Biosolids Composting At the Borough of Mechanicsburg, PA WWTP

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ABSTRACT
The Borough of Mechanicsburg, located in central Pennsylvania, was experiencing challenges in finding sufficient agricultural fields to continue the beneficial use of their anaerobically-digested liquid Wastewater Treatment Plant (WWTP) Class B biosolids. At the time, the only alternative available was dewatering and going to landfill, which is significantly more expensive. Due to environmental concerns and costs, biosolids composting was selected to produce a Class A Exceptional Quality (EQ) biosolids product, thus providing expanded opportunities for beneficial use. From the initial feasibility review to operational status, the implementation spanned nine (9) years, staring in 2005. The upgrade to composting was in conjunction with many other plant upgrades. Material Matters, Inc. provided support through the entire process including the feasibility study, pilot testing, cost assessment, compost facility design requirements, equipment assessment and recommendation, start-up testing, software development, permitting, fertilizer registration, product promotion, and marketing.

KEYWORDS
composting, aeration, biosolids, Class A EQ, start-up, marketing, pilot, self-managed

Figure 1. Overview of Mechanicsburg WWTP facility rehabilitation and upgrades.
INTRODUCTION

The Mechanicsburg biosolids compost facility construction was part of the WWTP Improvements Project to meet nutrient limits associated with the multi-state Chesapeake Bay Tributary Strategy. The biosolids compost facility is part of and within the WWTP fence line, which is adjacent to the Mechanicsburg Borough and Silver Spring Township Joint Composting Facility (Figure 1). The Joint Composting Facility is a joint municipal operation that handles yard waste (leaves), brush, tree trimmings, and trees. The leaves are composted and distributed to residents of the two municipalities. Woody waste is processed with a county-owned tub grinder, and the piles of ground material self-compost until distributed to residents of the two municipalities, or utilized in the biosolids compost operation. The proximity of the yard waste facility makes good use of the large quantity of shredded woody waste as a bulking amendment for biosolids composting. WWTP personnel operate and maintain both composting operations, sharing process equipment between the two (2) facilities, as appropriate.

METHODOLOGY

Facility Process Overview

Solids production and handling occurs in several stages at the facility. Raw sludge from the Primary Clarifiers is co-mingled with Waste Activated Sludge from the biological system in one of the two (2) Gravity Thickeners. The solids are then stabilized through a two-stage, high-rate mesophilic anaerobic digestion process. Thickened sludge is transferred from the Thickeners to the Primary Anaerobic Digester. The completely mixed and heated Primary Digester provides between 45 and 55% volatile solids reduction. Solids are hydraulically displaced from the Primary Anaerobic Digester to the Secondary Anaerobic Digester. The Secondary Digester is not mixed or heated and the contents are allowed to settle for additional thickening. After digestion, the stabilized solids are dewatered by one (1) of two (2) Belt Filter Presses (BFPs). Polymer is added as a coagulating agent just prior to sludge introduction into the BFPs. Approximately 130 dry tons are produced annually as belt filter press cake with a Total Solids of 15-20%. Dewatered solids are typically discharged directly into the compost mix truck for processing at the Borough’s Biosolids Composting Facility and processed in accordance with the composting procedure described below.


The Borough first began investigating biosolids composting in 2005 as part of a feasibility evaluation. This evaluation included site visits to several other biosolids composting facilities and a cost-benefit analysis of this option. In fall 2007, the Borough
constructed and operated a pilot Aerated Static Pile (ASP) biosolids composting system to demonstrate operational feasibility and technical/regulatory compliance. The pilot was intended to confirm that the biosolids were suitable for composting and that nuisance odors would not create community concerns. Compost time and temperature requirements for EQ standards were easily achieved during the pilot trial (Figure 2), and subsequent testing of the compost showed that pathogen reduction standards for EQ processing were met. Nuisance odors were not observed during the compost pilot, likely due to the use of well-digested biosolids and adequate ratio of biosolids to amendments. Based on the findings of this pilot study, the Borough decided to include a biosolids compost facility as part of the WWTP Improvements Project (Figure 1).


