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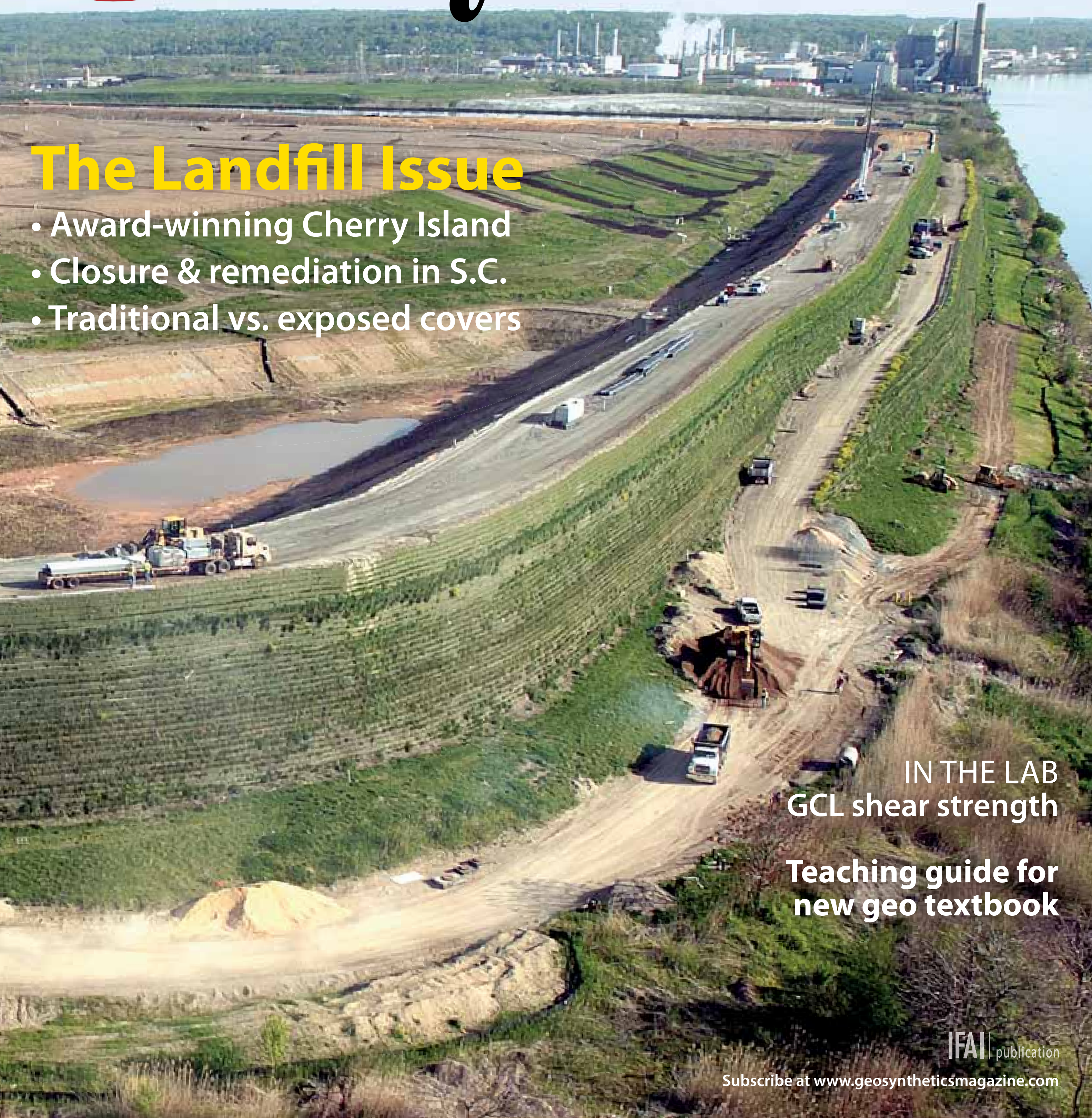

The Landfill Issue

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The only option to increase the waste capacity at the Cherry Island Landfill in Delaware was vertical expansion with a massive MSE berm.

Finalist for 2012 award for Outstanding Civil Engineering Achievement

Massive soil reinforcement at Cherry Island extends landfill's use for decades

The challenge

Cherry Island Landfill, operated by the Delaware Solid Waste Authority (DSWA), has been used for municipal solid-waste disposal since 1985. Built on an old dredge disposal site at the confluence of the Delaware and Christina rivers in Wilmington, Del., the subsurface conditions at the landfill consist of soft, compressible materials.

By the early 2000s, the Cherry Island Landfill was nearing its waste capacity and the DSWA needed to develop a plan to extend the life of the landfill. However, the original landfill was geographically confined by the Delaware River on the east, the Christina River on the south, Interstate 495 to the west, and by dredge lagoons to the north, so horizontal land expansion of the facility was not an option.

The only option to increase the waste capacity of the landfill was a vertical expansion. But to expand vertically, significant ground improvement measures and ground reinforcement techniques were required.

The design

The subsurface conditions at the site consisted of dredge material approximately 40ft thick, overlaying an alluvial deposit about 45ft thick.

