9601-MSWLF-1981

Stats

2-14-02

OPERATION/CONSTRUCTION MANAGERS

Municipal Services

PO Box 97, Garner, North Carolina 27529 (919) 772-5393

CIVIL/SANITARY ENGINEERS

Engineering Company, P.A.

PO Box 349, Boone, North Carolina 28607 (828) 262-1767

June 11, 2002

Carmen Johnson

Fac/Perm/Co ID #	Date	Doc ID#
96-01	7/19/12	DIN

JUN 2002
Received
Solid Waste
Section

Mr. Larry Rose
Solid Waste Section
Division of Waste Management
North Carolina Department of Environment and Natural Resources
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Groundwater Sampling and Analysis
Wayne County Closed Sanitary Landfill (Dudley)
MESCO Project No. G02016.0

Dear Mr. Rose:

Municipal Engineering Services Company, P.A. (MESCO) completed the statistical analyses for the Wayne County Closed Sanitary Landfill located in Dudley, North Carolina. The purpose of these analyses is to determine, in comparison to background levels, statistical significance of constituents detected during the February-2002 sampling event.

Statistical Analysis Methodology

Metals

A few minor concentrations of metals were detected within compliance wells MW-2, MW-3, MW-5, MW-6 and MW-8. An interwell analysis was conducted upon the inorganic constituents chromium, cadmium, tin, mercury, and vanadium. Monitoring well MW-1 was defined as the background well, and an upper tolerance limit (UTL) with 95% coverage was computed for the detected constituent from the background data at a 95% confidence level. For each detected parameter, an appropriate statistical analysis method was selected based on the percentages of non-detects (%ND) in the historical background data. The following table (Table 1) summarizes the methods used for four different %ND ranges.

Table 1. Statistical Analysis Methods for Various %ND Ranges

%ND	Analysis Method	ND Substitution
%ND<15%	Parametric tolerance limit	1/2 ND
15%<%ND<50%	Parametric tolerance limit	Cohen or 1/2 ND
50%<%ND<90%	Non-parametric tolerance limit	1/2 ND
90%<%ND	Poisson tolerance limit	-

NOTE: For parametric tolerance interval, normality of the background data was checked by the Shapiro-Wilks normality test, as the method requires that the data be normally distributed.

Due to the lack of historical detections within the background well the Poisson tolerance limit method was used upon all five metals with no ND substitution except for vanadium within MW-3. The Poisson count of background samples exceeded the maximum 420 for vanadium, therefore ½ ND substitution had to be used prior to completing the Poisson tolerance limit analysis.

VOCs

All historical VOC data was compiled for the background well MW-1 in order to determine the total number of detections, from which the expected number of detections in a single down gradient monitoring point (y^*) was derived by utilizing the Poisson prediction interval. The parameter y^* is defined by the following equation:

$$y^* = cy + \frac{t^2 c}{2} + tc\sqrt{y\left(1+\frac{1}{c}\right)+\frac{t^2}{4}}$$

where

$c = 1/n$ (n =number of background samples)
t = one-sided value of students t -Statistic at 95% confidence [a]
y = number of events observed in n previous samples
y^* = expected number of events in a single future sample

[a] Gibbons, R.D., 1994, Statistical methods for groundwater monitoring: John Wiley & Sons, Inc., p.12.

For each monitoring location showing any VOC detections, the number of detected VOCs was counted with each detection being considered a "hit". The number was then compared with the expected number of detections derived from the background VOC data. The value of Student's t-Statistic was derived from tabulated values included in Gibbons (1994).

Intrawell Analyses

Intrawell analysis were conducted only upon those constituents that were initially found to be statistically significant by interwell analysis. In general, intrawell analysis is conducted in order to differentiate true contamination from spatial variability. Shewhart-CUSUM control charts were generated for each of the triggered constituents to determine its baseline levels. Baseline levels in this context are defined as the background level derived from the data in a given downgradient well. Intrawell analyses through Shewhart-CUSUM control charts require a minimum of eight independent historical sampling events and a detection rate greater than 25% (%ND≤75%). Due to these requirements only chromium within compliance wells MW-3 and MW-6 could be analyzed at this time.

Results

Interwell analysis was performed upon all five inorganic constituents detected within the compliance wells. Historical data compiled for monitoring well MW-1 was used as the baseline. Data distributions were reviewed using time series and box and whiskers plots (enclosed charts). The following table summarizes those metals that were found to be significantly higher than their background levels by interwell analysis.

Table 2. Interwell Analysis Summary

Well	Cr	Sn	Va
MW-2		x	
MW-3	x		x
MW-6	x		

x=level significantly higher than the background level

Contrary to the interwell analysis the concentrations of chromium within MW-3 and MW-6 was found to not be significant by intrawell analysis by Shewhart-CUSUM control charts. The statistical insignificance of the chromium detections suggest that the source is not originating from the closed landfill.

All VOCs that were detected were found to be statistically significant based upon their VOC counts after the Poisson prediction interval analysis was conducted. The expected number of VOC detections in a single downgradient well derived from the background data is slightly less than one therefore all compliance wells containing any VOC detection would be considered to be contaminated. The VOC detections primarily consisted of benzene derivatives and upon review of the enclosed time series plots the concentrations appear to not conform to any particular trend at this time. MW-8, located south of the uncapped portion of the landfill contained both detectable amounts of 1,4-Dichlorobenzene and it's biodegradation byproduct chlorobenzene. The only Appendix II parameter detected was the pesticide dieldrin within MW-4. Dieldrin has never previously been detected at any monitoring location.

Overall, the observed levels of VOCs remain significantly higher than background levels within MW-2, MW-4, MW-6, and MW-8. As expected the VOC concentrations appear to not be increasing with time. It is the recommendation of MESCO to continue with the detection monitoring program including sampling for Appendix II constituents at MW-2, MW-4, MW-6, and MW-8. The next detection monitoring sampling event is scheduled for August 2002. If you have any questions or comments regarding this report, please contact me by phone at (919) 772-5393 or by email at jpfohl@mesco.com.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., P.A.