The Borough awarded design of the WWTP Improvements Project to Gannett Fleming, Inc. in 2008. Material Matters, Inc. was retained as a subcontractor for the Biosolids Compost Facility component of the project. Design of the biosolids composting facility incorporated many unique features and cost savings approaches. The building is an open-ended, membrane-covered steel frame structure to maximize usable space. Aeration of the piles is accomplished using twenty-one (21) 1.5-horsepower blowers, housed within the compost building. The blower headers and distribution pipes are 6-inch x 6-inch box steel channels installed with the top surface flush with the concrete floor. The top of the aeration channel has a series of unevenly-spaced ¾-inch diameter holes to balance air distribution along the length of each pile. The existing Sludge Storage Pad has been repurposed as a compost final product storage. Potential future odor
concerns were addressed by leaving space for a biofilter next to the Compost Building. This was especially important due to the close proximity of a large municipal park and several industries. Odor potential is reasonably low, as the biosolids are fully digested anaerobically prior to composting. Operations to date do not show an odor footprint larger than prior to composting.

The Water Quality Management (WQM) Part II Permit application for the Improvements Project was submitted to PADEP in April 2009 and PADEP issued a WQM Part II Permit for the facility on September 21, 2009. The WWTP Improvements Project was advertised in October 2009 and bid opening was on April 8, 2010. The contracts were awarded to Galway Bay Corporation (Contract 1) and Garden Spot Electrical, Inc. (Contracts 2 and 3). Construction of the WWTP Improvements Project began in summer 2010 with substantial completion in summer 2013.

The composting building is a 120’ x 180’ Cover-All membrane structure. The selected “low profile” design on risers was selected such that the large loader would not be able to strike the trusses when its bucket is fully raised. End-caps are available for the building, which can be added at a later date. If installed, the end-caps would help in the event of wind-driven rain. The amount of rain entering the building without endcaps is low and does not show evidence of negatively impacting the compost process. Composting to date has shown piles getting dry on the sides, so incidental rain could even be a benefit. At the end of the composting process, the moisture content can be lowered via extended aeration program immediately prior to breaking down the pile for screening, regardless of incidental rainfall. The lower moisture content is helpful by reducing clumping in the screening process, allowing more finished compost to pass the screen.

During the composting process, temperature is the primary monitored parameter, both for blower control and for regulatory confirmation of time-temperature. Temperature is automatically monitored using wireless ReoTemp EcoProbes. The probes periodically transmit ID/time/tip-temperature/mid-shaft-temperature/battery-voltage to a logging computer housed in the adjacent Biosolids Office Building. The ReoTemp Compost Watch software logs the data into a mySQL database, and provides a graphed and tabular view of the data. The temperature data could be used for trimming the blower timer settings, but the lag makes it a poor indicator. If the blower settings are questioned, or there is unexpected temperature data, manually collected oxygen probe (ReoTemp OxyTemp) data is collected from the pile immediately before the blower turning on, and immediately after the blower on-cycle is complete. Prior to the blower coming on the oxygen must not be below 5%. After the blower’s on cycle, oxygen must recover to at least 15%.
The Compost Watch system does not overlay temperature graphs from multiple probes, and it does not include any windrow management functions. Material Matters developed a set of tools for pile management, recordkeeping, and monitoring using Excel and VBA. The spreadsheet lets the user create a recipe, scale the recipe for the mix truck capacity (determining whether weight or volume is the limiting factor), log each mix truck load that goes into a windrow, monitor the temperature probes assigned to the windrow (and ambient), log blower on/off settings and changes to those settings, graph temperature and airflow, document whether the collected temperature data meet the time-temperature requirements to meet Class A EQ standards, and serve as a repository for notes for that pile’s history from the day it is built to the day it is screened for distribution. The spreadsheet directly interfaces with the MySQL database, so the latest data are always available. Each compost pile is managed through a separate Excel file, which allows for regulatory archiving of the data associated with that pile.


