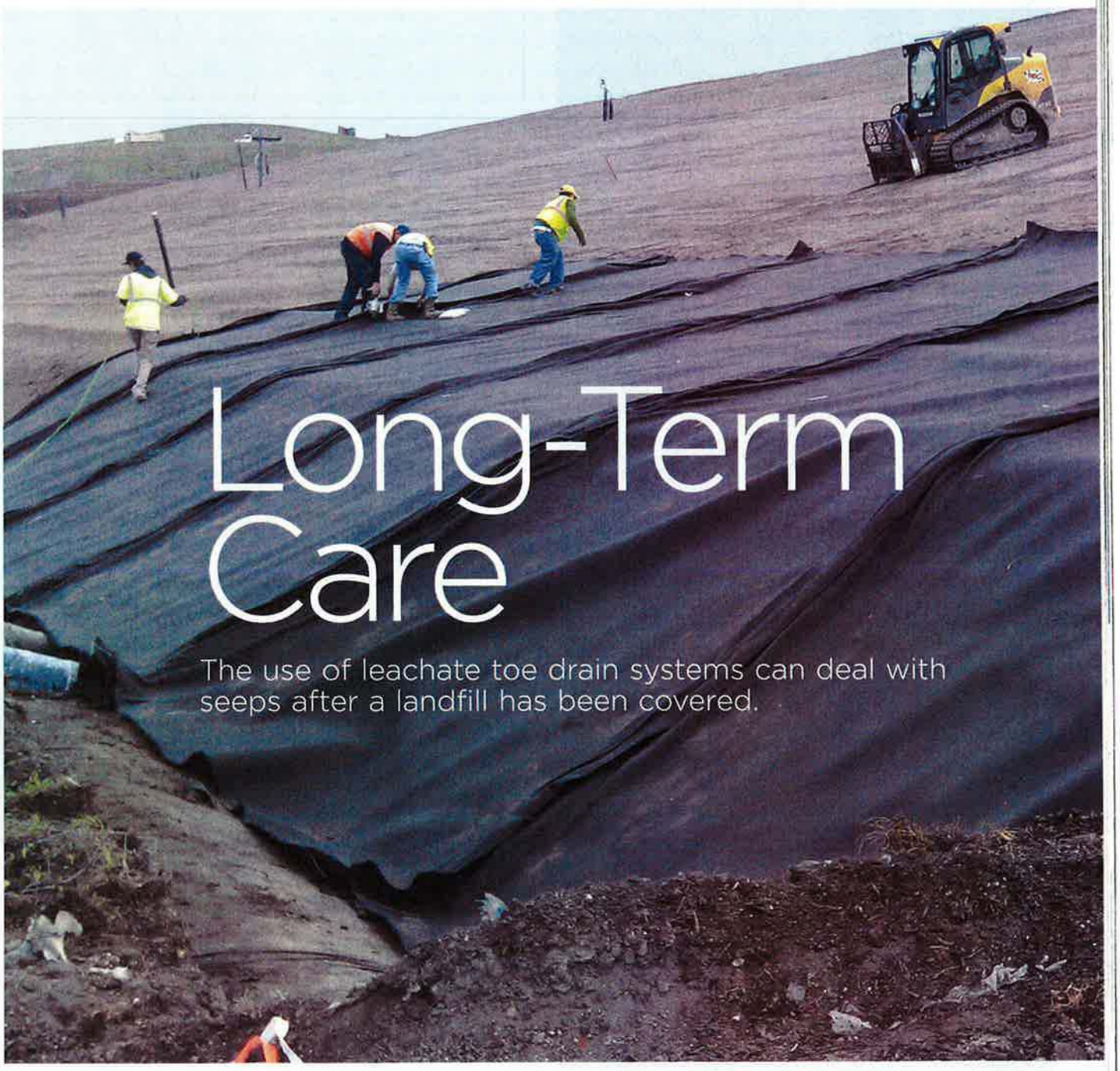

Long-Term Care

The use of leachate toe drain systems can deal with seeps after a landfill has been covered.