Jonathan Pfohl
Environmental Technician

Enclosures

cc: Mr. Lloyd Cook
Wayne County

Exceedance Scan
Wayne County Closed Sanitary Landfill (Dudley)

Well ID	Parameter Name [1]	Sample Date	Result	Unit	PQL [2]	MCL [3]	Exceedance
MW-2	Tin, total	2/14/2002	0.47	mg/l	0.1	-	
MW-3	Chromium, total	2/14/2002	0.021	mg/l	0.01	0.05	
MW-3	Vanadium	2/14/2002	0.108	mg/l	0.04	-	
MW-5	Cadmium, total	2/14/2002	0.001	mg/l	0.001	0.005	
MW-6	Chromium, total	2/14/2002	0.018	mg/l	0.01	0.05	
MW-8	Mercury	2/14/2002	0.00062	mg/l	0.0005	0.0011	
MW-2	Chlorobenzene	2/14/2002	11	ug/l	5	50	
MW-4	Dieldrin	2/14/2002	0.45	ug/l	0.1	-	
MW-6	1,4-Dichlorobenzene	2/14/2002	5.1	ug/l	5	75	
MW-8	1,4-Dichlorobenzene	2/14/2002	28	ug/l	5	75	
MW-8	Chlorobenzene	2/14/2002	15	ug/l	5	50	

[1] Table only contains detected constituents.
[2] PQL = Practical Quantitation Limit
[3] MCL = Maximum Contaminant Level (North Carolina Groundwater Standard)

Statistical Analyses Summary

Inter-Well Analyses Summary
Wayne County Closed Sanitary Landfill (Dudley)

Background Well: MW-1

Cadmium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance interval	ND	4	ug/l

Well	Result	Significance
MW-5	1	no

Chromium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance interval	ND	17	ug/l

Well	Result	Significance
MW-3	21	yes
MW-6	18	yes

Mercury

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance interval	ND	4.5	ug/l

Well	Result	Significance
MW-8	1	no

Tin, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance interval	ND	130.0	ug/l

Well	Result	Significance
MW-2	470	yes

Vanadium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Poisson tolerance interval	1/2 ND	29.5	ug/l

Well	Result	Significance
MW-3	108	yes

NOTE: Bold-faced monitoring points indicate detected levels exceed North Carolina Groundwater Standard.

Summary of Pooled VOCs in Background Well (MW-1)
Wayne County Closed Sanitary Landfill (Dudley)

Constituent	Samples	NDs	% NDs
1,1,1,2-Tetrachloroethane	18	18	100.00
1,1,1-Trichloroethane	18	18	100.00
1,1,2,2-Tetrachloroethane	18	18	100.00
1,1,2-Trichloroethane	18	18	100.00
1,1-Dichloroethane	18	18	100.00
1,1-Dichloroethene	18	18	100.00
1,2,3-Trichloropropane	18	18	100.00
1,2-Dibromo-3-chloropropane	18	18	100.00
1,2-Dibromoethane	18	18	100.00
1,2-Dichlorobenzene	18	18	100.00
1,2-Dichloroethane	18	18	100.00
1,2-Dichloropropane	18	18	100.00
1,4-Dichlorobenzene	18	18	100.00
2-Butanone	18	18	100.00
2-Hexanone	18	18	100.00
4-Methyl-2-Pentanone	18	18	100.00
Acetone	18	18	100.00
Acrylonitrile	18	18	100.00
Benzene	18	18	100.00
Bromochloromethane	18	18	100.00
Bromodichloromethane	18	18	100.00
Bromoform	18	18	100.00
Bromomethane	18	18	100.00
Carbon disulfide	18	18	100.00
Carbon tetrachloride	18	18	100.00
Chlorobenzene	18	18	100.00
Chloroethane	18	18	100.00
Chloroform	18	18	100.00
Chloromethane	18	18	100.00
cis-1,2-Dichloroethene	18	18	100.00
cis-1,3-Dichloropropene	18	18	100.00
Chlorodibromomethane	18	18	100.00
Dibromomethane	18	18	100.00
Ethylbenzene	18	18	100.00
Iodomethane	18	18	100.00
Dichloromethane	18	18	100.00
Styrene	18	18	100.00
Tetrachloroethylene	18	18	100.00
Toluene	18	18	100.00
trans-1,2-Dichloroethene	18	18	100.00
trans-1,3-Dichloropropene	18	18	100.00
trans-1,4-Dichloro-2-butene	18	18	100.00
Trichloroethylene	18	18	100.00
Trichlorofluoromethane	18	18	100.00
Vinyl acetate	18	18	100.00
Vinyl chloride	18	18	100.00
Xylene	18	18	100.00
Total	**846**	**846**	**100.00**

Poisson Prediction Interval Based upon Pooled Background VOCs
Wayne County Closed Sanitary Landfill (Dudley)

All detected VOCs (Background Well: MW-1)

Constituent	MW-2	MW-4	MW-6	MW-8
1,4-dichlorobenzene			x	x
Chlorobenzene	x			x
Dieldrin		x		
Detection(s) per Scan	1.00	1.00	1.00	2.00

Total number of sampling events [n] = 17
Total number of detections in background wells [y] = 0
Number of comparisons (downgradient wells) [k] = 7
One-sided value of Student's t-statistic (95% confidence) [t] = 2.702
Expected number of detections in a single future sample [y*] = **0.4056**

Statistically significant VOC detections at 95% confidence level within MW-2, MW-4, MW-6, & MW-8

Intra-Well Analysis Summary (VOCs & Metals)
Wayne County Closed Sanitary Landfill (Dudley)

