

# OPERATIONAL CHANGES BENEFIT ODOR MANAGEMENT

*Mechanical and aeration improvements, as well as alterations in operating mode, have had a positive effect on controlling odors.*

## Part I

*William G. Horst,  
Stephen H. Vold, Frank  
Mattern, Gary Bowers,  
and John Walker*

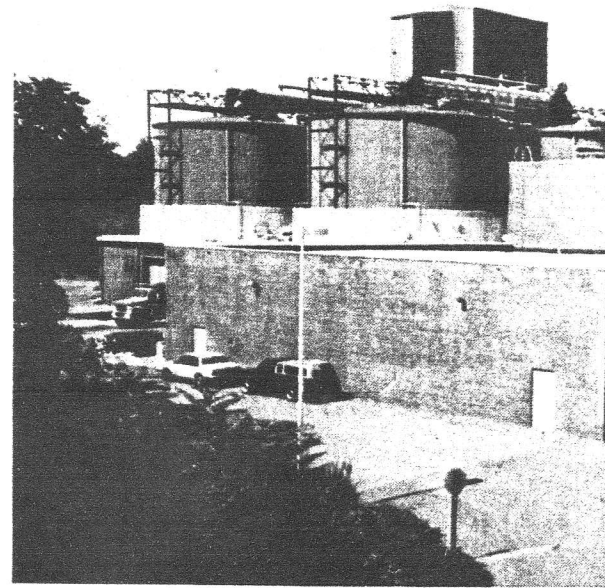
**T**HE CITY OF Lancaster, Pennsylvania's South Sewage Treatment Plant was one of two plants constructed in the early 1930s to serve residents. To take advantage of natural gravity flow, the plant was located in a low site along the Conestoga Creek, in an area that in current parlance would be referred to as the "boonies." As the urban and suburban population grew, the plant became hemmed in by housing developments. Today, neighbors from above look down onto the sewage treatment plant — and any malodorous fumes generated from the operations rise directly toward them with little or no chance of dispersion.

In the late 1970s, to meet more stringent water quality parameters, eliminate odors caused by the plant's heat treating process for sludge handling, and to generally protect surrounding natural resources and waterways, the Lancaster Sewer Authority (LSA) began planning and designing a \$52 million state-of-the-art advanced secondary wastewater treatment plant. Incorporated into this design was an advanced mechanical in-vessel composting system for sludge processing. At the time, it was only the second of its type to be built in the United States. The Authority chose this type of system because it seemed logical that odors would be easier to capture and treat. A one stage chemical scrubbing unit to handle compost process air was part of the original design.

Not long after the composting system began operating in 1987, odor problems were encountered. Achieving the present success with odor control involved a combination of both process and odor control unit improvements. Part One of this report reviews changes to the composting system itself. Table 1 summarizes the problems and solutions discussed in this article. Part II, to appear in the next issue, covers improvements in the odor control system.

### PLANT DESIGN

Dewatered sludge fed to the Taulman composting vessels is a blend of raw waste



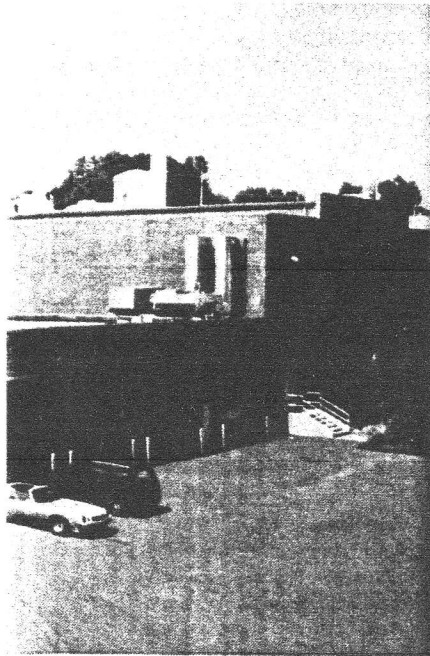
activated and primary sludge. The composting plant consists of two 1,200 cubic meter bioreactors; two 1,200 cubic meter cure reactors; and one carbonaceous storage silo.

