Geosynthetics solutions for Australian desalination plant

By Pat Elliott

PROJECT HIGHLIGHTS

VICTORIA DESALINATION PLANT
Melbourne, Victoria, Australia
Construction: 2011–2012

PUBLIC/PRIVATE PARTNERSHIP
State of Victoria/AquaSure Pty Ltd.

FABRICATOR & INSTALLER
Colorado Lining Intl. Inc.

GEOSYNTHETIC MATERIAL WELDING
Varamat hot-air welders
Demtech hot-wedge welders

GEOTEXTILE
TerraStop 600 CAD,
Polyfabrics Australia

GEOMEMBRANE
CSPE-R, 45- & 90-mil, Burke Industries

Introduction

Climate changes and drought have prompted major coastal cities in Australia, and worldwide, to construct desalination plants large enough to provide major populations with rainfall-independent sources of drinking water.

In July 2009 the Australian state of Victoria signed a $3.5 billion contract with a private consortium to finance, design, build, operate, and maintain a new desalination plant. The Victoria Desalination Plant (VDP) layout features **(photos, page 19)**:

- 29 buildings, including the reverse osmosis center—the heart of the VDP.
- marine construction, including intake and outlet structures and two underground tunnels beneath the seabed.
- a multi-layered floating cover and a holding tank baffle system for potable water storage in two 150,000sf holding tanks.

The plant was designed to produce 150 billion liters (≈40 billion U.S. gallons) of desalinated drinking water a year to Melbourne. The VDP is one of the largest public/private partnership (PPP) projects in the country.

The VDP, located 83 miles southeast of Melbourne in Wonthaggi, Victoria, is designed to be aesthetically pleasing, including green roof design. On the roof are indigenous shrubs, grasses, and other vegetation that help the buildings blend into the natural habitat. The roof designs also provide acoustic protection, thermal control, and resistance to corrosion. The highest point of the plant sits 65ft above sea level, ensuring limited visibility by blending into the landscape.

Desalination process

The desalination process for this facility uses reverse osmosis technology to create freshwater from saltwater. To begin the process, seawater is drawn in through underwater and underground tunnels. Coarse particles are removed during the initial screening process. Subsequent filtrations are then completed before the water is forced through fine membranes under extremely high pressure in a two-pass reverse osmosis process.

Freshwater passes through, leaving higher salt concentrated water behind to be returned to the ocean through diffuser structures. The desalinated water is then re-mineralized to meet the water quality specifications in the VDP contract and the Australian drinking water guidelines. In its final stage, the water is moved

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Photos provided by Colorado Lining

The VDP layout includes 29 buildings and two lined 150,000sf holding tanks.

The project started in early 2011 with the custom design fabrication of the tank and floating cover panels.

into two lined, floating cover potable water storage tanks, prior to distribution through a pipeline.

Treated water storage tanks (TWST): A geosynthetics solution

Chlorosulfonated polyethylene reinforced (CSPE-R) material was used to line the treated water storage tanks and for the floating covers. The 45-mil used in this project has a green top ply and a black bottom ply.

The green color for the liner was required for pleasing aesthetics to match the environment around the holding tanks. Each tank was designed with collection piping to an outfall to continuously monitor for leakage in the tanks as well as extensive quality control (QC) testing during installation. The geotextile underlayment, tank liner, and floating cover were all attached to a concrete ring beam using a mechanical batten bar system.

Prefabrication

The project started in early 2011 with the custom design fabrication of the tank and floating cover panels for international shipping and efficient installation in the two 150,000ft² holding tanks on-site **(photos, left)**.

The 45-mil geomembrane was custom fabricated prior to installation using hot-air welders and solvent adhesive. More than 600,000ft² of liner was custom fabricated in the U.S. using air-lance testing on each completed factory seam. Destruct testing of each panel—a technique that requires a cutout sample of each seam that is then tested by engineers for quality assurance (QA) purposes—was also completed before shipping to Australia.

After each panel was fabricated, it was rolled up and packaged onto a 7ft-long core, with layers of protection to eliminate any potential damage the rolls could face during overseas transport. Prefabrication of the tank and floating cover panels in a climate-controlled environment also ensured quality seaming in the cover panels and the utility objects on the cover.

Ballast tube weights, straps, and floats were also designed in the U.S. fabrication plant and shipped in the protective sea-land ocean containers, along with the prefabricated tank and floating cover panels. The prefabricated 90-mil baffle curtain was also packaged and sent with the tank and floating cover panels overseas for this project.

Installation

In September 2011, installation started on the prefabricated tank and floating cover panels **(photo, page 22)**, consisting of the 45-mil geomembrane in the two 150,000ft^2 holding tanks for the desalinated water, before distribution. During the nine months of installation, a four-man U.S. technical crew worked directly with local Australian union labor during construction.

Once on-site, installation began with an initial layer of white, 20-oz./square-yard geotextile. The 45-mil liner was installed over the geotextile to provide additional cushion and protection in the tanks.

The geotextile also acts as a secondary drainage for any leaks that may come from the primary geomembrane liner. The prefabricated panels, ranging from 6,000 to 20,000 square feet per floor panel, were installed using a hot-wedge welder.

Quality control (QC) procedures were completed during installation, as well as construction quality assurance (CQA) observation by several on-site engineers. However, before each panel was seamed together with the hot-wedge welder, the seam was vigorously scrubbed with xylene, providing a clean and thorough weld.

After the seam was welded, scribe testing was completed on each seam and repair patch, followed by an air-lance test to ensure the best possible quality on each weld. Destructive sampling was required for installation as well, but it was proving to be counter-productive because of the repair work that was needed on-site. To minimize the amount of repair work, representative samples were welded with the wedge welders before each seam during installation, using sample material, that was then peel and shear tested.

Stainless steel stairs, installed in both holding tanks on top of the initial liner and underneath the floating cover, provided safe access to the bottom of the tank while the cover was inflated. The stairs allowed the installation crew to bring the proper equipment down the slope of the tank while it was inflated to do any necessary repairs. A canopy built with the green 45-mil was attached directly to the cover and liner itself to provide easy access to the stainless steel stairs.

Seaming the panels with the wedge welder proved difficult at times with the erratic coastal weather during installation. High winds and heavy rains made the installation process frustrating, with more than 30 working days affected by the weather. The majority of the mornings were used for water removal due to heavy rainfall at night or during the late afternoon the day before.

Baffle technology

A 90-mil geomembrane baffle curtain was installed in both of the holding tanks to increase contact time with chlorine before it is transferred back to the pipeline for distribution.

The baffle curtain, which is attached to the ground floor and the floating cover, acts as a dividing wall between the inlet and outlet structures in the tank. By channeling water through the reservoir in a circular motion, starting in the inlet structure, the water does not stagnant in the tank. This allows the required contact time for chlorination before the water is transferred into the pipeline for distribution.

The 90-mil was manufactured with three layers of CSPE and two layers of scrim.

A long-term containment for valuable water storage

Installation of the cover was completed in May 2012 despite the erratic coastal weather in southeastern Australia.

Today, data is continuously collected on the liners' performance and will continue to be monitored for the next 30 years. Geomembrane floating cover designs are, and will continue to be, effective solutions for desalinated water projects. G

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Installation started with the geomembrane panels for the two holding tanks.