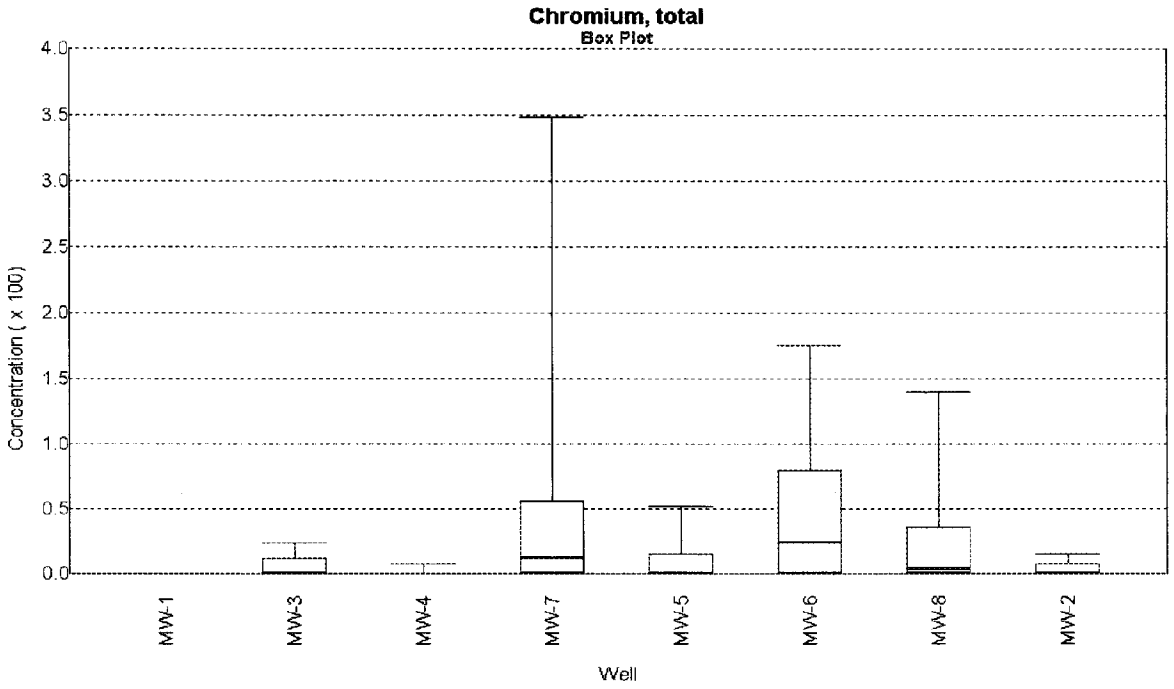
Well	Chromium
MW-3	no
MW-6	no

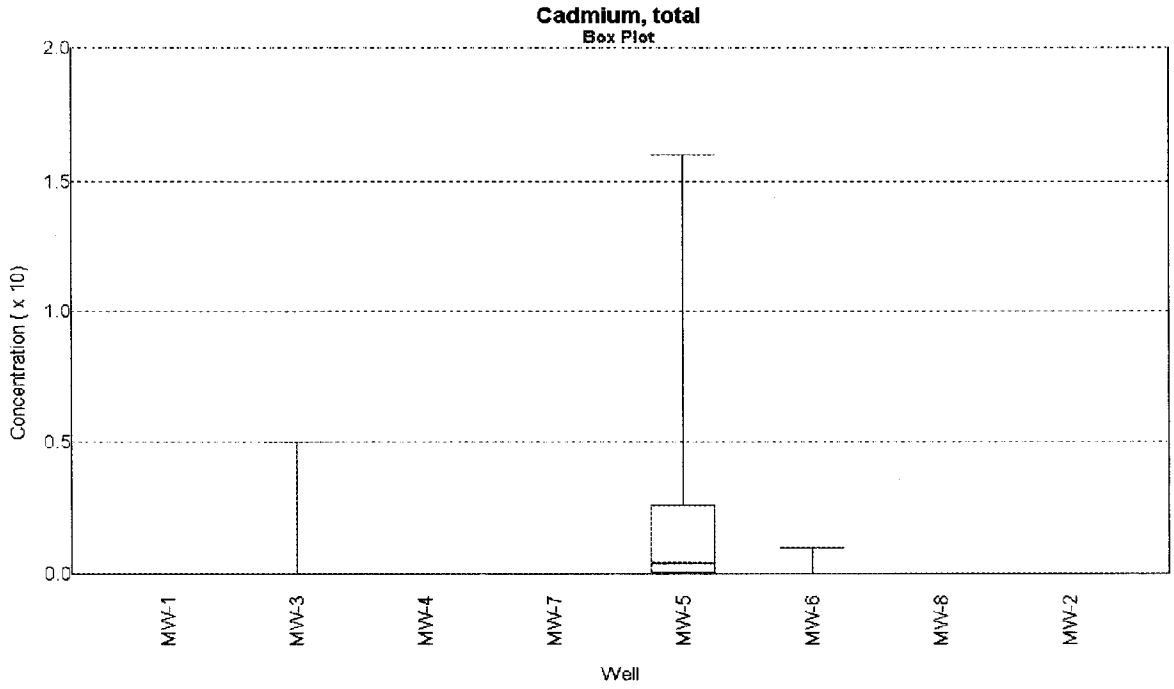
EXPLANATION

yes=detection statistically significant by intrawell analysis
no=detection not statistically significant by intrawell analysis

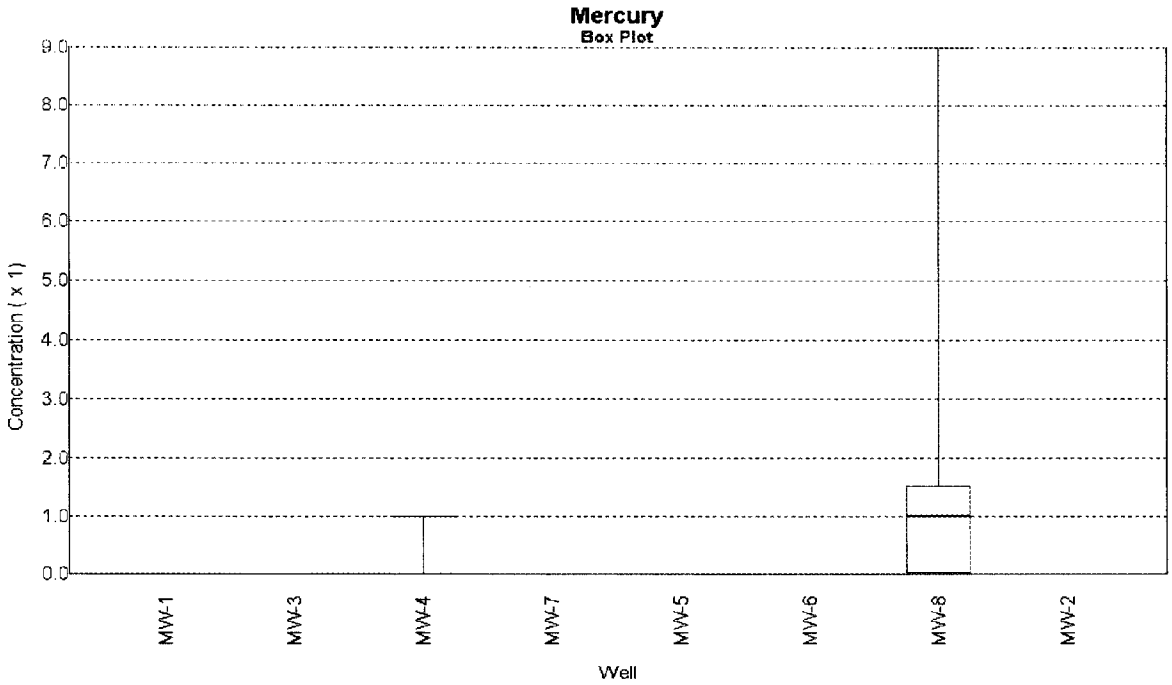
Chromium within MW-3 and MW-6 Not increased according to Intrawell Analysis