**Compost Ingredients and Procedure**

**Bulking Agents**
Mechanicsburg uses a “double-grind woody waste” bulking feedstock. It is woody/shrub vegetation ground twice to a mulch-like material. Compost screening “overs” also serve as a bulking material in new compost piles. The overs are generated from the screening of a compost pile, which is comprised of plenum material, cover material, and the compost pile itself; the overs are material too large to pass through the screen. Periodically the bulking agents are tested for solids, volatile solids, carbon, and nitrogen. Bulking agents are loaded into the mix truck using a front end loader or similar type of machinery. The mix truck’s scale indicates the weight of each material upon loading; the weight of each material is recorded for internal recipe quality control.

**Biosolids**
Typically, dewatered cake biosolids (15-20% total solids) are conveyed directly into the mix truck. Biosolids may alternatively be loaded from a storage pad into the mix truck by a front end loader or similar piece of equipment. Weight of the truck before and after biosolids addition is recorded for internal recipe quality control. Total solids content of the biosolids may be analyzed by Mechanicsburg WWTP laboratory personnel or other accredited laboratory.

**Pile Construction**
The composting facility is comprised of 21 at-grade permanent aeration channels. A plenum is formed approximately one foot deep, eight feet wide over the aeration channel by a front end loader. The plenum material is comprised of wood chips, screened woody waste overs, or screened finished compost overs. Biosolids are combined with bulking agents at

![Figure 5: Building a compost pile with the Roto-Mix mix truck.](image)
an approximate ratio of one part biosolids to 3-4 parts bulking agents. The recipe may change as necessary to achieve desired moisture content, C:N ratio, and/or porosity of the mix. The net weight of each ingredient is available for recording from the integral compost mix truck scale. The materials are blended, hauled, and offloaded into a compost pile at the Biosolids Composting Facility (Figure 5).

Each pile is constructed in layers, comprised of approximately 7-10 loads from the compost mix truck. Piles are centered on the aeration channels, which are approximately 40-50 feet long and spaced 12 feet apart. The piles are covered with woody waste or finished compost as an insulating blanket. The initial pile height is approximately 10 feet. After the aerated static pile is built and covered, no fewer than two EcoProbe probes are inserted into the compost pile, which regularly record temperature for process control monitoring and for regulatory reporting (Figure 6). The pile location, construction details, and related information are recorded and tracked within a single spreadsheet.

**Pile Aeration**

Compost piles are aerated via permanent at-grade in-slab aeration headers with holes drilled at uneven spacing increments to provide uniform air distribution. The system operates at positive pressure. Each compost pile has its own blower, controlled via an on/off timer. Along the length of the building there is space for three (3) piles to form a single large windrow. Piles are laid up against the previous windrow, and there is room for seven (7) windrows (21 piles) across the width of the building (Figure 6). There is no feedback from the wireless temperature sensors into the blower timer controls. The aeration schedule (duty cycle or “blower on/off time” for each pile is independent of other piles and may be modified at any time, based on oxygen demand of the microbes in the pile. Duty cycle settings and modifications are recorded on the aeration log sheet within the pile’s recordkeeping spreadsheet. Aeration requirements vary by the blended pile’s porosity and moisture content. Typically the aeration cycle is initiated during construction, may increase during the PR phase, and may decrease through the VAR and curing phases. Low (<5%) oxygen measurements are the primary indicator that may lead to changing the aeration duty cycle.
Pathogen Reduction/Vector Attraction Reduction
Active composting occurs over a period of approximately three weeks. The regulatory pathogen reduction (PR) and vector attraction reduction (VAR) requirements are met in the first 14 days once the pile exceeds the PR-minimum temperature. For PR, the pile is held at or above 131°F (55°C) for three days. For VAR, the pile is maintained with temperatures at or above 104°F (40°C) for a total of 14 days (an additional 11 days beyond the three days of PR). Additionally, for the 14-day VAR cycle, the pile must average at least 113°F (45°C).

