

PERMIT ATTACHMENT Q

STATISTICS

OVERVIEW

In accordance with Permit Condition 7.5.1.a., these procedures shall be used to perform release determinations for metals and radionuclides in water (i.e., fluid) samples obtained in the vadose zone monitoring system (VZMS) wells. These procedures shall be applicable to the following analytes obtained under Permit Conditions 7.3.1 and 7.3.3: dissolved and total metals (Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Ti, Zn) and radionuclides (gross alpha, gross beta, gamma emitters, total uranium, radium 226/228, radon).

As identified in Permit Condition 7.5.1.a, note that the following procedures do not apply to general water chemistry parameters (bicarbonate, chloride, dissolved major cations) or to organic parameters. As identified in Permit Condition 7.5.1.a, release determinations for general water chemistry parameters shall be made through a trilinear diagram comparison between vadose zone monitoring system (VZMS) well fluid samples and baseline non-leachate fluid samples (i.e., fluid obtained by extracting non-leachate source water through representative soil samples obtained from the installation of the VZMS wells). The release determinations for organics shall be made by the detection of any organic in a VZMS well sample.

The overall statistical procedure for making release determinations for metals and radionuclides in VZMS well samples is as follows:

1. An upper tolerance limit shall be constructed for non-leachate analytes in water samples extracted under the Meteoric Water Mobility Procedure (MWMP) (see Permit Attachment I, *Vadose Zone Monitoring System Work Plan*,

Appendix A, *Meteoric Water Mobility Procedure*) for baseline soil boring samples (or baseline soil cutting samples) obtained under Permit Condition 7.3.1. This non-leachate MWMP-extractant analyte tolerance limit shall be constructed for each individual metal analyte and for each individual radionuclide analyte in the non-leachate MWMP-extracted samples. These non-leachate MWMP-extractant analyte tolerance limits shall be reported as required at Permit Condition 7.3.1.b.

2. Analyte concentrations of dissolved/total metals and radionuclides from VZMS well samples, as obtained under Permit Condition 7.3.3, shall be compared against each individual non-leachate MWMP-extractant analyte tolerance limit. The results of this comparison shall be reported according to VZMS well sample reporting requirements established under Permit Conditions 7.4.2 and 7.5.2.

The construction of the non-leachate MWMP-extractant analyte tolerance limits shall adhere to the following guidelines:

1. A minimum of 20 non-leachate MWMP-extractant analyte concentrations (e.g., total lead) from baseline MWMP-extractant samples are required to construct an adequate upper tolerance limit for each non-leachate analyte in the MWMP-extractant data sets.
2. Each set of non-leachate MWMP-extractant analyte concentrations shall be evaluated for the occurrence of values reported below the achievable detection limits (i.e., non-detects). The procedure for performing this evaluation, and the methods to manage non-detects, is provided below.
3. Each set of non-leachate MWMP-extractant analyte concentrations shall be evaluated for normality using the procedure described below. If each set of non-leachate MWMP-extractant analyte concentrations from the MWMP-extractant samples exhibits a normal distribution, the non-leachate MWMP-extractant analyte tolerance limits shall be constructed on the original (i.e., raw) data set using the parametric tolerance limit procedure described below. If each set of non-leachate MWMP-extractant analyte concentrations from the MWMP-extractant samples

exhibits a log-normal distribution instead, the non-leachate MWMP-extractant analyte tolerance limit shall be constructed on the log-transformed baseline data set using the parametric tolerance limit procedure, with the respective log-normal VZMS well sample concentration for that analyte being used in the comparison of the VZMS well sample to the log-normal non-leachate MWMP-extractant analyte tolerance limit.

These procedures are based upon the following guidance developed by the U.S. Environmental Protection Agency (EPA): *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance*, (EPA Interim Final Guidance, April 1989) and *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Draft Addendum to Interim Final Guidance*, (EPA, July 1992). Requirements set forth in *Use of Tolerance Intervals for Determining Inorganic Background Concentrations* (New Mexico Environment Department (NMED), Hazardous Materials Bureau, March 2, 2000) shall also be adhered to, including the following:

- each parametric and non-parametric analyte tolerance limit shall be constructed with a minimum of 20 MWMP-extractant samples; and
- each parametric analyte tolerance limit shall be constructed with a minimum coverage of 95% and a minimum tolerance coefficient of 95%.

MANAGING NON-DETECTS IN NON-LEACHATE MWMP-EXTRACTANT DATA SETS

If concentrations of any non-leachate MWMP-extractant analyte are reported below the achievable detection limits in each non-leachate MWMP-extractant analyte data set (i.e., minimum of 20 samples), the following procedure must be followed before the tolerance limit is calculated for the data set.

If the non-leachate MWMP-extractant analyte data set has no more than 15% non-detects, use one-half of the detection limit for that particular measurement. Subsequently, proceed to the normality test procedures described below.