The operation is divided into two trains, each consisting of a bio and a cure reactor. The first stage of composting — achieving pathogen kill and initial biodegradation — occurs in the bioreactors. The second stage of composting takes place in the curing vessels where the compost is further stabilized and undergoes a substantial reduction in moisture content. The designed detention time was 12 to 14 days in the bioreactor, followed by 14 days in the curing vessel. No on-site, out of vessel curing was provided.

Sludge is transported by a belt conveyor from the adjacent dewatering building and stored daily in the sludge bin. Amendment (sawdust) is dumped into a receiving pit, screened and pneumatically transferred into the amendment storage silo. Sludge, amendment and recycled compost are mixed together and transported to the top of the reactors by a series of belt and chain conveyors and loaded into the appropriate reactor. The finished compost is transferred directly from the cure vessel to trucks for distribution.

When the Lancaster system was designed, the sludge solids feed to the composting system was assumed to be 23 percent. The system was rated as being capable of processing 32 dry tons of sludge per calendar day. The fill mix at this loading rate was to be 33 percent solids. Each vessel can be supplied with up to 2300 cfm of air. The air supplied to the vessel is first drawn through the sludge bin, then forced into the vessels by positive displacement blowers. Each vessel was equipped with an exhaust fan and a vacuum/pressure relief valve. At design, each exhaust fan was capable of maintaining a slight vacuum in the vessels. The compost vessel exhaust gases were sent to an odor control unit.

The compost process controller was origi-



**Lancaster's compost system and adjacent dewatering building.**

nally programmed to turn off the supply air every time material was discharged from a vessel. The purpose of turning off the air was to prevent compost odors and gases from escaping into the compost unloading and control area (which is in an enclosed building). Exhaust fans were provided in this area to maintain comfortable working conditions. None of this exhaust air was treated to reduce odor. The belt conveyors used to load material into the top of the reactors were covered on the top only to shield against rain.

The compost facility was slowly brought on line during the fall of 1987. By February 1988, the bioreactors approached operational levels and transferring of material to the cure vessels commenced. The first discharge of compost from the system occurred during April and May 1988. Compost was given to farmers free of charge and used as daily cover at a local landfill.

Prior to actual start-up, the system supplier realized that the fill mix should be between 36 and 40 percent solids, and not the 33 percent solids assumed at design. Initially, the fill mix typically ranged between 34 and 44 percent solids. Sludge solids alone ranged from 33 percent during start-up to

less than 20 percent. Initially, only primary sludge was composted. But as liquid treatment operations came up to full-scale levels, the waste activated sludge component in the sludge blend increased. The net result of increasing that component was a decrease in cake solids. The typical recycle component ranged between 37 and 44 percent solids; the amendment's solids content was between 55 and 60 percent.

As the vessels came up to operational levels — with a compost depth of approximately 26 feet — and sludge solids decreased, the operators experienced increasing back pressure on the blowers. Aerobic conditions within the vessels became increasingly difficult to maintain. Part of the problem was the inability of the amendment to provide adequate porosity in the mix inside the vessels. Ninety-five percent of the amendment was smaller than one-quarter inch in size and 80 percent was less than one-eighth inch in size. The inadequate solids content resulted in fill mixes that at times fell below 36 percent.

The product during this period ranged from 43 percent to 70 percent solids. The detention time of the compost in the vessels varied a great deal due to operational and mechanical problems. The loading rates to the vessels varied greatly during the first years of operation due to the wide swings in sludge solids. The compost system, at that time, had never been fully tested as designed to enable operators to determine what the maximum loading rate could be and still have a marketable product. Optimum product quality at this time was not a primary concern since it was being used mainly as landfill cover or on large scale farm operations as a soil conditioner.