Underlying the alluvial deposit was a medium dense to dense residual sand layer. Due to the soft ground, the landfill side slopes could be no steeper than 8H:1V (8 horizontal to 1 vertical) without ground improvement and geosynthetic reinforcement techniques.

PROJECT HIGHLIGHTS

CHERRY ISLAND LANDFILL VERTICAL EXPANSION PROJECT

LOCATION
Wilmington, Del.

OWNER
Delaware Solid Waste Authority

ENGINEER
Geosyntec Consultants

CONTRACTOR
Sevenson/Terra Structures

CONSTRUCTION
Fall 2006–Spring 2011

GEOSYNTHETIC MATERIALS
Mirafi PET1170, Miragrid 20XT, Miramesh GR, Nilex PVDs

Contributions for this article came from the American Society of Civil Engineers (ASCE), the 2012 OPAL(Outstanding Projects and Leaders) Awards presentations, the Delaware Solid Waste Authority, Geosyntec Consultants, and TenCate Mirafi; compiled and edited by Ron Bygness, *Geosynthetics* magazine.

Photos courtesy TenCate Geosynthetics

Berm facing using geogrids and wire-basket form work.

Some of the ground improvement techniques considered for the vertical expansion included deep soil mixing, sand drains, and prefabricated vertical wick drains (PVDs).

Consulting engineers selected a foundation improvement technique that used PVDs combined with a mechanically stabilized earth (MSE) berm. The combined dredged material and the underlying alluvium deposit form a 60- to 100-ft thick foundation of weak and low-permeability soils having undrained shear strengths as low as 200lbs per square foot (psf). The MSE berm plays a dual role, compressing and consolidating foundation soils while providing new disposal space.

Ultimately, the most cost-effective and construction friendly option was a high-strength, geosynthetic-reinforced berm constructed over PVDs. The PVDs drain water from the dredged alluvial material to an underlying sand deposit, thus allowing the dredge-alluvial soils to dissipate excess pore water pressures.

Due to the soft, compressible dredge and alluvial material, significant settlement was anticipated. Also, because of the massive size of the reinforced earth berm, development of a high-pore water pressure in the foundation soils was a concern.

Piezometers and other instrumentation devices were included in the design to monitor stability and prevent the berm from being built too rapidly.

The design of the MSE berm accomplished two key project components: compressing and consolidating foundation soils while providing new waste disposal space.

The construction

Construction began by installing more than 81,000 PVDs over 6.8 million linear feet. The drains were installed around the perimeter of the landfill in the foundation area of the berm.

Innovative design engineering, combined with proactive construction services, brought the final cost for the completed project within 2% of the original contract amount.

Construction of the berm on top of the PVDs began by placing the high-strength reinforcement geotextile with drainage sand. The sand provided quality backfill at the base of the berm and allows water to drain from the PVDs.

The bottom two layers of the reinforcement were crucial to provide stability to the reinforced berm. These two layers consisted of a polyester geotextile, considered the highest-strength geotextile ever manufactured for this type of construction in the United States. The ultimate strength of the woven polyester geotextile was 1,170 kN/m (80,000lb/ft). The embedment length of the bottom two layers of high-strength polyester geotextile was 140ft long. This long embedment length was required because of the extremely soft subgrade.

Two additional long embedment lengths of the high-strength geotextile were used at the mid-height of the berm for additional stability.

The remainder of the berm construction included polyester geogrid. Embedment lengths of the grid ranged from 20ft to 80ft. The berm was constructed with a face batter of 1H:3V, 72 degrees from horizontal, so technically it was a wall.

The face detail consisted of L-shape wire baskets acting as a form for fill placement and woven polypropylene small-aperture geogrid wrapped around the face. The geogrid was used as secondary reinforcement and facing wrap for stability and erosion protection. In addition, it allows for fast germination of vegetation through the reinforcement.


Installation of the first layer of high-strength geotextile.


Lower tier of berm and access road.


An MSE berm almost two miles in length was the critical component of this vertical expansion project. Located at the confluence of two rivers, the Cherry Island Landfill also presented challenging subsurface conditions.

Native vegetation was used at the site and it developed quickly at the face after construction.

The berm was constructed to heights of 60–70ft, with a total length of approximately 8,700ft (2,900yd or 1.6 miles). The total face area of the berm was approximately 475,000ft². More than 2 million cubic yards of fill was required for construction of the berm.

The berm also required more than 370,000 square yards of polyester geotextile, 670,000 square yards of woven polyester geogrid, and 315,000 square yards of woven polypropylene geogrid.

The performance

Vertical expansion of the Cherry Island Landfill could not have been accomplished without reinforcement by high-performance geosynthetic materials. The vertical expansion was an innovative design, effectively managing and constructing a massive berm on extremely soft soil.

Conclusion

The completed landfill expansion provided the DSWA with new leachate, landfill gas, electrical, and SCADA (supervisory control and data acquisition) systems for the site.

Innovative design engineering, combined with proactive construction services, brought the final cost for the completed project within 2% of the original contract amount.

The Cherry Island Landfill vertical expansion project was one of five finalists for the American Society of Civil Engineers' 2012 award for Outstanding Civil Engineering Achievement. G

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