Soil Excavation and Bioremediation Using ORC® and Organic Fertilizer at a Tidally-Influenced Site

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Background/Objectives. A former marine fueling terminal containing 19 aboveground tanks, located at Berths 171 through 173 within the Port of Los Angeles, was contaminated by a 1995 tank leak of approximately 294,000 gallons of crude oil. The tank farm was constructed in 1923 and undocumented pipe and tank leaks are suspected to have occurred. The Site is 17 acres, partially constructed of fill material, and is tidally influenced. Soil and groundwater cleanup goals were established through risk assessment and bench scale studies. Soil goals were developed specifically for the vadose and intertidal zones. The Under a Cleanup and Abatement Order issued by the Los Angeles Regional Water Quality Control Board, the Port of Los Angeles led the cleanup effort on behalf of three additional responsible parties.

Approach/Activities. The Remedial Action Plan (RAP) implementation included excavation of approximately 110,000 tons of contaminated soil in 11 excavation areas. The contaminated soil consisted of lead-contaminated surface soils (surface to 1.5 feet below ground surface [bgs]) and petroleum-contaminated soils within the vadose and intertidal zones (up to depths of 8 feet bgs). The RAP implementation included skimming of light non-aqueous phase liquid (LNAPL) and application of Oxygen Release Compound® (ORC®) and nutrients (nitrogen and phosphate through an organic fertilizer), in a slurry form, at the base of the intertidal zone to facilitate in situ bioremediation of site groundwater. The remedial design targeted a ratio of 10:1 for nitrogen (N) to phosphate (P). In order to assess effectiveness of the treatment, baseline soil samples were collected prior to soil mixing of ORC® and nutrients to identify baseline N and P concentrations, concentrations of total petroleum hydrocarbons (TPH) left-in-place, and pre-treatment bacteria population size. Dewatering was not implemented due to the tidal influence and mixing of ORC® and nutrients was predominantly conducted within groundwater. Due to the large-scale project by a public-bid contractor, the initial volume of ORC® and fertilizer was fixed based upon an estimated soil TPH concentration and target N:P range. Following mixing of the nutrients, composite verification samples were collected to identify total nitrogen, nitrate, nitrite and orthophosphate concentrations and, as needed, soil was remixed with or without additional nutrients to meet N and P concentration goals. In addition, subsurface piping was installed for addition of a di-ammonium phosphate and oxygen, as necessary. The estimated timeframe for bioremediation based upon a 67-day bench-scale study and modeling is one year.

Results/Lessons Learned. The selection of an organic fertilizer to supply nitrogen and phosphate was necessary due to contaminants (metals) within inorganic fertilizers. However, the bioavailability of phosphate from an organic fertilizer is much lower than an inorganic fertilizer so phosphate goals were not met during initial nutrient addition. Baseline TPH concentrations collected at the base of the intertidal zone pre-treatment ranged from not detected to 66,030 mg/kg. Baseline total N and orthophosphate concentrations ranged from 10.0 mg/kg to 6,605.6 mg/kg and not detected (ND) to 110 mg/kg, respectively. Upon addition of the organic fertilizer, the average total N concentration increased by 281%, but orthophosphate concentrations did not increase. Post-treatment soil and groundwater samples are included in the post-treatment evaluation. The ORC and nutrient addition was conducted over a non-contiguous period of 413 days, which has complicated the post-treatment analysis and determination of success of the bioremediation.