**Table 1. Summary of Problems and Solutions To Improve Compost Processes, Reduce Odors Generated and Overcome Fugitive Odor Escape.**

<i>Problem</i>	<i>Solution</i>
1) Fugitive Odor Escape from: (a) Conveyors  (b) Receiving & Mixing Area (c) Unloading Area	(a) Cover and exhaust air to second single stage scrubber via 8,000 cfm fan (b) Collect and treat building air in single stage scrubber (c) Same as (b)
2) Process air off 11 hours total (but no more than 4 hrs. at one time) during filling/unloading to minimize escape of odor	Installation of additional exhaust air capacity and improved ducting to create negative pressure and no loss of fugitive odors — even when air is on 24 hours and during vessel filling and unloading. Reduced odor generation and peak odor loading to scrubber, and improved composting and moisture release
3) Low solids content of sludge (Note that problems #3 and #4 led to poor porosity and air penetration as well as overly wet compost product): (a) System designed for 33% initial mix solids content (b) Expected sludge solids content of 23% but with addition of waste activated sludge, it was 20% solids	(a) Initial mix adjusted to 36 to 40% by addition of more and drier bulking agent (see #4 below) (b) With a drier sludge, composting capacity would be greater. Pilot test finding that increased sludge solids from 20 to 25% (using primary sludge only) cuts sawdust use in half
4) Amendment low in solids content and too fine in particle size: Sawdust used had 55% solids and 80% was less than 1/8 inch in size; Recycle had a 41% mean solids content	Specified drier sawdust (65% solids) with a bulk density of 12 lbs/cu.ft. and only 50% less than 1/8 inch in size
5) Varying stability in compost product	Steps taken in #2, #3 and #4 led to drier, more stable final product. City is obtaining equipment to test oxygen uptake rate of product to assess stability
6) Excessive age and septic state of feed sludge	Remove excess solids from wastewater treatment system with improved dewatering

## ENCOUNTERING ODORS

During the first few months of compost operation, approximately 16 dry tons of sludge were composted per day. As the compost system came fully on line, odor problems were noted. It was recognized that the odor control equipment installed during initial construction was inadequate, and modifications on that system began. (Part II of this report has complete details.) The modifications to the odor treatment scrubbers increased the back pressure (head) on the vessel exhaust fans. In addition, the exhaust lines also were found to be partially clogged with compost build up. The net effect was that as improvements to the odor control system were made, negative pressure could not be maintained in the vessel and increasing amounts of odors were escaping.

## AERATION, CONVEYOR MODIFICATIONS

By late 1989, most problems associated with the compost operation and odor control system were identified. Four new exhaust fans were installed to maintain negative pressure in the compost vessels. The diameter of the fans' exhaust ducts also was enlarged to accommodate increased air flow. Deflectors were installed to prevent compost

from being sucked into the exhaust lines — and into the scrubbers. The purpose of the deflectors was to reduce intake velocity and prevent material from being thrown directly into the exhaust intake. Recognizing that solids would eventually accumulate in these lines, flush out elbows were installed. A high pressure and volume water line also was run to the top of the compost vessels so that the exhaust line could be flushed with little effort. No problems now exist in maintaining negative pressure in the vessels.

Part of the odor control research conducted by city staff and its advisers included analysis of fugitive sources of odors from the composting operation (i.e. sources where odorous air escapes directly into the atmosphere without treatment, dilution, and/or dispersion). As Part II explains, it was decided to address the problem of fugitive odors prior to making significant adjustments to the chemical treatment system.

It is important to point out that when the

amount of odors escaped from the new auger. Ducting then was attached to this conveyor and odors were transported to odor control unit #2.

The control equipment for the composting system, as well as the loading/unloading area for the vessels, are in a building that utilized exhaust fans to maintain comfortable working conditions. These fans were another source of fugitive odor emissions. To address the problem, the existing fans were removed and a new ventilation fan was installed to pull air through the unloading area and sends it to odor control unit #2.

The air intake line to the blowers supplying air to the compost vessels also was modified to pull odorous air from the sludge conveyor, sawdust conveyor, and the compost unloading area — as well as from the sludge bin as originally designed. The lower compost feed conveyors also were covered to contain odors. By 1991, nearly all fugitive compost-related odors were contained or eliminated.

