Remediation of Hercules 009 Landfill

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Cement-based solidification/stabilization (S/S) treatment facilitated the sustainable development of Hercules 009 Superfund site. A former landfill, the site is now used by an automobile dealership.

Site History

Located on 16.5 acres (6.7 ha) near Brunswick, Ga., the Hercules 009 Landfill Superfund site was originally a borrow pit during the construction of Georgia State Highway 25 (Spur 25). In 1975, the Georgia Environmental Protection Division (GaEPD) issued a permit to chemical manufacturer Hercules Incorporated to use seven acres (2.8 ha) at the northern end of the pit as a landfill. Hercules used the landfill to dispose of waste from the production of the agricultural pesticide toxaphene.

Hercules began producing toxaphene in 1948 and continued production through 1980. Toxaphene was one of the most heavily used insecticides in the United States until 1982, when the U.S. Environmental Protection Agency (EPA) cancelled the registrations[1] of toxaphene for most uses. By 1990, the EPA had banned all uses of toxaphene.

Between 1975 and 1980, Hercules operated the 009 Landfill and the local chemical plant disposed of wastewater sludge from the production of toxaphene. Part of the landfill was also used for disposing empty toxaphene drums and toxaphene-contaminated glassware, rubble and trash.

The landfill was comprised of six cells divided by berms, reportedly lined with a soil-bentonite clay mixture across the bottom and along the bermed walls. The landfill closed in 1983 and in 1984, the EPA added the site to the Superfund National Priority List. Hercules designed and implemented the remedy for the site.

Hercules 009 Landfill during S/S treatment

Hercules 009 Landfill after S/S treatment and redevelopment

1: An EPA registration is a license allowing a pesticide product to be sold and distributed for specific uses in accordance with specific use instructions, precautions, and other terms and conditions.

The auto dealership at the former landfill site.

S/S treatment technology contributes to "green remediation" and the sustainable development of a contaminated property. While immobilizing hazardous constituents, the technology can also improve the construction properties of the treated material, enabling its reuse. Reuse of treated material conserves landfill disposal capacity and replacement fill. This reuse can also alleviate the concerns of surrounding communities that are often associated with the off-site transportation for disposal of contaminated materials and replacement. Haul trucks consume significant fuel, increase air pollution, add harmful greenhouse gases to the environment and amplify local traffic congestion.

S/S Portion of Site Remedy

The remedy included portland cement-based solidification/stabilization treatment. Remediation contractors treated the landfill using *in situ* (in place) methods. The contractor also treated on the site contaminated soil taken from areas outside of the landfill. This treated soil was reused to form the landfill cap.

S/S treatment involves mixing a binding agent, commonly portland cement, into contaminated soil, sediment, sludge or waste. The treatment protects human health and the environment by immobilizing hazardous constituents within the treated material. Successful treatment is accomplished through physical changes to the treated material, and often, chemical changes to the hazardous constituents. S/S has been used to treat a large variety of hazardous constituents in many different forms of waste and contaminated media.

The EPA has identified S/S treatment as the Best Demonstrated Available Technology (BDAT) for a variety of Resource Conservation and Recovery Act (RCRA)-listed hazardous wastes and has selected S/S treatment for 23 percent of its Superfund site source-control remedies. Innovative mixing techniques, developed and applied at full-scale remediation projects in the U.S., have contributed to the versatility of the technology.

S/S treatment operations may be conducted either ex-situ or *in situ*. During ex-situ treatment, the waste material is first excavated then mixed with the binding agent, commonly with excavators or in pugmills. Ex-situ treatment can be performed entirely at the remediation site with a mobile treatment plant. During *in situ* treatment, cement is mixed into the contaminated material while it remains in place, commonly with excavators, horizontal rotary soil mixers, or deep soil mixing augers.

Performance Standard

The EPA-required performance standards for the S/S treated material at the Hercules 009 Landfill site included: 1) Achieve at least 50 psi (0.34 MPa) unconfined compressive strength (UCS); 2) Toxaphene leaching of less than 0.5 mg/L on 28-day cured samples, as determined using the Toxicity Characteristic Leaching Procedure (TCLP).

