COMPOST SITE DESIGN FOR A CLOSED SANITARY LANDFILL

GEORGE DAKES
Clinton Bogert Associates
Englewood Cliffs, New Jersey

INTRODUCTION

With the prospects for dwindling landfill space in New Jersey, solid waste planners and engineers faced tough times in the mid-1980s.

The reluctance of public agencies to make critical siting decisions for new facilities led to ramifications in all fields of solid waste management including recycling, landfills, resource recovery and composting.

New Jersey became a net exporter of solid waste in 1988. In many cases, the toughest decision for public officials to make was where to site their transfer stations to have the garbage hauled out of state.

Corresponding with the cessation of landfilling and out-of-state hauling was a spike in the cost of disposal — often as much as four times the former rate. As the prices went up, so did the level of frustration. What used to be cheap to dump was now costing $100/ton to ship.

One of these expensive items was leaves. Those communities which were stuck without leaf composting facilities were forced to pay garbage prices to ship their leaves out of state.

Communities with the resources and available sites quickly implemented composting. Others scrambled.

Most towns encountered situations with piecemeal solutions that generated operational problems and odor complaints.

The problem of leaf handling was exacerbated in New Jersey with the prohibition of leaf disposal in the remaining in-state landfills and at the transfer stations. State Statute N.J.S.A. 13:1E-99.21 required that, by April 20, 1989, all leaves collected by a municipality be transported to a leaf composting facility. This legislation led to more forced solutions.

Siting was done on tight areas which resulted in odor complaints or risked using floodplain or poor soils such that proper operations were sacrificed and composting facilities became merely storage sites until the next solution could be found.

BERGEN COUNTY UTILITIES AUTHORITY

The Bergen County Utilities Authority (BCUA) is a regional governmental agency, located in the northeast corner of New Jersey, whose responsibility it is to manage the solid waste of the 70 Bergen County municipalities. Part of this responsibility includes making available to as many towns that so request a regional leaf composting facility.

Since 1986 (before the leaf ban), BCUA has operated a regional facility at its Kingsland Park Sanitary Landfill (KPSL). The landfill was in operation until 1988 when Bergen County also became an exporter of solid waste.

In mid-1986 where there first was sufficient interest on the part of municipalities for regional composting, BCUA received its initial permit to operate.

However, during the 1986 and 1987 seasons, ongoing landfilling activities were incompatible with composting. Despite the best intentions for composting, the disposal of over 4000 tons/day of garbage was necessarily the priority, with composting taking a back seat.

By 1988, with landfill operations terminated, the composting operation could proceed unimpeded by the daily onslaught of garbage.

The operators soon realized the 2-ft layer of soil cover material placed over the refuse was an unsuitable base for composting. Poor grading and no drainage resulted in extremely muddy conditions. Each time processing equipment or loaders attempted to turn the leaf windrows, mud and sometimes the underlying garbage became incorporated, resulting in an unusable product. It also contributed to the New Jersey Department of Environmental Protection's denial of BCUA's 1989 permit. Litigation ensued, and the proper operation of the facility was at issue, along with the stability of the landfill itself to support a composting facility.

The litigation between BCUA and NJDEP dragged on, preventing any possibility of operating in the 1989 leaf season. After the litigation concluded, the parties agreed in principle that the site could work. Concepts were reviewed with NJDEP to provide for a properly designed and constructed site, establishing a suitable base, and changing operators.

LEAF COMPOSTING

Leaf composting is a simple process with the potential for many operational nuisances.

Composting is the aerobic biodegradation of vegetative matter which, conducted in an orderly process, produces humus-like final product suitable for organic amending of soils, or as a stand-alone mulch or surface dressing. The duration of the process can vary from 6 to 24 months, depending on preprocessing and frequency of turning.

Upon delivery, leaves are placed into piles or "windrows." These windrows have a trapezoidal cross-section, 6 ft in height with a base of 14 ft.

As composting proceeds, monitoring is critical to insure that decomposition is occurring in an orderly fashion. Temperature, oxygen and moisture readings are taken periodically to confirm that certain levels are being maintained.

