. The conveyor belt should be agitated so as to loosen the plastic without slowing down production. While this issue plays a larger role for facilities planning to accept source separated organics (SSO) this is not an immediate concern for Norterra at this time.

Once the compost has traveled through the screen and the “overs” returned to the mixer area to be re-injected into the front end of the process, stable and sellable compost product will be moved to the storage area. It is desirable to retain a substantial storage area so as to meet the product demands of major projects when they arise. No less than 6 months storage is recommended for the facility and the Norterra site has ample space available to meet this need. A simple containment of lock blocks along the perimeter will provide the boundary of the storage area.