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Leachate seeping out of landfill slopes is a common occurrence. Operators struggle to address leachate seeps and manage liquids reaching landfill boundaries. During dry spells, it takes less effort on the part of operators to control liquids on landfill surfaces, and seeps are therefor more manageable. But during periods with frequent storm events or in high-precipitation regions, landfill operators must work constantly on slopes to stop seeps or devise means to control liquids when they do reach landfill surfaces.

Generally, after closure of a portion of a landfill slope, seeps that were problematic and bothersome are completely forgotten. Such seeps are no longer visible. In addition, there can be a tendency to assume that the seeps automatically disappeared because closures prevent rainwater from entering landfills. This assumption may be true if the source of water leading to the seep is in the closed area. But if the source is elsewhere (i.e., an area that is not yet closed), the seep underneath the final cover geomembrane continues until the actual source is covered by geomembrane at a later date.

To handle leachate seeps below the final cover geomembrane, the primary author of this article developed a collection system and later coined the term "leachate toe drain system" (LTDS). The first LTDS was designed and permitted in 2001, and implemented in 2002, at an extremely wet landfill located in south Florida. Severe leachate seeps from slopes had previously caused significant problems for a closed portion of the landfill slope and caused potential compliance issues for the facility operator.

The LTDS is simply a collection and removal system constructed below the final cover geomembrane at the perimeter of the landfill.

It was obvious that the source of the seeps was the large top area of the landfill that was going to remain open for a long time. The primary author modified the final cover design to incorporate the LTDS for collection and disposal of liquids flowing down the slope underneath the cover geomembrane. The LTDS was designed to be connected to the nearby leachate collection pipe cleanouts and/or nearby primary system riser from the sump. These connections conveyed the collected liquids in the LTDS to the leachate collection system for removal via the leachate collection sumps. The success of the project led to the inclusion of LTDS in all future final cover designs by the author.

How it works

The LTDS is simply a collection and removal system constructed below the final cover geomembrane at the perimeter of the landfill. The system involves a short-length geocomposite (LTDS geocomposite) over the lower portion of the slope, and a perforated pipe encased in gravel and wrapped in geotextile (LTDS burrito) at the perimeter berm within the lined area of the footprint.

The burrito is placed inside a depression near the top of the lined slope of the perimeter berm, but below and before the anchor trench shoulder. The depression is created near the top of the slope within the protective cover sand. The end of the LTDS geocomposite is placed at the bottom of the depression and the LTDS burrito is constructed directly above the LTDS geocomposite inside the depression.

The LTDS geocomposite is anchored on the slope approximately 10 ft. to 15 ft. above the perimeter berm. After installation, the cover geomembrane comes in contact with the LTDS geocomposite, and the geocomposite becomes the sole conduit for liquids below the cover geomembrane flowing to the bottom of the slope.

Since the LTDS geocomposite provides a preferential path for the flow of liquids, the liquids directly flow through the geocomposite to the LTDS burrito instead of entering soils at the bottom of the slope where they would have created a soft and saturated condition at the toe of the slope below the cover geomembrane. The perforated pipe in the LTDS burrito is connected to a cleanout pipe or a specifically designed piping system to convey liquids to a nearby leachate collection sump.

The specific piping system that conveys liquids in the LTDS to the leachate collection sump should be equipped with cleanouts so that the LTDS pipe can be cleaned, if needed. In the case of double-lining systems, the pipe that drains the LTDS pipe to the primary sump may have to cross over the detection riser inside the secondary sump (below the primary liner). Therefore, the drain pipe grades need to be carefully designed and closely monitored during construction to maintain gravity flow through the pipe.

