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Development of An Integrated Methodology for Optimizing Groundwater Long-Term Monitoring Programs

Many groundwater cleanup projects require compliance monitoring of their active remedial systems and post-closure sites where groundwater contamination is still present. This type of groundwater monitoring, known as long-term monitoring (LTM), is dictated by the Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, and Compensation and Liability Act (CERCLA), and Underground Storage Tank (UST) programs. LTM often requires decades of extensive sampling at tens or even hundreds of wells. In recent years, the increasing use of risk-based goals and natural attenuation has made the design of appropriate LTM plans a pressing problem from a cost standpoint. Properly designed LTM programs can mean considerable savings for responsible parties.

The purpose of this research is to develop a conceptually simple and robust methodology for the optimization of LTM plans and a decision-support software to implement this methodology. The integrated methodology consists of four parts: spatial sampling analysis, temporal sampling analysis, data sufficiency analysis, and data evaluation strategy. The Delaunay method is developed to analyze the spatial importance/uncertainty of sampling locations. The Modified CES method is developed to perform temporal analysis to determine the optimal sampling frequency for each monitoring well. Statistical power analysis is used to assess the sufficiency of an LTM program. The data evaluation strategy is aimed at minimizing false positive and false negative rates associated with statistical analysis of monitoring data. This integrated methodology is being incorporated into the Monitoring and Remediation Optimization System (*MAROS*) decision-support software. *MAROS* is developed for the Air Force Center for Environmental Excellence (AFCEE) as part of its Remedial Process Optimization (RPO) Initiative and is available free for public use. *Version 1.0* of *MAROS* has been developed and is available online at <http://www.afcee.brooks.af.mil/er/rpo.htm> and <http://www.gsi-net.com/RBCATools/MAROS.htm>.