The size of the windrow assists in keeping within proper parameters. A windrow built too high, for example, may not maintain a temperature below 140°F, a critical level, and the pile may become anaerobic, leading to odors and slowing decomposition.

A windrow built too low may tend to dry out the pile. Low moisture content diminishes microbial activity and thus also slows the decomposition significantly.

The initial construction of the windrow and maintenance of its cross-sectional area is hence an integral part of proper composting.

There is a wide variation in equipment suitable for composting processing. Equipment uses include preprocessing for size reduction and sorting unwanted materials, mechanical turning and shredding the in-place windrowed leaves for aeration and size reduction, and screening to obtain a uniform, sorted product.

Other, more sophisticated equipment, such as blowers for forced aeration are available but are rarely used for leaves. The equipment uses above signify the typical "intermediate" level technology for leaf composting.

BCUA OPERATION

The equipment utilized at the BCUA Regional Leaf Composting Facility is as follows:

(a) Case 826 Front-End Loader
(b) Wildcat Compost Turner Model M-700-E
(c) Royer Model 365 Shredder-Mixer

The Wildcat shredder consists of a series of hammermills which is passed longitudinally down the windrow. For optimum operation aeration and size reduction, processing is slow, with a speed which should not exceed 3 mph. The Wildcat is not mobile, and is driven by the loader. Through a quick-connect to remove the loader's bucket, the Wildcat is mounted such that the loader can be driven in between the windrows, while the Wildcat processes the leaves off to the side. The hammermills are driven by a diesel engine mounted on the Wildcat.

The Royer shredder-mixer is available to process the final product. However, throughput is low for the size of the facility and thus is infrequently used.

Because the Wildcat is driven by the loader, the vertical tolerance of the equipment is critical for optimum usefulness. A fairly flat, even surface is needed to prevent the hammers from digging into the base or from sending the hammers over the pile, providing no processing.

Figure 1 shows the Wildcat processing a windrow with the assistance of a loader.

The support wheel of the Wildcat accommodates a 14-ft wide windrow. Any imperfections in the base have a direct effect on the operation and especially on how the support wheel reacts.

A paved surface, for example, would be an ideal base for the operation, to prevent rocking of the support wheel.

FIG. 1 WILDCAT TURNER PROCESSING LEAF WINDROW

Landfill

The Kingsland Park Sanitary Landfill (KPSL) is a 137-acre site located in Lyndhurst and North Arlington in New Jersey. The landfill opened in the early 1960s to service the southeast region of Bergen County. From about 1979 through its closure on February 29, 1988, all 70 Bergen towns utilized the landfill, dumping between 3500 and 4000 tons each working day.

Cells were usually constructed by ramping, with each of two daily cells having typical dimensions of about 100 ft by 150 ft with lift heights of 5–8 ft. Garbage was crushed by dozers as dumping proceeded, making constant passes to achieve maximum compaction. Tests conducted on in-place refuse indicated an average density of about 900 lb/cy, signifying good compaction for the volume of refuse being handled at that time. Other, much smaller landfills receiving less volume can achieve 1300 lb/cy using shallower cells and more frequent passes. Bales of garbage can be compressed to a density of 1600 lb/cy.

Despite the compaction rates attained for a sanitary landfill operation as large as the KPSL, the landfill was constantly settling, subsiding and shifting. During filling, landfill heights were monitored by aerial topographic mapping and by land surveyors to check permit compliance, to maximize filling where possible and to comply with design criteria for prescribed loadings. As filling progressed, and landfill operations were relocated to various portions of the site, refilling could be conducted to account for the settlement which had occurred. Settlement of recently filled areas was substantial, and landfill operators could rely on extra capacity which could be used.

Following closure, aerial topographic surveys were continued to monitor long-term settlements. This work was done with respect to our work on recommending the final cover for the landfill.

Aerial photography for mapping was taken on March 5, 1988, 5 days after the conclusion of filling, and then on July 20, 1989 and September 25, 1990 to continue to monitor settlements.

