

Landfill Trends

PROJECT UPDATES: COLMA HOME DEPOT AND WESTPORT OFFICE PARK

Closed landfill sites present new building opportunities, but knowing that foundation support, landfill gas control and liner maintenance will be required can cause developers to shy away. However, both the Junipero Serra (Colma) landfill in San Mateo County, California, and the Redwood Shores municipal landfill in Redwood City, California, are proving that landfill development, maintenance and monitoring challenges are not insurmountable. The sites now are home to successful commercial businesses.

Ten years after closing in 1983, the Colma landfill site was selected by Bocci-Schneider Interests, Colma, California, to be developed as a Home Depot. Due to changes in California landfill regulations that made it more difficult to install deep foundations through closed landfill sites, the civil engineering firm Brian Kangas Faulk (now BKF Engineers), Redwood City, California, had to prepare an innovative foundation design for the redevelopment. The design included placing the building and structured parking atop a deep pile foundation, and allowing a hinged slab attached to the building to “float” with the settlement of the landfill, providing a controlled transition between the parking lot and the building.

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.

For the Colma landfill, the designers used empirical settlement monitoring data, and used a 20-year, straight-line projection to estimate future settlement. This approach yielded a

conservative estimate of settlement. Based on this information, designers at Colma called for a deep-pile foundation to support the building.

Piles consisted of 150-foot long steel “H” piles that extended through the buried trash and 20 feet into the Colma formation below the landfill. A cathodic protection system was used to protect the steel piles from the corrosive environment of the landfill

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. At the Colma site, an active landfill gas extraction system was installed in 1995 to control off-site gas migration and for building protection. LFG is collected and combusted in a fully-enclosed ground flare. The system consists of the following major components:

- A network of 9 vertical gas extraction wells, installed in the refuse mass to depths of up to 100 ft below grade. Five wells are installed in the northern perimeter of the site in the parking lot. The wells are accessible through vault boxes installed flush with grade. The other four wells are installed in the landfill slope near the southern property line. These wells are accessible from beneath the floating structural slab and driveway apron overhang.
- A series of eight parallel extraction trenches installed below the building structural slab. The trenches are approximately 285 feet long each, and are fitted with alternating sections of 4- and 6-inch diameter collection pipe.
- Approximately 1,850 lineal feet of gas collection header piping, installed both above- and below-grade, or below the building slab.
- One pneumatically-operated sump and one knock-out vessel for condensate. Collected liquids are pumped to an above-ground storage tank, and hauled off-site for disposal.
- Two extraction blowers, rated at 7.5 horsepower each and capable of a maximum flow rate of 700 standard cubic feet per minute (scfm) at 40 inches water column (in-wc) inlet vacuum. One blower is used as stand-by.
- Sur-lite Corporation (Santa Fe Springs, California) fully-enclosed ground flare, designed to operate over a flow range of 50 to 250 scfm and maximum heat input of 5.25 million BTU/hour. The flare was installed in 1999 and replaced the originally-installed unit. The

flare can operate continuously (24 hours/day) or on a timer basis.

A dual membrane liner system was installed below the Home Depot building structural slab.

The liner system consists of the following components (from bottom to top):

- Geotextile material (weight 10 oz/sq. yard), initially installed over the compacted subgrade/landfill cover soils.
- 60-mil thick high density polyethylene (HDPE) membrane (primary liner), installed above the geotextile layer.
- HDPE drainage net, installed above the primary liner.
- Secondary 60-mil HDPE liner, installed above the drainage net.
- Protective geotextile material, installed above the secondary liner. The structural slab was poured above the geotextile.

The membrane underlies the entire building footprint, except at the locations of foundation pile caps or grade beams. Both membrane liners are anchored to the bottom of the structural slab using a “Gundlock” system. The liner ends are welded to the Gundlock anchors, which were installed around and centered between all pile caps.

Utility penetrations through the slab are sealed using butyl rubber tape, polyurethane sealant, or special boots. The type of seal is dependent on the utility conduit size and shape. Key utilities are double-cased to reduce the potential for leaks into the landfill. Flexible utility connections were provided both where utilities joined the building and where utilities left the site.

SCS Field Services, Long Beach, California, provided the operation, monitoring and maintenance services for the landfill gas extraction, treatment and sensor systems. Landfill gas generation rates decreased over time, with the result that the original gas flare system was oversized and inefficient. SCS designed, permitted and installed a replacement gas flare that had a higher turn-down ratio (to accommodate lower flows), and that operated intermittently using a timer.

SCS also provided health and safety support and construction oversight for below-grade repairs to site utilities and the hinged slab, which doubles as a store entrance. Such repairs had been anticipated to be relatively frequent in the early years of store operation, and the first such repair was made in 1997. Repairs included exposing a grade beam at one side of the hinged slab, and jacking and shimming the slab to restore it to design grade. A second round of repairs is scheduled for later this year.

In 2002, the Colma project received the Solid Waste Association's Silver Award for landfill gas control, in recognition for successful long-term operations and monitoring of the landfill gas control system that allowed this former landfill site to be redeveloped and returned to productive use for the community.

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, California, asked SCS Engineers to provide landfill engineering, permitting and construction management services for the planned \$150 million, one-million square foot Westport Office Park.

The Westport Office Park was one of the largest and most ambitious landfill redevelopment projects ever undertaken. Because waste lies beneath the site, the engineers had to design protections for the 20-building development. This included providing management systems for explosive gases, site settlement, site utilities and preserving the landfill clay liner.

The key protection and monitoring features include:

- Subfloor membrane, passive-gas venting system and continuous, automated combustible gas sensors installed at 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.

Legal obstacles also may present challenges during closed landfill redevelopment. Concerns over liability under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also called Superfund) have been significant for landfill redevelopment projects.

Superfund can impose strict liability on owners of sites where there has been a release of hazardous substances, such as an old landfill site. Recent reforms of the Superfund law at the Federal level, and similar “Brownfields” reforms under state law, have reduced the concern over such liabilities.

For example, Under Section 222 of the Small Business Liability Relief and Brownfields Revitalization Act, a bona fide prospective purchaser of a closed landfill site can receive liability protections if specific conditions are met. A prospective purchaser of a closed landfill site probably can meet these conditions, provided that they take reasonable steps to mitigate the hazards presented by developing such a site

Scores of closed landfills in the United States have been successfully developed into productive land uses. Development ranges from institutional and residential to a wide variety of commercial, retail, and industrial land uses, in addition to more traditional closed landfill uses (e.g., passive recreation, golf courses, etc.).

However, 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. Legal liability challenges continue to present impediments to landfill redevelopment; however, recent Brownfield policy initiatives at the Federal and state levels suggest that such impediments also can be overcome.