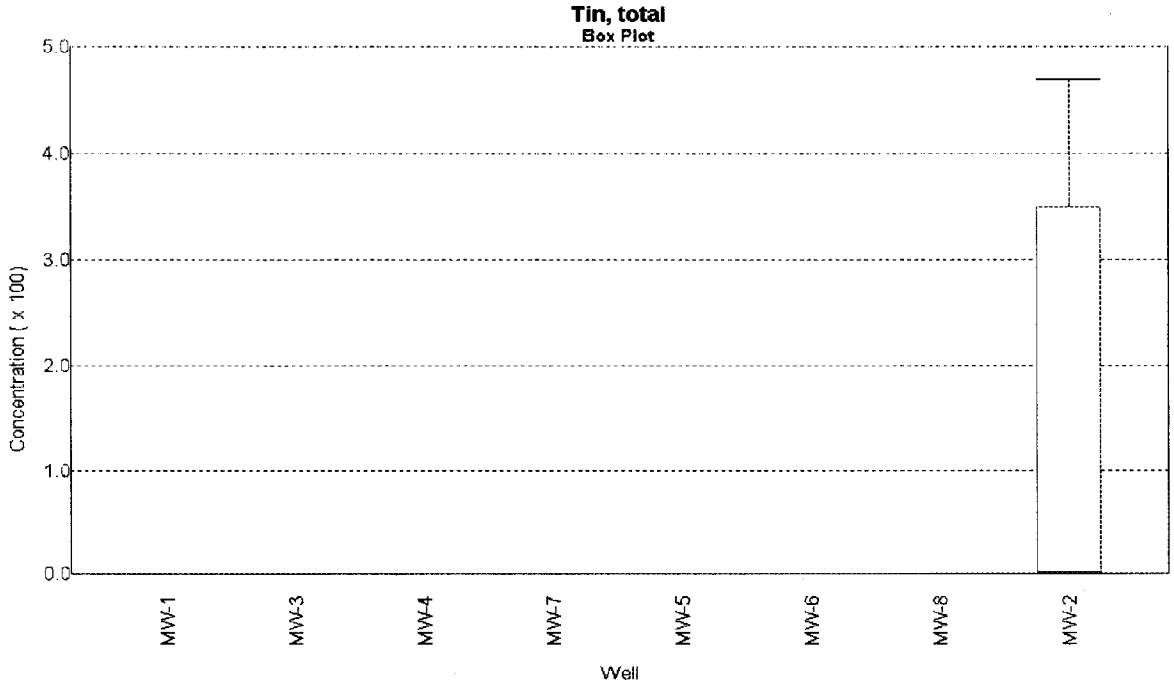
Box Plots for Select Constituents
Wayne County Closed Sanitary Landfill (Dudley)