### IMPROVING SLUDGE SOLIDS, POROSITY

Since the raw sludge fed to the compost system is an odor source in itself, methods to reduce its intensity were investigated. Ferric chloride was tested briefly as a means of reducing odor intensity and increasing sludge cake solids. Unfortunately, Lancaster sludge lacks alkalinity and therefore, ferric chloride would not work as a dewatering aid without the addition of a base such as sodium hydroxide or lime.

In addition, the age of the compost feed sludge during the first years of system operation was greater than desirable. Sludge that remains for long periods of time in the plant's liquid operations is more difficult to dewater and is more odorous, and has a negative impact on sludge handling operations. During the spring of 1991, excessive solids were removed from the wastewater treatment system. This resulted in more effective dewatering and a reduction of the septic characteristics of the sludge being composted.

Aerobic composting requires adequate porosity in the compost pile at all times. In Lancaster, porosity was difficult to maintain with substandard sludge solids (i.e. below 23 percent). The amendment also had a relatively low solids content and was too fine in particle size. The combination made it very difficult to maintain an initial mix content of over 33 percent solids.

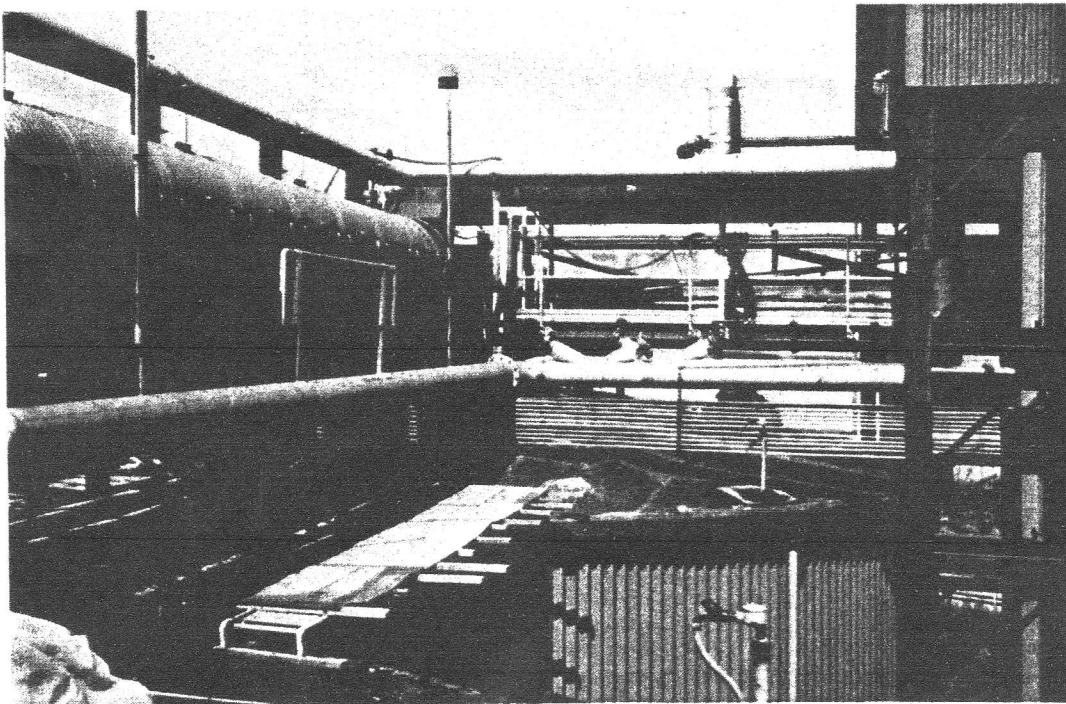
These conditions persisted until 1990 when the sawdust contract specifications were altered. The new contract specified a sawdust particle with a minimum solids content of 65 percent and a bulk density of 12 pounds per cu.ft. No more than five percent of the sawdust was allowed to be greater than 12.5 mm, and no more than 50 percent was allowed to be less than 2.23 mm. These standards allowed composting of sludge with as little as 20 percent solids while still obtaining the minimum 36 percent solids fill mix — and at the same time



