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MEMORANDUM

TO:	Mike Mateyk; Jon Williams	REF. NO.:	01069-20 / pw / 23
FROM:	Naz Syed-Ritchie; Wesley Dyck	DATE:	November 21, 2002

RE: Statistical Trend Analysis of Groundwater Monitoring Data
Third Quarter 2002 Monitoring
Hyde Park Landfill
Niagara Falls, New York

1.0 INTRODUCTION

Groundwater at the Hyde Park Landfill in Niagara Falls, New York (Site) is sampled quarterly and analyzed for indicator parameters including benzoic acid, chlorendic acid, phenolics, total chlorobenzoic acids, and total organic halides (TOX). As part of the evaluation of the quarterly monitoring data, a statistical analysis is performed to look for any evidence of increasing trends in indicator parameters at a given well over time.

This memorandum reports the findings of statistical evaluations of the Site groundwater monitoring data up to and including the third quarter 2002 samples.

2.0 STATISTICAL TREND ANALYSES

Helsel and Hirsch (1992) recommend a number of statistical trend analysis methods for application to environmental data sets. A typical pattern in groundwater constituent concentrations is a rapid decline in concentration immediately following a remedial action, which then slows and observed concentrations fluctuate up and down at a much lower level. This type of pattern has been observed at a number of Site monitoring wells, and may be observed in the concentration vs. time plots (Attachment A).

A recommended statistical procedure for trend assessment commonly applied to environmental monitoring data is the Mann-Kendall trend test. The Mann-Kendall test is a non-parametric (rank-based) method that evaluates a set of data for a monotonic (unidirectional) trend. The procedure makes no assumptions regarding the shape of the trend (e.g., linear, log-linear…), except that it is in a single direction (i.e., either consistently upward or downward). However, the Mann-Kendall procedure loses sensitivity if a large proportion of non-detected results is present.

For data sets with large proportions (> 50 percent) of censored data, logistic regression is recommended by Helsel and Hirsch. In this procedure, the numerical values of the monitoring data are not used, but instead the presence or absence of a detectable concentration of the analyte of interest is considered. Thus, the

TABLE 2

COMPARSION OF STATISTICAL TREND ANALYSES
(QUATERLY EVALUATIONS SINCE THE BEGINNING OF 2001) HYDE PARK LANDFILL
NIAGARA FALLS, NEW YORK

Location	*Analyte*	*First Quarter 2001*		*Second Quarter 2001*		*Third Quarter 2001*		*Fourth Quarter 2001*	
		Number of Samples	*Conclusion*	*Number of Samples*	*Conclusion*	*Number of Samples*	*Conclusion*	*Number of Samples*	*Conclusion*
B1U	Chlorendic Acid	9	NST	10	NST	11	NST	8	Increasing
	Total Organic Halides	9	NST	10	NST	11	NST	8	Decreasing
B1M	Total Chlorobenzoic Acid	9	Decreasing	10	NST	11	NST	8	NST
	Total Organic Halides	9	Decreasing	10	Decreasing	11	NST	8	NST
B1L	Total Organic Halides	9	NST	10	NST	11	NST	8	NST
C1U	Phenolics	9	NST	10	Decreasing	11	Decreasing	8	NST
	Total Organic Halides	9	NST	10	NST	11	NST	8	NST
C1M	Chlorendic Acid	9	Decreasing	10	NST	11	NST	8	NST
	Total Chlorobenzoic Acid	9	Decreasing	10	NST	11	NST	8	NST
	Total Organic Halides	9	NST	10	NST	11	NST	8	Decreasing
C1L	Total Chlorobenzoic Acid	9	Decreasing	10	NST	11	NST	8	NST
	Total Organic Halides	9	Decreasing	10	Decreasing	11	Decreasing	8	NST
D3U	No Trends	--	--	--	--	--	--	--	--
D2M	Phenolics	9	NST	10	NST	11	NST	8	Decreasing
	Total Organic Halides	9	NST	10	NST	11	NST	8	NST
D1L	No Trends	--	--	--	--	--	--	--	--
E3U	No Trends	--	--	--	--	--	--	--	--
E3M	No Trends	--	--	--	--	--	--	--	--
E2L	No Data	--	--	--	--	--	--	--	--
F4U	Total Organic Halides	9	NST	10	NST	11	Decreasing	8	Decreasing
F1M	Total Organic Halides	9	NST	10	NST	11	Decreasing	8	NST
F2L	No Data	--	--	--	--	--	--	--	--
G4U	No Trends	--	--	--	--	--	--	--	--
G1M	No Trends	--	--	--	--	--	--	--	--
G1L	Total Organic Halides	9	Decreasing	10	Decreasing	11	NST	8	NST
H1U	No Trends	--	--	--	--	--	--	--	--
H2M	Total Organic Halides	9	Decreasing	10	NST	11	NST	8	NST
H3L	Total Organic Halides	9	Decreasing	10	Decreasing	11	Decreasing	8	NST
J1U	No Trends	--	--	--	--	--	--	--	--
J2M	Benzoic Acid	9	Decreasing	10	NST	11	NST	8	NST
	Phenolics	9	Decreasing	10	Decreasing	11	NST	8	NST
	Total Chlorobenzoic Acid	9	Decreasing	10	NST	11	NST	8	Increasing
	Total Organic Halides	9	Decreasing	10	NST	11	NST	8	NST
J3L	Total Chlorobenzoic Acid	9	NST	10	NST	11	NST	8	Increasing