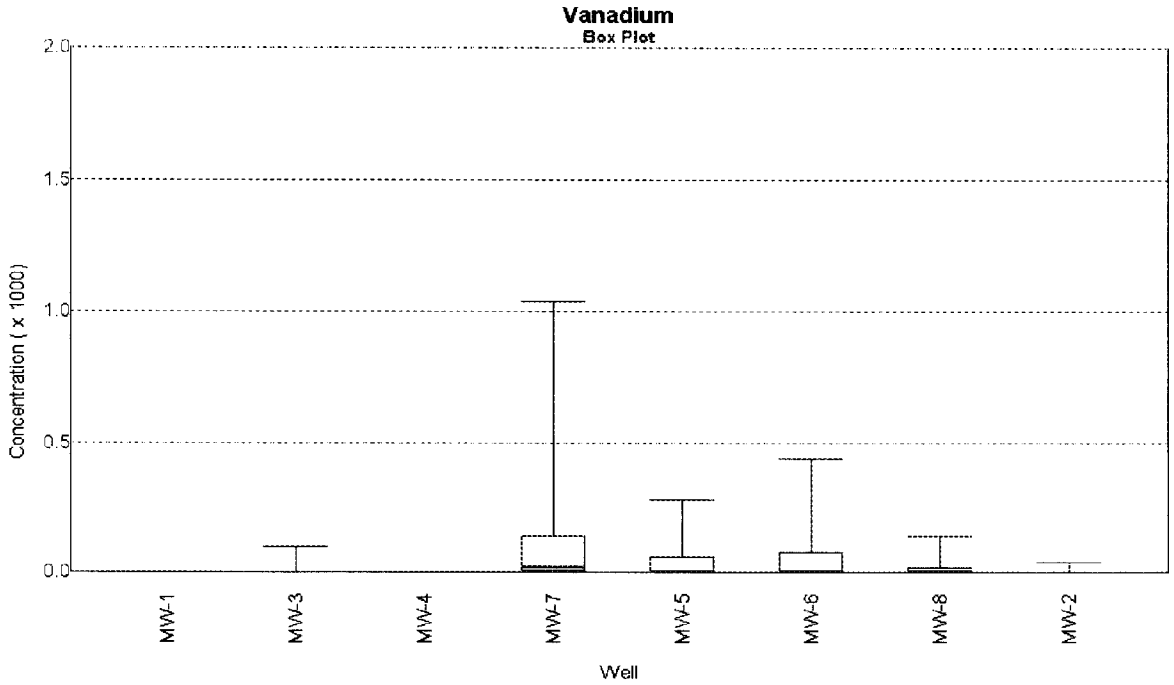


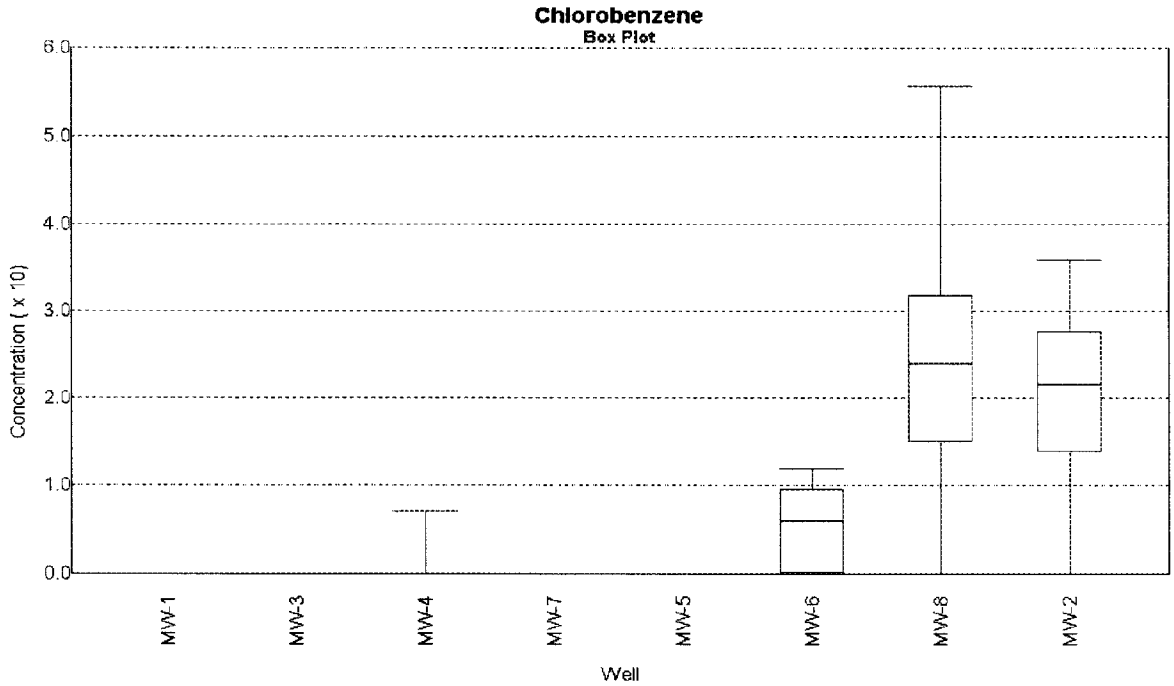
Box Plots for Select Constituents
Wayne County Closed Sanitary Landfill (Dudley)



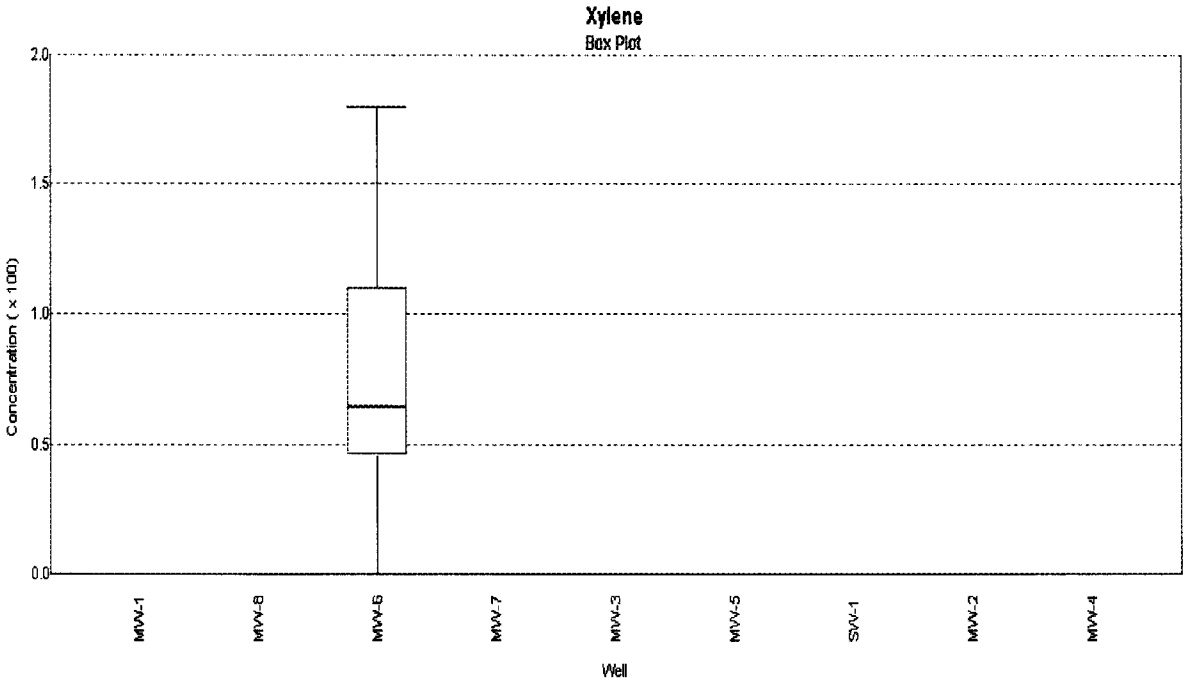


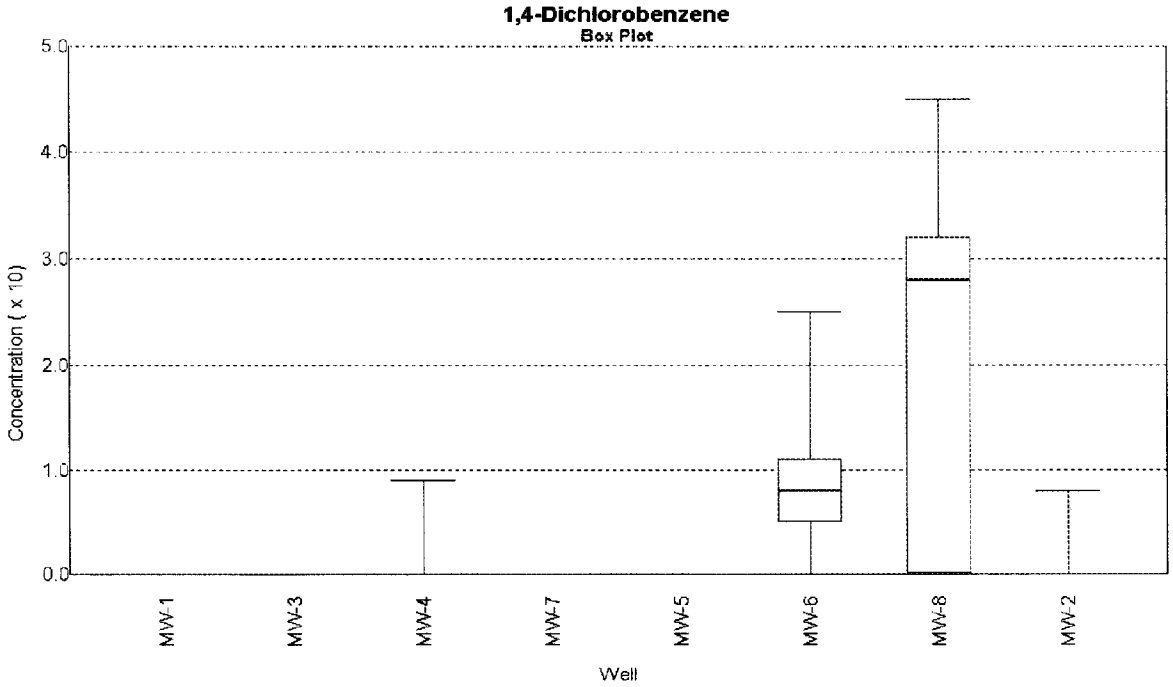
Box Plots for Select Constituents
Wayne County Closed Sanitary Landfill (Dudley)