Ground control was obtained using off-landfill stationary bench marks located at various points around the site. The bench marks remained constant for each aerial survey. Photogrammetry was conducted and topographic maps were prepared showing pertinent features with contours at 2-ft elevation differences.

Using this mapping, elevation differences were plotted to graphically show settlements. Figure 2 shows elevations at a cross section through the western part of the landfill in an area where the most recent filling occurred. Since this area had the largest uninterrupted plateau, and also exhibited greater underlying soil stability as compared with the rest of the landfill, it was

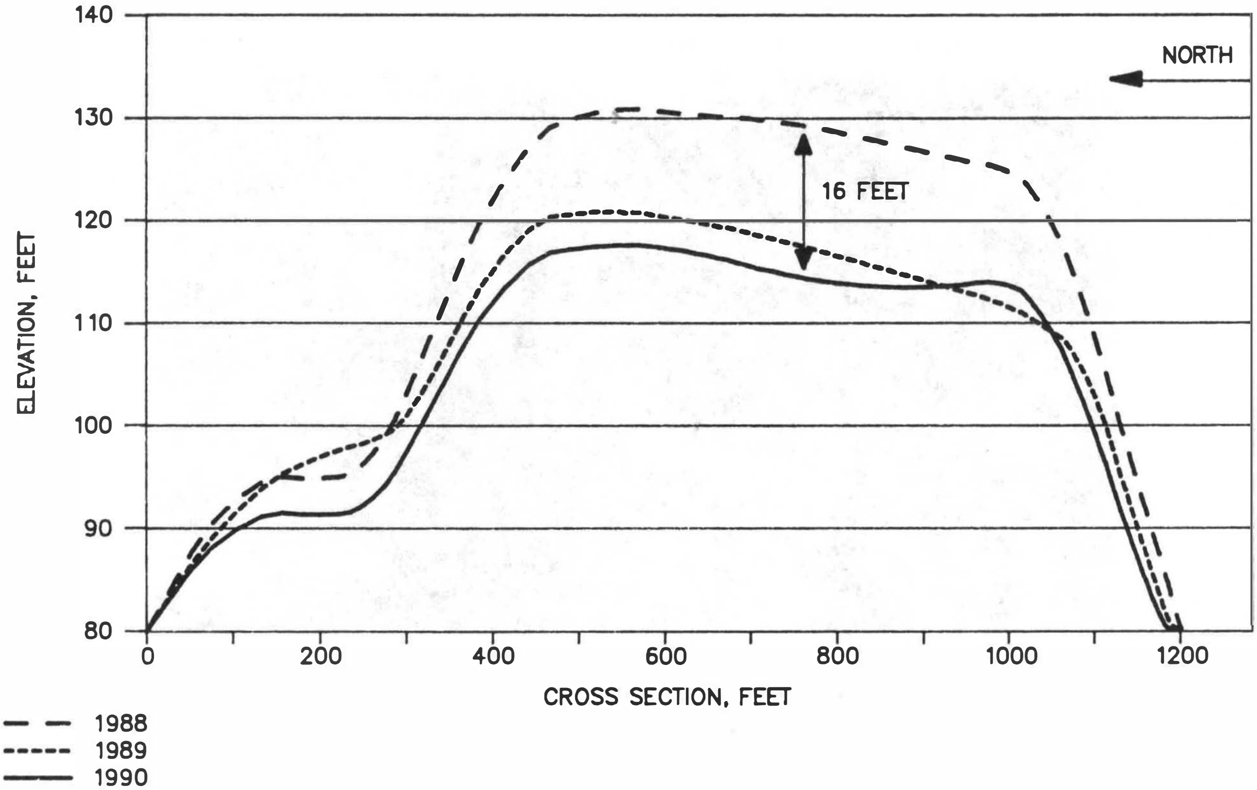

FIG. 2 CHANGES IN ELEVATION BETWEEN 1988 AND 1990

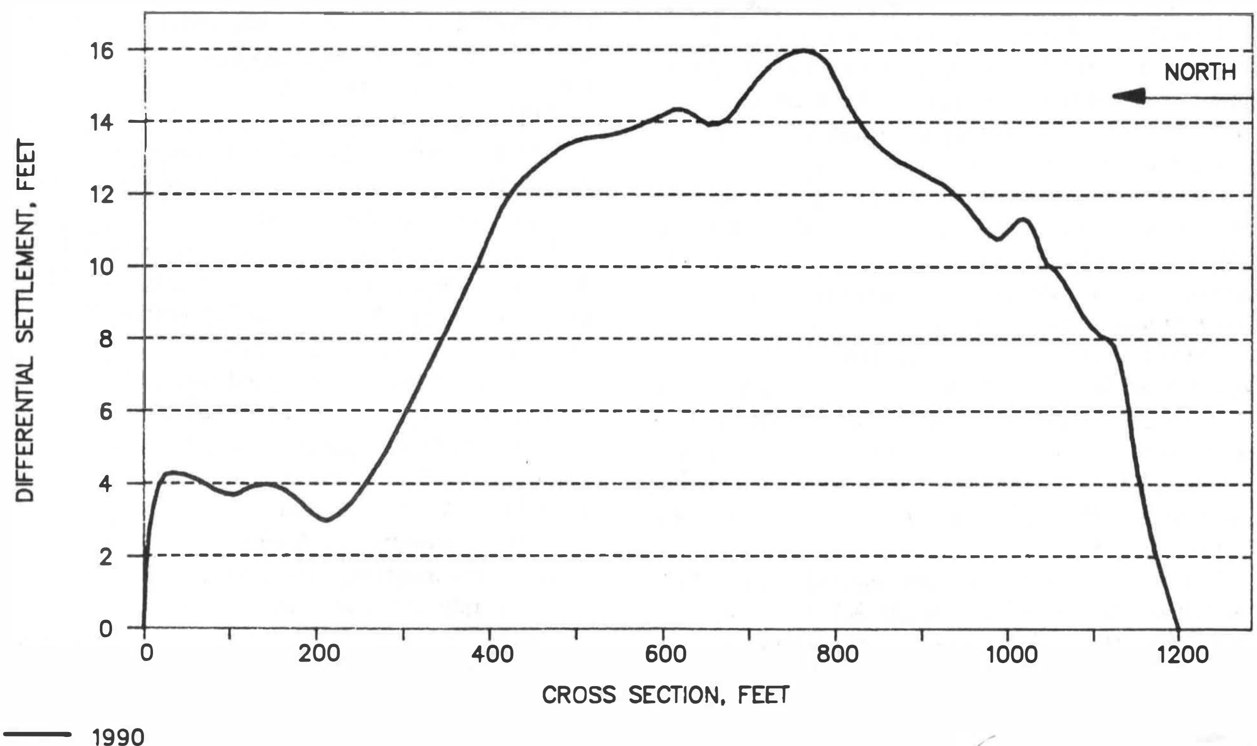

FIG. 3 DIFFERENTIAL SETTLEMENT IN 1990

determined that this location would be preferred for the composting facility.

The figure shows elevations along the section for the 1988, 1989 and 1990 aerial surveys. Over most of the plateau, landfill settlements as high as 16 ft took place from 1988 to 1990 with lesser, but measurable settlements along the side slopes.

Figure 3 is a plot of differential settlements for the same cross section. The plot indicates that, even on the relatively flat upper plateau, settlements from 1988 to 1990 occurred unevenly. It is expected that these settlements will continue, albeit at a slower pace. Future settlements will be more a function of refuse decomposition, rather than irregular initial compaction of refuse.

The Problem

Considering the likely effects of settlements, the need was to prepare a compost site with minimum equipment interference. The site improvements proposed would have to require little or no maintenance, since windrows would be located on the site for several months. Windrows could not be relocated for rehabilitation work.

The surface preparation required positive drainage as well, with no sink holes or gullies to create ponding. Unimpeded runoff was necessary so that equipment would not be operated in standing water and so that leaves would not be submerged.