Notes:

No Trends: No statistically significant trends identified to date for any of the analytes at this well.
No Data: No data collected at this well for the year 2001 sampling rounds.
NST: No statistically significant ($P<0.05$) trend detected.
Increasing: Statistically significant ($P<0.05$) increasing trend detected.
Decreasing: Statistically significant ($P<0.05$) decreasing trend detected.

TABLE 2

COMPARSION OF STATISTICAL TREND ANALYSES
(QUATERLY EVALUATIONS SINCE THE BEGINNING OF 2001) HYDE PARK LANDFILL
NIAGARA FALLS, NEW YORK

Location	*Analyte*	*First Quarter 2002*		*Second Quarter 2002*		*Third Quarter 2002*	
		Number of Samples	*Conclusion*	*Number of Samples*	*Conclusion*	*Number of Samples*	*Conclusion*
B1U	Chlorendic Acid	9	NST	10	NST	11	NST
	Total Organic Halides	9	Decreasing	10	Decreasing	11	Decreasing
B1M	Total Chlorobenzoic Acid	9	NST	10	NST	11	NST
	Total Organic Halides	9	NST	10	NST	11	NST
B1L	Total Organic Halides	9	NST	10	Decreasing	11	Decreasing
C1U	Phenolics	9	NST	10	NST	11	NST
	Total Organic Halides	9	Decreasing	10	Decreasing	11	Decreasing
C1M	Chlorendic Acid	9	NST	10	NST	11	NST
	Total Chlorobenzoic Acid	9	NST	10	NST	11	NST
	Total Organic Halides	9	Decreasing	10	Decreasing	11	NST
C1L	Total Chlorobenzoic Acid	9	NST	9	NST	10	NST
	Total Organic Halides	9	NST	9	Decreasing	10	NST
D3U	No Trends	--	--	--	--		--
D2M	Phenolics	9	NST	10	NST	11	NST
	Total Organic Halides	9	NST	10	Decreasing	11	NST
D1L	No Trends	--	--	--	--		--
E3U	No Trends	--	--	--	--		--
E3M	No Trends	--	--	--	--		--
E2L	No Data	--	--	--	--		--
F4U	Total Organic Halides	9	NST	10	NST	10	NST
F1M	Total Organic Halides	9	NST	10	NST	11	NST
F2L	No Data	--	--	--	--	--	--
G4U	No Trends	--	--	--	--	--	--
G1M	No Trends	--	--	--	--		--
G1L	Total Organic Halides	9	NST	9	NST	9	NST
H1U	No Trends	--	--	--	--	--	--
H2M	Total Organic Halides	9	NST	10	NST	10	NST
H3L	Total Organic Halides	9	NST	10	NST	11	NST
J1U	No Trends	--	--	--	--	--	--
J2M	Benzoic Acid	9	NST	10	NST	11	NST
	Phenolics	9	NST	10	NST	11	NST
	Total Chlorobenzoic Acid	9	Increasing	10	Increasing	11	Increasing
	Total Organic Halides	9	NST	10	NST	11	NST
J3L	Total Chlorobenzoic Acid	9	NST	10	NST	11	NST