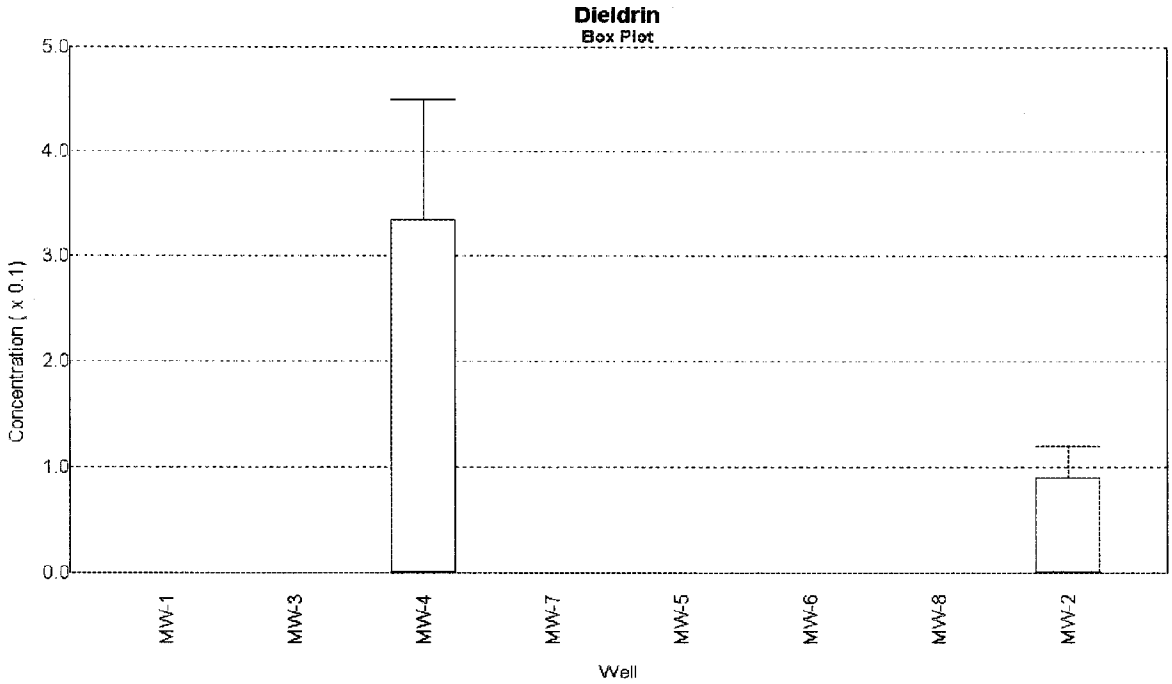


Box Plots for Select Constituents
Wayne County Closed Sanitary Landfill (Dudley)

