Statistical Analyses of Groundwater Monitoring Data for RCRA Compliance (Newsletter)*

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The Resource Conservation and Recovery Act (RCRA) as implemented by EPA and state regulations requires monitoring of groundwater chemistry and statistical analyses of these data. The latest revision of the EPA's statistical guidance document is 887 pages long (plus supplements) and has been augmented by a Webinar because the statistical analyses are not simple or easily understood by non-statisticians/data analysts. Some commercial software is sold to perform these analyses, but like all other statistical software it does not ensure that the user completely understands how to select models to apply or can properly interpret the results.

Many industrial operations have solid and/or hazardous waste disposal sites regulated under a RCRA permit. There is potential liability if the statistical analyses are not provably appropriate and properly interpreted; in other words the data analyses must be technically sound and legally defensible. Unfortunately, the EPA guidelines (and that is what they are, not requirements) are inadequate, particularly with regard to spatial and temporal evaluations of groundwater chemistry and handling of data with many zeros as is the case when levels are below detection limits. Trying to fit all situations to a t-test or ANOVA model leaves vulnerabilities that can be legally challenged. Not all data fit a linear model (which is an underlying assumption of these two models).

Non-linear regressions (establishing cause and effect), covariance, mixed models that include categorical data (such as different land use types or industrial activities) can be handled by general additive models (GAM) better than by general linear models (GLM). Spatial analyses should consider well-to-well differences based on both direction and distance. Spatial and time series regressions can be used to predict groundwater chemical concentrations and movement rates for short periods in the future.

Engineers and hydrogeologists establish monitoring well locations for planned or existing sites and samples are collected by company or consultant technical staff. Experienced data analysts/statisticians provide the required

expertise to determine the most appropriate statistical model for each situation and interpret the results for compliance with permit conditions. Not all companies have such statistical and data-analytical expertise on staff, yet they want to ensure proper compliance and reduce their potential liability.

At the same time, regulators need confidence that their oversight is based on proper and robust statistical analyses and interpretations to rebut charges of insufficient regulatory effectiveness. Attorneys, too, need the confidence in defending their clients in litigation that comes from clearly and effectively understanding the complexities of statistical data analyses applied to natural systems such as groundwater under and surrounding a landfill, waste dump, or chemically contaminated industrial site.

Applied Ecosystem Services has been providing clients with robust, sophisticated statistical and modeling services as integral parts of client assignments. Recently we were made aware of the need of such expertise as a separate service by an engineering consulting company that lacks a staff statistician. Baseline data acquisition efforts, impact assessment data sets, and permit compliance monitoring data yield valuable insights with the application of appropriate statistical models. Such analyses increase the value provided by the investment of time and money in collecting these data. Fulfilling RCRA permit requirements by meeting and exceeding the EPA statistical monitoring guidelines is one such situation. To increase the value of your groundwater monitoring data call us at 503-667-4517.