

## **Remediation Costing and Interim Measures Selection for NASA's Launch Complex 34**

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Launch Complex 34 (LC34) is a former National Aeronautics and Space Administration (NASA) operated facility located at Cape Canaveral Air Force Station (CCAFS), Florida. The complex was used for the launch of Saturn I and IB rockets, with site operations including the extensive cleaning of spaceflight components with trichloroethene (TCE). The site has the distinction of being the largest known DNAPL site in the State of Florida, with over 100,000 pounds of TCE in a 2-acre source area. Remediation costing and remedy evaluations required management decisions based upon the reality that no existing technology has achieved maximum contaminant levels (MCLs) at a large DNAPL site, and that the costs associated with attempting to achieve greater than 80% DNAPL removal would be significant. Site-specific information considered during the evaluation process included: (i) the site location on a barrier island with no current exposure pathways, (ii) radial groundwater flow pattern, (iii) persistence of DNAPL to a depth of 80 feet below land surface (ft BLS), (iv) hydrogeologic setting dominated by large spatial variations in permeability, comprised of sands, silts, and clays, with varying fractions of shell fragments, and (v) the age of the release (40+ years), which has provided sufficient time for the DNAPL to diffuse into the fine-grained media.

Source area remedies retained for detailed evaluation included: Hydraulic containment via pump and treat (P&T), permeable reactive barrier, slurry wall barrier, enhanced bioremediation, conventional excavation coupled with enhanced bioremediation, and large-diameter auger with steam coupled with enhanced bioremediation. As required in NASA's Hazardous and Solid Waste Amendments (HSWA) permit, costs were calculated as the net present value (NPV) of the capital and operation and maintenance costs. While NPV analyses are typically required, NASA and other government agencies typically implement projects using a non-discounted "pay as you go" approach. In consideration of the costs associated with implementing any remedial action at LC34, cost evaluations considered permit-required NPV costs; however, due to the likely long-term timeframes associated with any proposed remedy, "pay as you go" costs were also evaluated.

Cost evaluations revealed first year capital costs for the source area which ranged from \$1 million to over \$50 million, total non-discounted costs which ranged from \$43.7 million to over \$100 million, and total NPV costs which ranged from \$4 million to over \$50 million. Based upon first year capital costs and total NPV costs, hydraulic containment via P&T was the most cost effective technology; however, evaluated using a "pay as you go" analysis, and assuming the technology operated for more than an interim period, P&T had the highest costs. Coupling the low capital costs with the risk management provided, hydraulic containment via P&T was selected as an interim remedy for the

source area. Based upon the realization that no technology would achieve MCLs in a reasonable period of time, the low capital cost DNAPL containment provided by P&T in conjunction with the substantial mass the system will remove at a low annual cost was selected as the optimal interim risk management approach for LC34.