In situ S/S Treatment of Landfill Contents

The S/S mix design called for adding 15 percent portland cement by weight into the landfill contents. To accomplish this, the contractors divided the six landfill cells into 25 x 25-ft (7.6 x 7.6-m) square subcells for treatment. They determined the total wet weight of the untreated soil and sludge in the cell by using a density of 100 lb/cu ft (1,600 kg/m^3) and the depth of untreated soil and sludge in the cell. The remedial action contractor treated up to six subcells at once using an excavator with various attachments to mix dry cement into the contaminated material *in situ*. The crew added water for hydration as needed and kept records of the

Hercules 009 Landfill after S/S treatment and prior to paving

"as-treated" (as built) subcells including depths of the treatment. Actual treatment depths in all the subcells extended below the bottom of the landfill contents sludge zone, adding to the total volume of treated material. The treated depth of the majority of subcells extended into the regional groundwater table. Contractors reported a total of 88,148 cu yd (67,394 m^3) treated *in situ*.

Site capped and paved after S/S treatment (note elevation change)

In situ S/S Performance Verification

During treatment, engineers made composite samples from the S/S-treated material collected at one-third and two-thirds of the total treatment depth of each subcell. They also verified cement addition rates based on written logs used for each subcell which recorded subcell volume and weight of cement used. The average dosage of portland cement applied to the landfill materials was approximately 14.8 percent, judged within project tolerances. UCS was determined by a pocket penetrometer on the composite samples. The team tested selected cylinders made from treated material from the remedial action start-up period for UCS according to ASTM D2166. This process correlates pocket penetrometer results to UCS. Compressive strength of the treated material increased over time and generally exceeded the 50 psi (0.34 MPa) requirement within 3 to 5 days of curing. TCLP testing conducted on composite samples of blocks of four subcells did not reveal any presence of toxaphene in the leachate.

Ex-situ Treatment of Stockpiled Soils

Following *in situ* S/S treatment of the landfill contents, contractors began treatment of stockpiled soils excavated from nearby residences and properties. The stockpiled soils had toxaphene concentrations greater than 0.25 mg/kg. The crew transported and placed soils from the stockpile area on the landfill in 1-2 ft (0.3-0.6 m) lifts. Debris 5 inches (125 mm) or larger was removed and placed into an open excavation. After marking off the proposed lift treatment areas into 25 x 50-ft (7.6 x 15-m) cells, they mixed the material in each lift with a portland cement and water slurry using an excavator, resulting in a minimum of 3 percent addition of portland cement by weight. The reported density of the stockpiled soil was 73 lb/cu ft (1170 kg/m^3). Contractors then compacted the treated grid with a smooth drum roller. Ex-situ treatment areas were tested for compressive strength by pocket penetrometer measurements. A reported total of 15,056 cu yd (11,511 m^3) was treated ex-situ.

Investigators collected and submitted samples to evaluate the integrity of the completed soil-cement cover for permeability testing and TCLP analysis. The reported permeability of the treated soil-cement cover was 4.2×10^{-6} cm/sec. This compares favorably to the characteristics of a conventional clay landfill cover, where permeability ranging from 1×10^{-5} cm/sec to 1×10^{-7} cm/sec can be expected. Toxaphene was not detected (<0.050 mg/L) in the TCLP extracts for soil-cement cover samples. Pocket penetrometer testing conducted on the soil-cement exceeded EPA's compressive strength target of 50 psi (0.34 MPa).

Site Restoration

To complete the remedial action construction, a crew regraded and revegetated the site. The primary intent was to establish an adequate vegetative cover over the soil, the stabilized landfill contents and other disturbed areas of the site that had resulted from the remedial activity. Rough grading involved adding some selected fill from a nearby borrow area which had been tested to confirm that constituents of concern were not present. The team placed borrow soils onto the landfill surface, soil removal areas and the ex-situ-treated soil-cement landfill cap. During the fill placement, contractors rough-graded and compacted the area to promote positive drainage. Finally, they placed a fertilized and seeded vegetative cap atop the graded area comprised of six inches (150 mm) of loose fill.

Green Remediation, Sustainable Development and Reuse of Site

S/S treatment technology contributed to "green remediation" and the sustainable development of this Superfund site. While protecting human health and the environment by immobilizing hazardous constituents, the technology also improved the construction properties of the treated materials, enabling reuse. This project resulted in the treatment of over 103,000 cu yd (78,700 m^3) of material. This process eliminated 5,000 roundtrips using an 18 cu yd (14 m^3) dump truck to transport, dispose and replace the 88,000 cu yd (67,000 m^3) *in situ* treated material.

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Brownfield 2008 Poster Number 59, Detroit, Michigan, Tim Russell, RMT Inc.

Project Credits

Property Owner and Project Funding:
Hercules Incorporated, Brunswick, Georgia

Remedial Design and Oversight:
RMT Incorporated, Greenville, South Carolina

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