Notes:

No Trends: No statistically significant trends identified to date for any of the analytes at this well.
No Data: No data collected at this well for the year 2001 sampling rounds.
NST: No statistically significant (P<0.05) trend detected.
Increasing: Statistically significant (P<0.05) increasing trend detected.
Decreasing: Statistically significant (P<0.05) decreasing trend detected.

hypothesis tested as a measure of trend by logistic regression is that more detectable results are occurring later than earlier (increasing trend), or earlier than later (decreasing trend).

The Site groundwater monitoring data were assessed for trends on an individual well basis using either the Mann-Kendall trend test (if < 50 percent non-detects) or logistic regression (for 50-99 percent non-detects). Analytes that were not detected at a given well (i.e., 100 percent non-detects) during the time period of interest were not statistically evaluated.

3.0 SCOPE OF DATA

The approach most applicable to assessing current trends in groundwater quality at the Site is to apply a given test to analytical data representative of the current groundwater conditions at the Site. This is accomplished for the Site by treating calendar years as a unit (i.e. either keeping or removing the four quarters of monitoring data for a calendar year) and ensuring that a minimum of 8 data points and maximum of 11 data points are used for the statistical evaluation. In the case of the third quarter 2002 data analysis, the analytical data include ten sampling events from 2000 to present. This data scope approach provides a moving two to three year comparison window.

For the concentration vs. time plots (Attachment A), all historical data are included (1993 to present).

4.0 RESULTS

The results of the trend analyses are presented in Table 1. One statistically significant ($P<0.05$) increasing trend was identified; total chlorobenzoic acid at well J2M. Three statistically significant ($P<0.05$) decreasing trends were observed; all for TOX at wells B1U, B1L, and CIU.

Table 2 presents a comparison of results from the statistical trend analyses performed following monitoring events since the first quarter of 2001. Only wells / analytes with a significant trend identified during at least one evaluation are presented. This represents a total of 24 wells / analytes. No trend was observed for TOX at C1M, C1L, and D2M for the third quarter evaluation of 2002. A statistically significant decrease was observed for these well / parameter combinations in the previous evaluations.

Comparing the present event's results to the previous round, the four statistically significant trends identified (see above) were all previously identified, and no new trends were noted. However, three previously identified decreasing trends (TOX at C1M, C1L and D3M) were not observed during the current monitoring event. It appears that the lack of trend at these locations is due to random fluctuation on TOX concentrations at these wells, since the most recent monitoring results (i.e. third quarter 2002 data) fall well within the range of previous sampling events.

Comparing the present event's results to those from one year ago, no consistent trends can be identified. The three decreasing and one increasing trend from the current event are all for different wells / analytes than the five decreasing trends identified following the third quarter 2001 monitoring event. It is noteworthy that seven of these nine observed trends were decreasing TOX, which may be suggestive of a general pattern across the site.

5.0 CONCLUSIONS

Statistical trend evaluations of Site groundwater monitoring data following the third quarter 2002 monitoring unit were carried out using either the Mann-Kendall trend test or logistic regression depending on proportion of non-detect values present. Data sets consisting entirely of non-detect results were not evaluated. One statistically significant increasing trend and three statistically significant decreasing trends were identified as noted in Section 4.0 and on Table 1. These findings are consistent with those following the previous event. However three decreasing trends observed during the previous evaluation were not detected this time, which is thought to be due to natural variation in analyte concentrations at the site.

6.0 REFERENCE

Helsel, D.R. & R.M. Hirsch, 1992. Statistical Methods in Water Resources. Amsterdam: Elsevier.