In the case of sloping perimeter berms, it is recommended that the LTDS to be constructed along the perimeter berm to eliminate leachate flowing down the sloped berm below the cover geomembrane. The berm slope provides an efficient gravity

flow for the LTDS pipe. A similar condition may also exist when a lined overlay (liner over a side slope of an existing landfill) is in the design. The LTDS should be extended along the berm over the overlay area.

If specific leachate seep locations are identified on the slope above the LTDS geocomposite boundary, the seep locations are surveyed prior to disturbing the slope for construction of the final cover. After the slope is prepared and before installation of the cover geomembrane, the surveyed locations are staked for identification on the prepared slope and the

> The LTDS pipe can also be used as a gas collection system for the lower portion of the slope.

LTDS geocomposite panel directly below each seep location is extended up the slope to cover the seep location and is anchored above the seep.

The extended geocomposite panel provides a preferential path for liquids coming out of the seep underneath the cover geomembrane to the LTDS burrito. Even if the seep remains active for many years after closure of the slope, the LTDS geocomposite will continue directing liquids coming out of the seep to the LTDS at the toe of the landfill slope for collection and disposal.

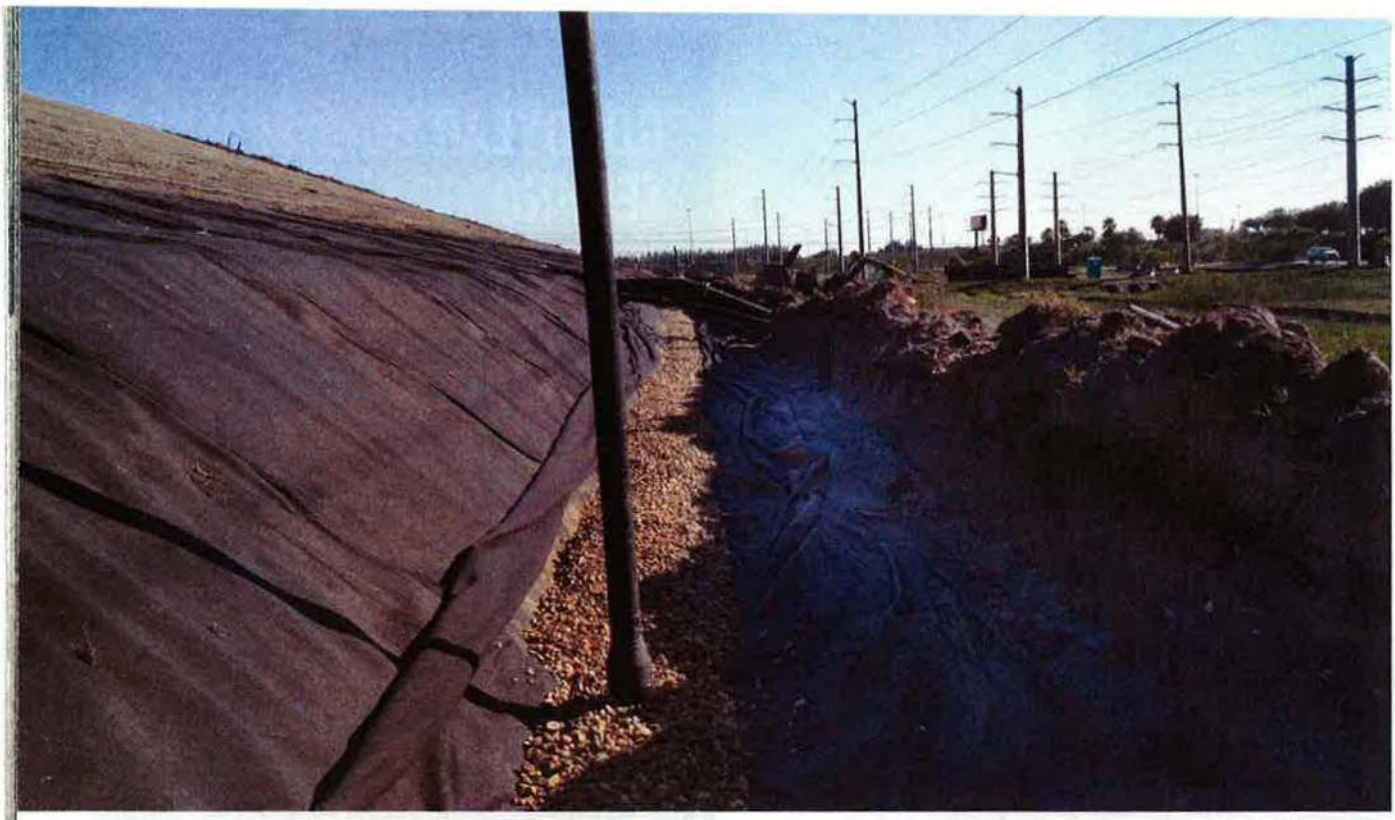
The LTDS pipe can also be used as a gas collection system for the lower portion of the slope. Since the LTDS is below the cover geomembrane, landfill gas in the vicinity of the LTDS burrito can enter the pipe. By installing vertical pipes on the LTDS pipe at spacing of approximately 300 ft., a vacuum can be applied to the LTDS pipe to remove landfill gas from underneath the cover geomembrane. This will not only reduce gas pressure below the cover geomembrane at the toe of the slope, but it will also increase gas collection efficiency from the lower portion of the landfill slope.

