



Standard Guide for Developing Appropriate Statistical Approaches for Ground- Water Detection Monitoring Programs¹

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1. Scope

1.1 This guide covers the context of ground-water monitoring at waste disposal facilities, regulations have required statistical methods as the basis for investigating potential environmental impact due to waste disposal facility operation. Owner/operators must perform a statistical analysis on a quarterly or semiannual basis. A statistical test is performed on each of many constituents (for example, 10 to 50 or more) for each of many wells (5 to 100 or more). The result is potentially hundreds, and in some cases, a thousand or more statistical comparisons performed on each monitoring event. Even if the false positive rate for a single test is small (for example, 1 %), the possibility of failing at least one test on any monitoring event is virtually guaranteed. This assumes you have done the correct statistic in the first place.

1.2 This guide is intended to assist regulators and industry in developing statistically powerful ground-water monitoring programs for waste disposal facilities. The purpose of these methods is to detect a potential ground-water impact from the facility at the earliest possible time while simultaneously minimizing the probability of falsely concluding that the facility has impacted ground water when it has not.

1.3 When applied inappropriately existing regulation and guidance on statistical approaches to ground-water monitoring often suffer from a lack of statistical clarity and often implement methods that will either fail to detect contamination when it is present (a false negative result) or conclude that the facility has impacted ground water when it has not (a false positive). Historical approaches to this problem have often sacrificed one type of error to maintain control over the other. For example, some regulatory approaches err on the side of conservatism, keeping false negative rates near zero while false positive rates approach 100 %.

1.4 The purpose of this guide is to illustrate a statistical ground-water monitoring strategy that minimizes both false negative and false positive rates without sacrificing one for the other.

1.5 This guide is applicable to statistical aspects of ground-

water detection monitoring for hazardous and municipal solid waste disposal facilities.

1.6 It is of critical importance to realize that on the basis of a statistical analysis alone, it can never be concluded that a waste disposal facility has impacted ground water. A statistically significant exceedance over background levels indicates that the new measurement in a particular monitoring well for a particular constituent is inconsistent with chance expectations based on the available sample of background measurements.

1.7 Similarly, statistical methods can never overcome limitations of a groundwater monitoring network that might arise due to poor site characterization, well installation and location, sampling, or analysis.

1.8 It is noted that when justified, intra-well comparisons are generally preferable to their inter-well counterparts because they completely eliminate the spatial component of variability. Due to the absence of spatial variability, the uncertainty in measured concentrations is decreased making intra-well comparisons more sensitive to real releases (that is, false negatives) and false positive results due to spatial variability are completely eliminated.

1.9 Finally, it should be noted that the statistical methods described here are not the only valid methods for analysis of ground-water monitoring data. They are, however, currently the most useful from the perspective of balancing site-wide false positive and false negative rates at nominal levels. A more complete review of this topic and the associated literature is presented by Gibbons (1).²

1.10 The values stated in both inch-pound and SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.11 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.12 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional*

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² The boldface numbers given in parentheses refer to a list of references at the end of the text.