If the non-leachate MWMP-extractant analyte data set has more than 15% non-detects, but less than or equal to 50% non-detects, use Cohen's approximation to approximate the mean and standard deviation of the analyte non-leachate MWMP-extractant analyte data set. However, before calculating Cohen's approximation, it must be decided whether the analyte data is more closely approximate to a normal or a log-normal distribution. To make this determination, Censored Probability Plots, as described in EPA's *Draft Addendum to Interim Final Guidance*, should be constructed on both the raw measurements and the log-transformed measurements.

Compare the two Censored Probability Plots. If the plot based on the raw measurements is more linear than the plot based on the log-transformed values, compute Cohen's approximation using the raw measurements and then proceed with the normality test procedures described below. If the plot based on the log-transformed measurements is more linear, compute Cohen's approximation using the log-transformed measurements and then proceed with the normality test procedures described below.

If the non-leachate MWMP-extractant analyte data set contains more than 50% non-detects, then use the procedure to calculate the non-parametric tolerance limit for the data set, as described below.

NORMALITY TEST OF NON-LEACHATE MWMP-EXTRACTANT DATA SETS

Following the management of non-detects for each non-leachate MWMP-extractant analyte data set, the normality or log-normality of each non-leachate MWMP-extractant analyte data set must be confirmed before constructing the analyte tolerance limit for each data set. If the non-leachate MWMP-extractant analyte data set contains more than 50% non-detects, do not test for normality and proceed directly to the method for calculating the non-parametric tolerance limit for the data set, as described below.

The normality or log-normality of each non-leachate MWMP-extractant analyte data set shall be tested by first constructing a probability plot on the compliance data, as described in EPA's *Addendum to Interim Final Guidance*. In addition, since the probability plot is not a formal test of distribution, each compliance data set shall be assessed using the Shapiro-Wilk test of normality at the 0.01 level of significance. Note that to test normality of each non-leachate

MWMP-extractant analyte data set, the raw measurements should be used in the construction of the probability plot and the calculation of the Shapiro-Wilk test. If normality of the data is confirmed, the non-leachate MWMP-extractant analyte data set tolerance limit can be calculated on the raw measurements, as described below in the discussion of parametric tolerance limit procedures.

If the probability plot and the results of the Shapiro-Wilk test indicates the non-leachate MWMP-extractant analyte data set is not normally distributed, the data set should be log-transformed. Subsequently, the normality tests (i.e., probability plot and Shapiro-Wilk test) should be applied to the log-transformed data set to determine if the non-leachate MWMP-extractant analyte data set is log-normally distributed. If log-normality of the data is confirmed, the parametric tolerance limit can be calculated on the log-transformed data set, as described below in the discussion of parametric tolerance limit procedures.

If both normality and log-normality of the non-leachate MWMP-extractant analyte data set are rejected using the probability test and the Shapiro-Wilk test at the 0.01 level of significance, then construct the non-parametric tolerance limit as described below.

PARAMETRIC TOLERANCE LIMIT FOR NON-LEACHATE MWMP-EXTRACTANT ANALYTE DATA SET

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1. Calculate the mean, \bar{X} , and standard deviation, S , for the non-leachate MWMP-extractant analyte data set.
2. Construct the one-sided, upper tolerance limit for the non-leachate MWMP-extractant analyte data set as:

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$$\text{Tolerance Limit} = \bar{X} + K S,$$

3. where K is the one-sided normal tolerance factor found in EPA *Interim Final Guidance* (Appendix B, Table 5).

4. Compare each dissolved/total metal analyte and radionuclide analyte obtained for each VZMS well sample, as obtained under Permit Condition 7.3.3, to each respective non-leachate MWMP-extractant analyte data set parametric tolerance limit constructed for the analyte under Step 2. If the non-leachate MWMP-extractant analyte data set tolerance limit was constructed on the logarithm of the original data, the logarithm of the VZMS well sample analyte should be compared to the non-leachate MWMP-extractant analyte data set tolerance limit for each analyte under Step 2.

5. If the VZMS well sample analyte concentration exceeds the respective parametric non-leachate MWMP-extractant analyte data set tolerance limit for that analyte, then there is statistically significant evidence that the VZMS well sample is composed of leachate from the Landfill or the Surface Impoundment.

NON-PARAMETRIC TOLERANCE LIMIT FOR NON-LEACHATE MWMP-EXTRACTANT ANALYTE DATA SET

1. Examine the non-leachate MWMP-extractant analyte data set to observe and obtain the maximum value for the data set.

2. Set the non-parametric upper tolerance limit for the non-leachate MWMP-extractant analyte data set to this maximum value obtained in Step 1.

3. Compare each dissolved/total metal analyte and radionuclide analyte obtained for each VZMS well sample, as obtained under Permit Condition 7.3.3, to the non-parametric non-leachate MWMP-extractant analyte data set tolerance limit constructed for each analyte under Step 2.

4. If the VZMS well sample analyte concentration exceeds the respective non-parametric non-leachate MWMP-extractant analyte data set tolerance limit for that analyte, then there is statistically significant evidence that the VZMS well sample is composed of leachate from the Landfill or the Surface Impoundment.