As shown on Fig. 2, drainage on the plateau was poor because of settlements. The elevation change for a 500-ft run is indicated as about 3 ft, or a 0.6% grade. Without substantial regrading, ponding would be likely.

SITE IMPROVEMENTS

After landfilling was concluded, the landfill operators placed about 2 ft of soil cover over the compacted refuse. Through precipitation, wind erosion, shifting and settlements, some refuse was exposed, with many visible outcroppings. More troublesome, however, was the dense vegetation which had taken root in the 2½ years since filling stopped. The vegetation prohibited a clear view of recommended grades. Staking was not possible and the job did not lend itself to cut and fill quantity calculations for exact volumes used typically for earthmoving projects.

Instead, the vegetation was first stripped and deposited off the plateau for later removal and disposal. The plateau could then be observed to determine a general runoff pattern. Whereas it had been intended to "crown" the plateau to permit runoff in all directions (to decrease the possibility of adjacent erosion problems), the high point was located along the northern tier of the plateau. Drainage accordingly was sloped to the south.

Grades were provided only by visual inspection and equipment operators. The grading was accomplished almost entirely with on-site cover material with a nominal quantity imported to fill holes.

After the drainage was set and the grading completed, some refuse still protruded through the improved surface. As with most sanitary landfills, protrusions usually consisted of tires and reinforcing bars. These items were dislodged using a front-end loader and removed for disposal.

The entire site was then compacted with several passes of a vibratory roller. This process showed even smaller imperfections in the surface, and remediation such as additional void filling and removal of more protrusions could be conducted.

The rolling of the graded surface permitted the placement of a geotextile. During landfill operations, substantial quantities of road building crushed stone was lost to mud and continuous hauler traffic. It was determined that a geotextile was needed to keep the recommended base material in place. Thus, a geotextile was selected to sustain the impact of dumping loads of material over the geotextile without shearing, to maintain its integrity by preventing the intrusion of the underlying cover, and to provide a porous surface to promote drainage beneath the layer. Drainage was needed to complement the porous material proposed and to hamper the potential for erosion adjacent to the plateau. It was determined that the Mirafi 600X would be acceptable for these needs.

A suitable base material was needed to top the geotextile, to remain in-place for the duration of composting. It was determined that the optimum material for this application would be crushed stone, probably to a maximum of 2½ in., with a corresponding distribution of sieve sizes.

A typical section of the base preparation is shown on Fig. 4.

In the Northern New Jersey area, with the high cost of all waste disposal, there are many recyclers who process waste materials to produce aggregate. The origin of these materials is typically demolition projects of varying origin, including housing and industrial buildings, and roadway reconstruction. Aggregate produced from these demolition projects is, for the most part, suitable for the base material, with the exception of wood. The specifications for the base material, fa-

