

PALOS VERDES LANDFILL
REMEDIAL INVESTIGATION REPORT

APPENDIX E.6

TREND ANALYSIS DISCUSSION

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MANN-KENDALL TEST FOR TREND

The Mann-Kendall test for trend is a non-parametric statistical test for trend. The test is essentially a non-parametric test for zero slope of the data versus time plot. The following paragraphs discuss the specifics of the test.

In order to perform the Mann Kendall Test for Trend, one must calculate the Mann Kendall Statistic (S) and compare the statistic to tabulated values. The analyst arranges the data in time order, $X_1, X_2, X_3, \dots, X_n$, where X_i is the datum collected at time i and n is the number of time periods. Data reported as less than the detection limit are assigned a common value smaller than the lowest reported measurable value. The sign of all differences, $X_j - X_k$ where $j > k$ is calculated. The Mann-Kendall Statistic (S) is the number of positive differences minus the number of negative differences. Mathematically it is represented:

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^n \text{SGN}(X_j - X_k)$$

where

$$\text{SGN}(X_j - X_k) = \begin{array}{ll} 1 & \text{if } X_j - X_k > 0 \\ 0 & \text{if } X_j - X_k = 0 \\ -1 & \text{if } X_j - X_k < 0 \end{array}$$

If S is a large positive number, later measurements are higher than earlier measurements and an increasing trend is indicated. If S is a large negative number, later measurements are lower than earlier measurements and a decreasing trend is indicated. The probability associated with S may be obtained from statistical tables. When $N > 40$ a function of S is normally distributed and a table of normal probabilities may be used.

The null hypothesis and alternative hypothesis for the test for trend may be defined as follows;

$$\begin{array}{ll} H_0 & \text{data show no trend} \\ H_a & \text{data show either an upward or downward trend} \end{array}$$

If the probability value of the absolute value of S is less than an a priori selected probability value (5%), the null hypothesis is rejected and a trend is indicated. If S is negative, the indicated trend is negative, and if S is positive, the indicated trend is positive.

Reference: Gilbert, R.O., Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Co. Inc., New York, New York. 1987.