Curing
The compost is either cured in place or moved to another location within the Biosolids Composting Facility for at least two weeks of curing. Curing time may vary, depending on preference and planned activities at the WWTP; however, it will not be less than two weeks.

Screening
After curing, compost piles are removed from the aeration facility using a front end loader and screened into a “finished compost” area. A Doppstadt screen was purchased for this task (Figure 8). The screened overs are transferred to a pile to be used as a bulking agent in subsequent compost mixes. Screened, finished compost is available for distribution as an EQ product. Based on customer needs and demand, unscreened finished compost and/or finished compost overs may also be distributed as additional EQ products.

Storage
Screened (finished) compost is stored in the finished product area under cover. The finished compost is tested quarterly (40 CFR §503.16 Table 1) to verify the continued compliance with EPA metals (40 CFR §503.19 Table 3) and pathogen reduction (§503.32(a)) via microbiological testing for fecal coliform and salmonella.

Biosolids Permitting
The Mechanicsburg composted biosolids are permitted by Pennsylvania Department of Environmental Protection via the state PAG-07 general permit for Class A EQ biosolids. The permit notice of intent was submitted in August 2014 and it was issued in September 2014.

Marketing
In Pennsylvania, any fertilizer that is sold requires a registration from the PA Department of Agriculture and the facility needs to be certified as a seller. The registration provides the end-
user a minimum 2-3-0 N-P-K guarantee and a 2% calcium minimum guarantee. The license and registration were obtained in September 2014.

The initial marketing groundwork started in early 2012, searching for the most likely large-scale customer candidates. In 2014, twenty nine (29) business end-users were contacted to evaluate their receptiveness to the product, their ability to use the product in bulk, the seasonality of their need, their location, and any specific sales terms that they require (Figure 9). The end-users were primarily landscapers, nurseries, and soil blenders. The product value is estimated at $15 per cubic yard, which was used when contacting potential customers in 2014. The bulk sales in late 2014 and early 2015 were transacted at a lower $5 per cubic yard price, the same price set for local residents, in order to promote the product and establish a base of satisfied customers. The first bulk sale of compost was in October, 2014, and the customer took all finished compost that was available at the time.

![Figure 9. A potential large-volume customer was visited in October 15, 2014. The Mechanicsburg compost would be an ideal ingredient to their commercially available soil blend.](image)

To further enhance customer demand and excitement about the product, the Borough’s Recycling Committee and Environmental Advisory Council held a naming contest for the compost. The winner will receive a load of compost, unloaded by the Mechanicsburg Mayor; other gardening prizes were offered for runner-up entries. The product name Waste No More was selected as the winner in March 2015, along with a logo, that is being used for product marketing (Figure 10).

![Figure 10. The product name resulting from the naming competition is Waste No More, with this logo for marketing.](image)

In April 2015, Mechanicsburg Borough held its annual Earth Day festival (www.mechanicsburgearthdayfestival.com). At that festival, samples of compost were given out for free.

**DISCUSSION**

Start-up and optimization of any new treatment process can pose its own unique set of challenges and the Borough of Mechanicsburg Biosolids Composting Facility was no exception. Finding a
suitable combination of biosolids quality, compost “recipe”, and aeration requirements was fine-tuned over a 10 month period. Aeration monitoring, control, and adjustment procedures had to be developed to allow Borough staff to control the temperature of the ASP. Initially, oxygen monitoring was not performed; once initiated, it was determined that excessive over-aeration was unnecessarily driving off heat and moisture, leading to premature temperature drop, especially during the coldest of the winter months.

Although the implementation of the Borough Biosolids Composting Facility has been almost 10 years in the making, the facility is an innovative and cost effective operation that takes advantage of existing infrastructure and processes to create a natural extension of the Borough’s solids handling operations. The compost is a high quality EQ Class A product that provides the Borough with many options for beneficial use into the future.