For the case of shallow-depth landfills (coastal area landfills) where the closest vertical gas wells may be 150 ft. to 200 ft. away from the perimeter berm, collection of gas through the vertical pipes on the LTDS can potentially prevent gas pressure issues at the toe of the slope. (Note that the vertical pipes will penetrate the cover geomembrane, thereby requiring the installation of geomembrane boots.)

Construction complications

Construction of a LTDS at the time of the installation of the final cover can become more complicated if the landfill slope is overfilled. The excess waste must be shaved back to open space for construction of the depression for the LTDS. Handling leachate during shaving of waste and preparing the depression is another complication.

Alternatively, the LTDS can be constructed at the time of construction of a new cell and protected by a sacrificial geotextile (to be kept clean) so that it can be placed in service when the



final cover is constructed over the slope above the LTDS at a later date. In that case, the LTDS geocomposite will be placed above the LTDS burrito; therefore, measures must be taken to ensure that no soil is trapped between the LTDS geocomposite and the LTDS burrito that could potentially create a future bottleneck in the flow path of leachate to the LTDS burrito.

In any case, sandy soil should be used over the completed LTDS burrito to form a gradual slope over which the cover geomembrane will be installed. Proper grading of the sandy soil prevents development of depressions that might trap water

above the cover geomembrane.

For the LTDS to function properly, it is important that the cover geomembrane be welded to the geomembrane in the bottom lining system. The extrusion weld connecting the cover geomembrane to the bottom geomembrane should be properly vacuum tested to close all openings through which leachate can escape.

The authors usually take even additional measures to ensure that leachate cannot escape through even pinholes that might exist in the extrusion welds. Such measures may include placement

of dry bentonite powder over the extrusion weld and/or placement of a 3-ft.-wide strip of geosynthetics clay liner over the extrusion weld or over the dry bentonite powder.

If the landfill is unlined, a LTDS may still be constructed, but leachate may escape at the landfill boundary into the environment. Additional site specific measures may be taken by the design engineer to minimize escaping of leachate from the boundary of the unlined landfill.

The authors have been involved in construction of numerous partial closures at very to relatively wet landfills, and the LTDS included in the closure system has proven to be an important component for keeping the final cover intact and stable on the slope. Since 2002, the authors' clients have adopted the LTDS feature as a standard component of their landfills' final cover systems.

The construction cost of a LTDS varies from project to project depending on the components included in the design. The unit cost of construction may vary from $27 to $35 per linear ft. ■

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