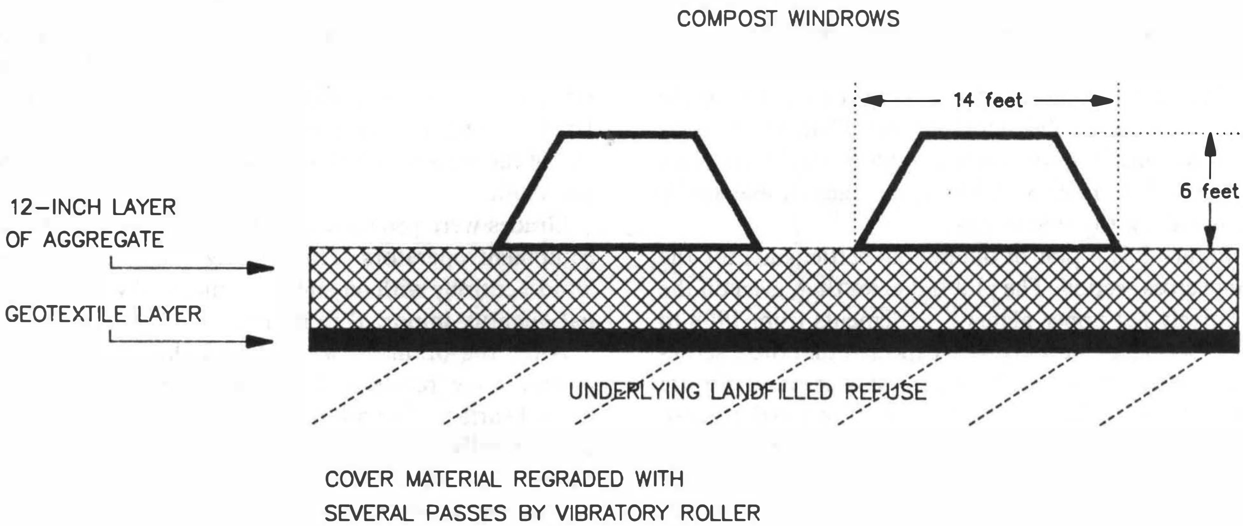

FIG. 4 BASE PREPARATION

vored the use of recycled material to discourage the use of virgin materials and to keep costs down, while eliminating unwanted materials.

The specified unit item, called paving materials, included the following description:

"Paving materials furnished by the Contractor shall consist of reclaimed asphalt pavement (RAP), shot rock and/or crushed stone. The RAP shall conform to Subsection 901.10 of the NJDOT Standard Specifications for Road and Bridge Construction."

The material was further specified by size gradation as follows:

Sieve Size	Percentage Passing
2½	100
2	70–100
¼	45–65
No. 200	5–20

Bids were received for the materials specified. It appeared those contractors who obtained commitments for the recycled material benefited by lower prices, as discernible by the bids received:

Contractor	Bid $/cubic yard
A	4.34
B	5.00
C	9.00
D	11.00
E	14.00
F	14.40
G	19.95

The low bidder proposed ash from incinerated sludge, with the theory that 100% of the material passed the 2½-in. sieve. The bidder and the material was rejected as nonresponsive to the specification.

Some latitude was given to the contractor for deliveries of suitable material. Each load of base material was monitored and loads of unacceptable material were rejected and sent back to the supplier for sorting. Acceptable loads included, at times, the following materials:

(a) recycled concrete
(b) asphalt
(c) ceramic (plumbing fixtures, tile)
(d) crushed stone
(e) brick

In allowing such varying sizes as with the brickbat, void filling was done, but not to the detriment of site drainage, nor to adverse impacts (puncturing and tearing) of the geotextile.

The varying nature of the allowable material, all in accordance with the specifications, permitted:

(a) Distribution of particle sizes.
(b) Interlocking of materials to promote stability.
(c) Porosity, to promote drainage.
(d) Keeping costs down.

A total of 25,000 cu yd of material was placed atop the geotextile as a base for the composting operation. As the material was placed, field inspection was conducted to confirm depths of 8–12 in. A vibratory roller was used to foster interlocking of the particle sizes, thus providing a more stable base.

Delivery of leaves for composting commenced around October 15, 1990. Packer trucks and other transport vehicles were directed to the windrow area, where loads were placed, for windrow formation by the front-end loader and the Wildcat turner.

Approximately 17,000 cu yd of leaves were received for processing over an area of 15 acres.

Because of the careful consideration of design criteria, no site maintenance was necessary during the operation of the composting facility. Minimal additional material was needed for regrading at the start of the fall 1991 season.

The adherence to design criteria resulted in the preparation of a final product suitable for amendment to soils for subsequent marketing.

BCUA is marketing its final compost product to a vendor manufacturing upgraded soils and is in the process of selling its entire product.

Through its diligence with design and construction standards, BCUA has thus produced an end-product of leaf composting which has generated interest in the private sector.

There are numerous potential pitfalls of operating a compost facility atop a large sanitary landfill. It has been demonstrated that it is possible to overcome these pitfalls and produce a marketable compost product.

Utilizing a large site, such as the Kingsland Park Sanitary Landfill, for leaf composting is a beneficial use with potentially widespread applicability for other landfill owners and operators.