Photo courtesy of Caterpillar

Landfill Lif

FEATURE Given the difficulties of permitting new facilities, landfill owners are using

As it has become more difficult (virtually impossible in some locations) to permit new landfills, owners and operators of these facilities are viewing airspace as an increasingly valuable resource. Most landfill operators understand the importance of increasing compaction and minimizing daily cover, but there are many other methods that can be used to maximize airspace. This article provides a summary of available methods as well as the potential benefits and obstacles that may be encountered.

Putting Off Permitting

Permitting a municipal solid waste (MSW) landfill has become one of the most difficult, most expensive and riskiest tasks that a solid waste authority or private company can undertake. It involves a significant expenditure of funds on public relations, engineering and legal services, with little or no guarantee that the permitting and design process will be successful. Unlike water, wastewater and other utilities, solid waste disposal often is viewed as a necessary evil, and funding is only provided when absolutely necessary.

After the stress of permitting a new facility is over, it is common for owners and operators to do their best to fill the landfill so that tipping fees can pay for past permitting expenditures. The problem with this mentality is that it often leads to an inefficient use of airspace, which in turn creates the need to again go through the permitting process sooner than expected.

Consequently, many landfill owners now consider their airspace a valuable resource that must be filled carefully through proper planning and innovative use and reuse. The following sections summarize the conventional and innovative methods that are being used by many landfill owners and operators to maximize their airspace.

Conventional Methods

Increasing waste density and minimizing the use of daily cover soils are two time-tested methods for increasing the life of a landfill. Both of these methods require additional investment in heavier and more efficient compaction equipment, and in alternative daily cover. Knowing when compaction is complete and placing cover soils in a thin, six-inch lift can be very difficult. To assist landfill equipment operators with making these interpretations, many landfills are using the following:

• **Global positioning system (GPS) units.** Waste placement and compaction on landfills is essentially elevation control. Mounting a GPS unit on compaction equipment and/or dozers allows operators to know when they are at the desired elevation and when additional compaction should be applied.

• **Frequent tracking of landfill volume and gate tonnage.** At a properly run landfill, there should be some correlation between the tonnage of waste received at the gate and the volume of the landfill after the waste is placed in the site. Maximizing airspace requires more frequent measurements of the landfill volume and correlation to the gate tonnage records. More frequent volume measurements allow the landfill owner to establish goals for minimum in-place waste density and to discover problems with MSW compaction before large volumes of airspace are wasted.

• **Diligent use of soil and alternative daily cover materials.** Alternative daily cover and efficient use of cover soils are proven methods for decreasing the cost and volume of non-waste materials that are placed in a landfill. In an optimized landfill, the financial decisions on the use of soil and alternative cover systems take into consideration the increased value of airspace.

In addition to the methods for increasing compaction and the efficient use of daily cover material, landfill owners increasingly are considering methods to expand vertically without encroaching into new areas of valuable landfill footprint. These methods include the following:

• **Mechanically stabilized earth and steepened slopes.** Specially designed geosynthetic materials for steepened waste slopes and mechanically stabilized earth (MSE) walls have been successfully applied at several large solid waste landfills in the past 10 years. The principle behind the use of steepened slopes and MSE walls is to stack waste materials higher over the same permitted landfill footprint. Advantages of these methods include avoidance of the cost of lining and/or the permitting of horizontal expansion areas. Disadvantages include hidden costs from long-term monitoring and maintenance, and the unknown performance rate of some geosynthetic materials over a 30-year-plus post-closure period.

• **Perimeter retaining walls.** It is common for landfills with limited airspace to gain 15 to 20 percent additional airspace by installing a perimeter retaining wall. Expanding a landfill vertically with retaining walls typically requires a permit

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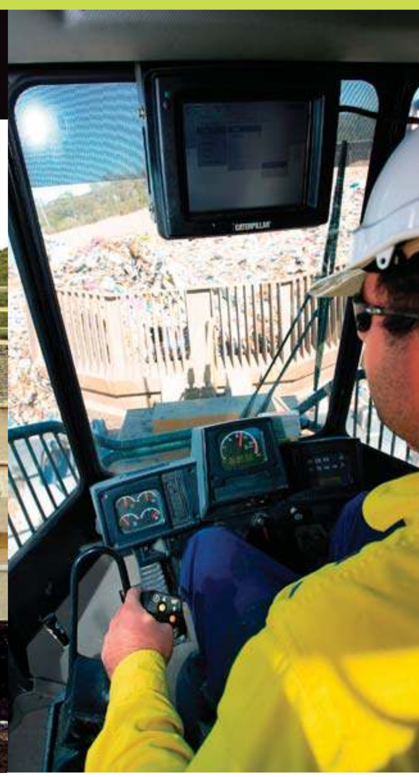
a variety of methods to maximize the lifespans of their sites.