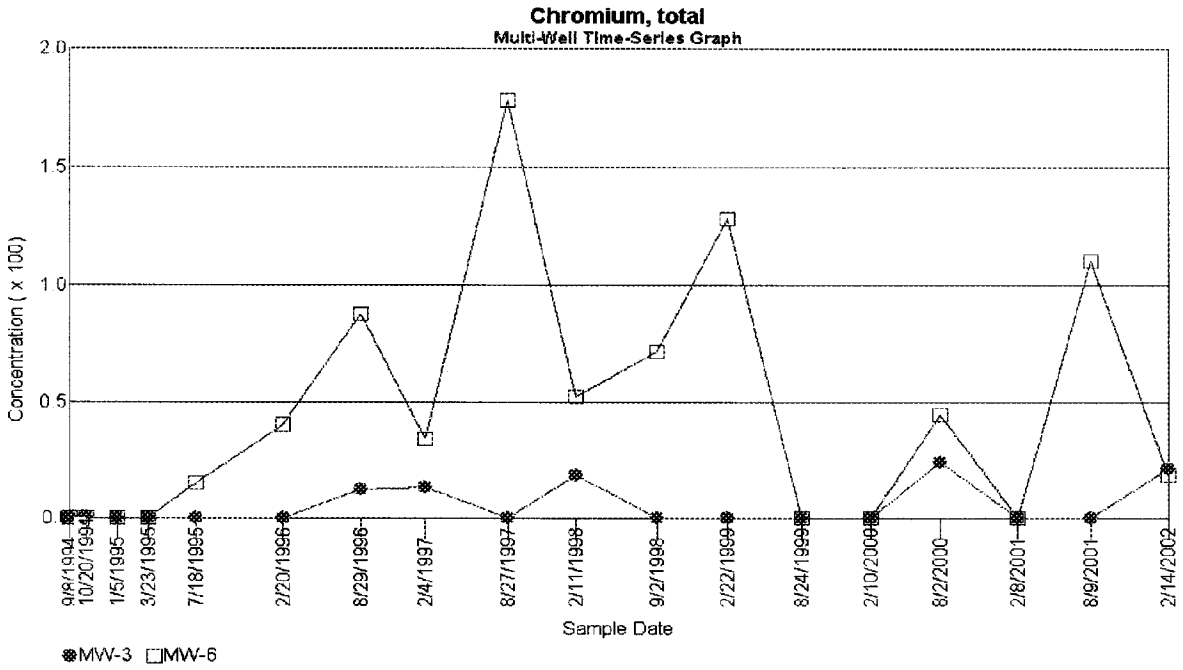


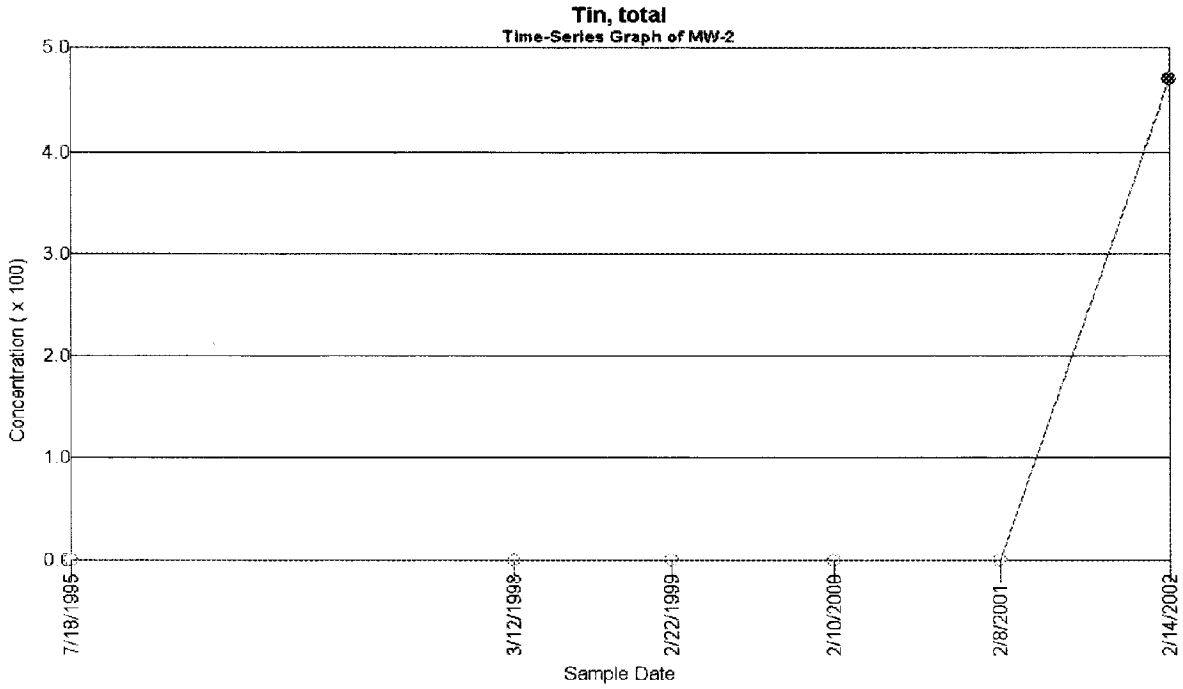


Box Plots for Select Constituents
Wayne County Closed Sanitary Landfill (Dudley)

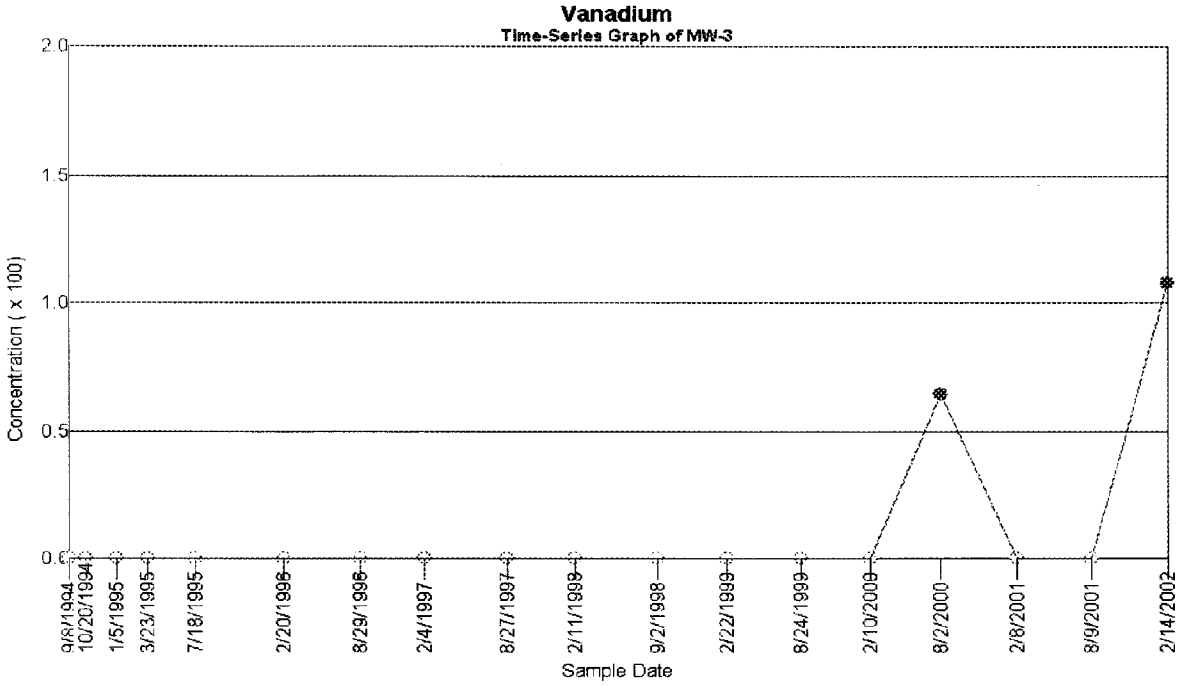


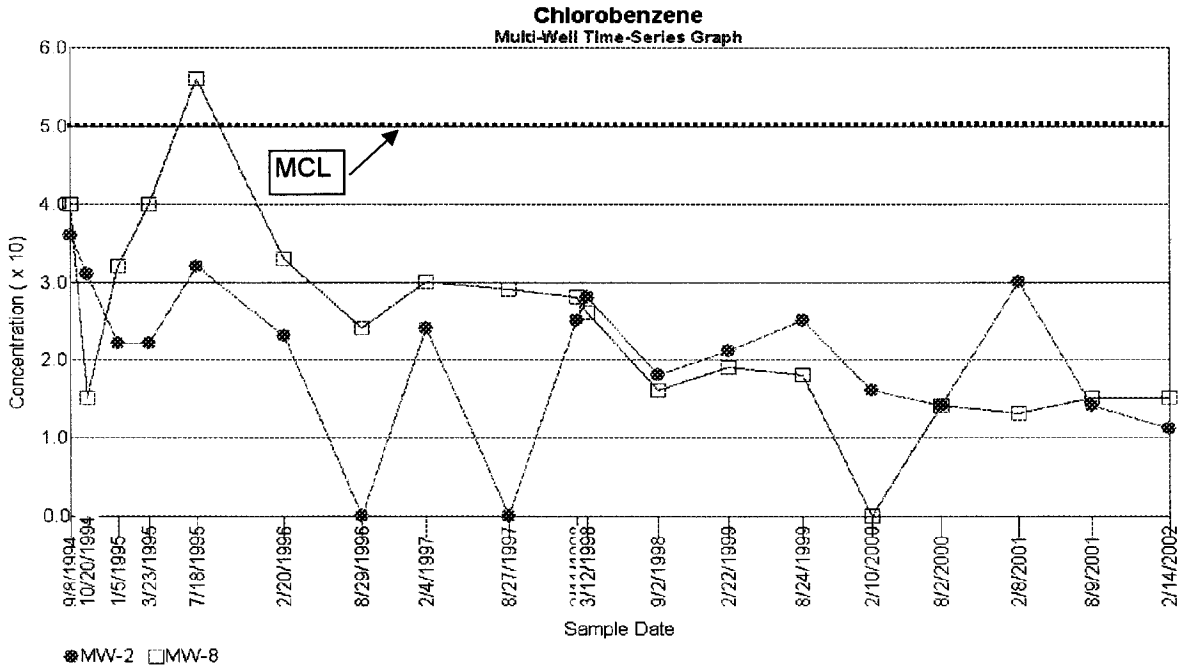
Time Series Plots for Select Constituents
Wayne County Closed Sanitary Landfill (Dudley)