**Compost produced after 1990 was drier and nearly odor free.**

upgrade was done at the wastewater treatment plant, a number of chemical scrubbing units supplied by Quad Environmental Technologies Corporation were installed to treat odors from a range of sources. There are three units in the composting operations area. Odor unit #1 handles all compost process air from the vessels (and is a three stage scrubbing unit). Odor unit #2 originally handled only odors from the dissolved air flotation thickener room. Odor unit #3 handles air from the belt filter press room.

The open sided conveyors were identified as a source of fugitive odors. To address the situation, all open compost belt conveyors were enclosed and the odorous air was transported by the use of an 8,000 cu.ft. per minute fan to odor control unit #2. Two of the belt conveyors then were replaced with an enclosed reversible auger. This further contained odors and improved operational flexibility. Even though enclosed, a small



Covering belt conveyors and providing exhaust lines helped control odors.

maintaining compost porosity. (The mix, until some experimentation got underway recently, was 1:1.6:1 of sludge, sawdust, and recycle.)

The highly improved porosity in the compost pile had another positive side effect. The aeration blowers could now be left on even when discharging material from the vessels because the new exhaust fans plus the improved porosity reduced back pressure in the system, enabling a negative pressure to be maintained. In turn, odors no longer escaped when the dump gates were opened. (Until this point, the blowers had to be turned off during loading and unloading procedures.) The continuous aeration also resulted in a more consistent quantity and quality of process air to be sent to the odor control system. Without this process change, odor control would have been very difficult to perfect and refine.

Product quality also was improved by the change in amendment characteristics. The main complaints about the compost produced prior to 1990 centered around high moisture content and odors. The compost produced after 1990 was drier and nearly odor free. The question of actual compost stability is still of concern to the city. The fact that the finished compost is dry and nearly odor free does not necessarily mean that the material is fully composted. (If the material is prematurely dried, the composting process will stop.) The city is acquiring the equipment needed to conduct a respiration test of compost stability.

#### LOADING RATE AND MONITORING

As of 1991, the city has composted up to 16 dry tons of sludge per calendar day and produced a marketable product. Approximately 100 cubic yards per day of finished compost is produced at this loading rate (assuming a minimum sludge solids content of 20 percent). An increase in sludge solids would result in an increase in the loading rate. The city is currently investigating var-

ious means of increasing the solids content of its sludge. (In early September, for example, experimentation began with composting only the primary sludge. Its solids content is 25 percent — versus the 20 percent solids of the blend of primary and waste activated sludges — and as of mid-September, the city already had seen its sawdust consumption in the mix reduced by half.)

The original Taulman design monitored the compost temperature at three different levels in the vessel, as well as the temperature of the exhaust gas. Although this information was useful, more detailed knowledge was desired. The city is installing four additional probes in each vessel. To process the additional readings, a new data recorder and personal computer were acquired. The new data processing system also will be capable of collecting data from the odor control system. The compost detention time will be computed instantaneously and continuously based on the daily information inputs. Currently, the dynamic nature of the in-vessel system, combined with occasional mechanical problems, makes it difficult to calculate an accurate detention time.

In-vessel composting is still a relatively new process. Much remains to be learned about its operation and controlling odors at such a facility. The City of Lancaster is committed to aggressively pursuing the latest technological developments. It believes that the best technology available is being used at this time, but the city will implement new ideas as they are developed. ■

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*The first four authors listed are with the City of Lancaster, Pennsylvania. William Horst is the Superintendent of Wastewater Operations, Stephen Vold is Sludge Treatment Supervisor, Frank Mattern is Supervisor of Maintenance, and Gary Bowers is the Chief Operator. Part II of this article will cover improvements to the composting plant's odor treatment system. John Walker is with the U.S. EPA's Office of Water Enforcement and Compliance.*