Photos courtesy of Landfill Service Corp. (left) and SCS Engineers (right) modification, but the permit changes are much easier to obtain because the wall does not involve a horizontal expansion of the landfill. An advantage of a perimeter retaining wall is that it uses conventional soil stabilization methods that can be designed with a low-maintenance concrete facing or segmental blocks. Disadvantages include challenges with managing surface stormwater and the potential for permitting obstacles if the local regulators are concerned about geotechnical stability and/or the long-term performance of the retaining wall materials.

In addition to compaction and the use of earth retaining structures for vertical expansions, landfill owners and operators are turning to innovative methods of pre-processing and/or rapidly degrading waste to maximize the volume of their usable airspace. The following sections describe methods that are becoming increasingly cost-effective.

Mechanical Pre-Processing

The variety of waste types and sizes can inhibit the degradation of materials under typical landfill conditions. By mechanically pre-processing MSW prior to its disposal in a landfill, several improvements can be made to the characteristics of the waste mass:

- Recyclable/reusable products may be extracted;
- Undesirable constituents may be removed;
- Waste types may be separated for further pre-treatment;
- Closed containers may be opened to allow for enhanced degradation; and
- Size reduction/homogenization of the waste mass may be performed to enhance degradation and increase compaction.

Processes that fall under the category of "mechanical pre-processing" include:

- Separation,
- Size reduction/shredding,
- Washing/flushing, and
- Baling.

Bioreactors

The Solid Waste Association of North America defines a bioreactor landfill as any "landfill or landfill cell where liquid (preferably leachate) or air is injected in a controlled fashion into the waste mass in order to accelerate or enhance" degradation of the waste. This rapid degradation, which can be done in just a few years, naturally stabilizes the waste, and reduces volatile organic compounds, methane gas and constituents that contribute to odors. This treatment of leachate reduces the risk of groundwater contamination.

Most importantly, increased waste degradation and settlement can enhance disposal capacity. In anaerobic bioreactors (in which only liquids are injected into the waste) not only is more LFG is produced in a shorter period, but degradation can occur in a matter of years versus decades. Thus, settlement occurs more rapidly than in a standard dry cell.

In aerobic bioreactors, air is injected along with liquids to slow down methane production. However, degradation occurs up to 30 times more rapidly than in a standard dry cell. In these cases, waste degradation and settlement can occur within months of a system start-up. Anaerobic or aerobic, bioreactors lead to a recapturing of landfill airspace before closure occurs; thus additional MSW can be placed in the landfill before a cap is put on.

Moreover, stabilization means that the waste becomes less chemically or biologically active, which means less risks to human health and the environment. There are numerous examples of sites realizing a 10 percent to 15 percent gain in airspace due to rapid settlement. Sites that have experienced such gains include the Williamson County Landfill in Franklin, Tenn., and Outer Loop RDF in Louisville, Ky. The potential advantages and benefits that may be realized through the use of anaerobic or aerobic bioreactor technology include:

- airspace gain;
- avoidance of leachate treatment;
- delay of closure;
- lowering monitoring costs (due to lower risks); and
- ownership of greenhouse gas (methane) reduction credits.

Landfill Mining

Landfill mining and waste reclamation are techniques whereby solid wastes that have previously been landfilled are excavated and processed. Processing typically involves a series of mechanical operations designed to recover one or all of the following: recyclable materials, a combustible fraction, soil and landfill space. In addition, mining and reclamation can be used to remediate poorly designed or improperly operated landfills and to upgrade landfills that do not meet environmental and public health specifications.

Landfill mining is primarily applicable to sites that are confronted with the following issues:

- limited airspace and no local alternate waste disposal site;
- limited borrow areas for cover soil material;
- the need to remove a source of groundwater contamination; and
- a situation in which the recovery of landfill footprint is much more cost-effective than permitting a new landfill.

The application of landfill mining technology may be limited by the following factors:

- LFG levels that are too high;
- the waste disposed in the landfill may not yet be sufficiently degraded to optimize the recovery of recyclable materials; and
- the market demand for recyclable materials recovered from degraded MSW may not be sufficient to economically justify implementation.

However, in high-density areas where land for disposal is scarce, landfill mining technology may be found to be a cost-effective, logistically feasible and environmentally conscious alternative. Furthermore, in cases where an existing landfill is adversely impacting the environment, landfill mining may be economically superior to other remediation options.

Landfill mining uses standard construction equipment to perform the mining operations. The material is excavated and removed to an on- or off-site processing facility. The excavated material generally includes a mixture of MSW and/or other solid wastes with soil. The processing facility generally incorporates conveyor belts, screens, air separators and magnets to sort the various waste streams from fine-grained inert material (i.e., soil). The recovered materials (metal, paper, refuse derived fuel, etc.) are further processed, as necessary, prior to market distribution or re-use. The residual finegrained material may be re-cycled as daily cover, and the remaining fraction of over-sized unrecoverable material may be placed back in the landfill. ■

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