# Commercial Redevelopment of Closed Landfills

By Mike McLaughlin and Joe Miller

Developers of commercial office parks might want to talk trash. The old municipal landfill, with its existing access road network and smart growth bona fides, could make an excellent site for office buildings and related land uses. However, knowing that foundation support, special utility improvements, landfill gas control, and liner maintenance will be required to assure safe and successful redevelopment may cause developers to shy away. The Redwood Shores municipal landfill in Redwood City, California, is proving that landfill development, maintenance and monitoring challenges are not insurmountable. The site is now home to successful commercial businesses.

The 85-acre Redwood Shores site served as a municipal waste landfill from the 1940s to 1970. Approximately 4 to 10 feet of fill soils were placed over the waste in 1978. The site remained vacant until 1998, when general contractor Vance Brown, Inc., Palo Alto, Calif., asked SCS Engineers to provide landfill engineering, permitting and construction management services for the planned $150 million, 1 million-square-foot Westport Office Park.

Before buildings or other improvements can be constructed on a closed landfill, estimates of expected settlement must be made based on experience, empirical observations and numerical models. The age of the landfill must be considered, given that active settlement takes place for many years depending on the depth of the fill, the types of waste present and the placement method.

To protect structures from landfill gas, engineers must determine whether to use active control technologies, which remove gases before they reach structures; air injection or air curtain systems, which use pressure to drive gases away from structures; or passive control technologies, which use membrane barriers and vents to prevent gases from entering structures.

The Westport Office Park was one of the largest and most ambitious landfill redevelopment projects ever undertaken. The 20 office buildings, each covering a footprint of about 25,000 square feet, had to be supported on a deep pile foundation that extended through the landfill (45 feet deep) and into underlying competent soils, known locally as bay muds. Over 2,200 pre-cast concrete friction piles, each 125 feet long, were driven through the landfill. This foundation added about $12 per square foot to the construction costs (estimated in 2000 dollars).

Because waste lies beneath the site, the engineers had to design protection systems for the 20-building development. These included management systems for explosive gases, site settlement, site utilities, and for preserving the landfill clay liner.

The key protection and monitoring features include:

- Clay cap and structural fill was constructed over the landfill as needed to reach final grades;
- Utility trenches were incorporated in floor slabs to provide access and reduce damage from settlement, with flexible connections at building edges and floating utility vaults;
- Subfloor membrane, passive-gas venting systems and continuous, automated combustible gas sensors installed in each building;
- Subsurface gas migration barriers installed in site utility corridors;
- Venting system to relieve gas pressure buildup in parking lots overlying the deeper portions of the landfill; and
- Subsurface gas venting and monitoring system, and a leachate cut-off trench installed at the property line.

How have the buildings performed since they were opened in 2001? Prudential Real Estate Investors and Harvest Properties purchased the project in 2005 for $238 million (about $246 per building square foot), and renamed it the Bayshore Technology Park. They report that the gas mitigation systems have worked, with no methane alarms or repairs required. The anticipated settlement at the building perimeters has been repaired by backfilling soils in low points and along the building foundations. Floating utility vaults have been reset flush with grade as needed.

The challenges inherent in development of a closed landfill can be significant. Experience has shown that technical challenges such as settlement, deep foundations and gas protection can be met. Successful projects such as the Bayshore Technology Park, with proper design features and proper maintenance programs in place, demonstrate that redevelopment of closed landfills for commercial land uses works. **BFN**

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