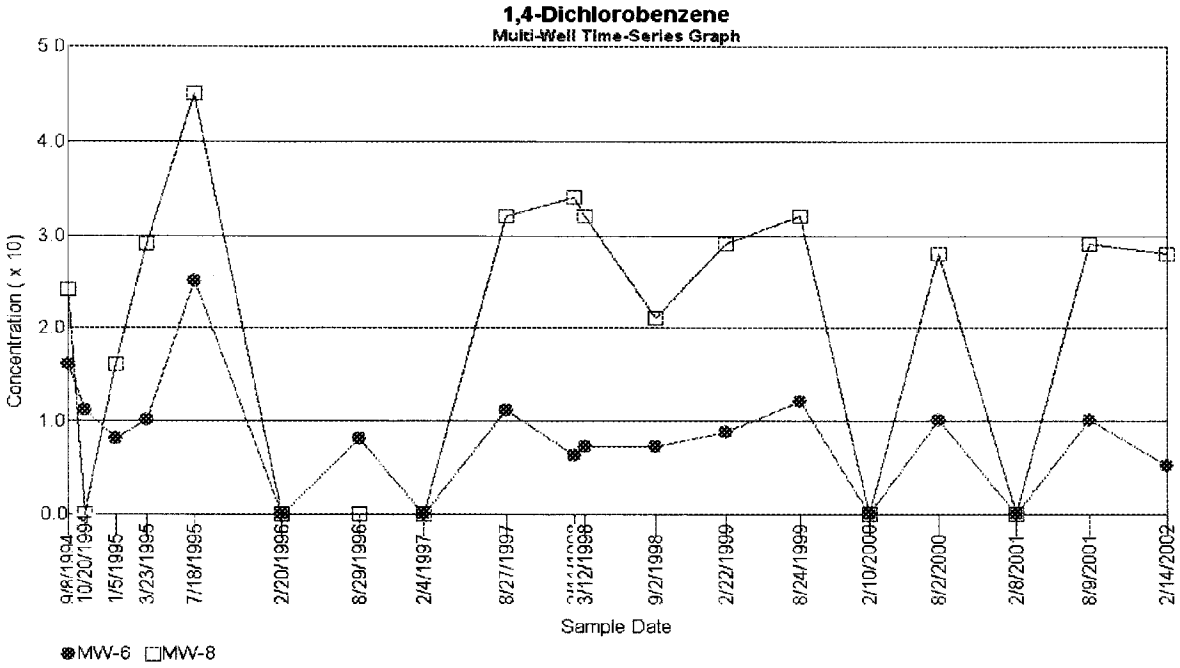


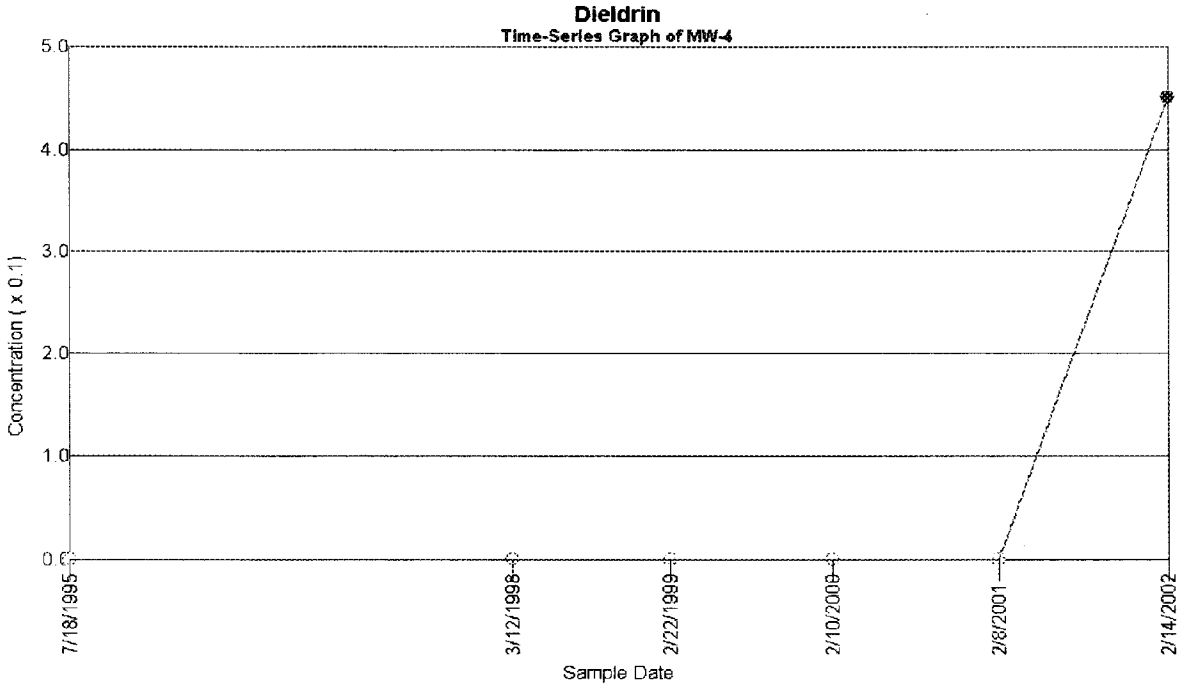
Time Series Plots for Select Constituents
Wayne County Closed Sanitary Landfill (Dudley)



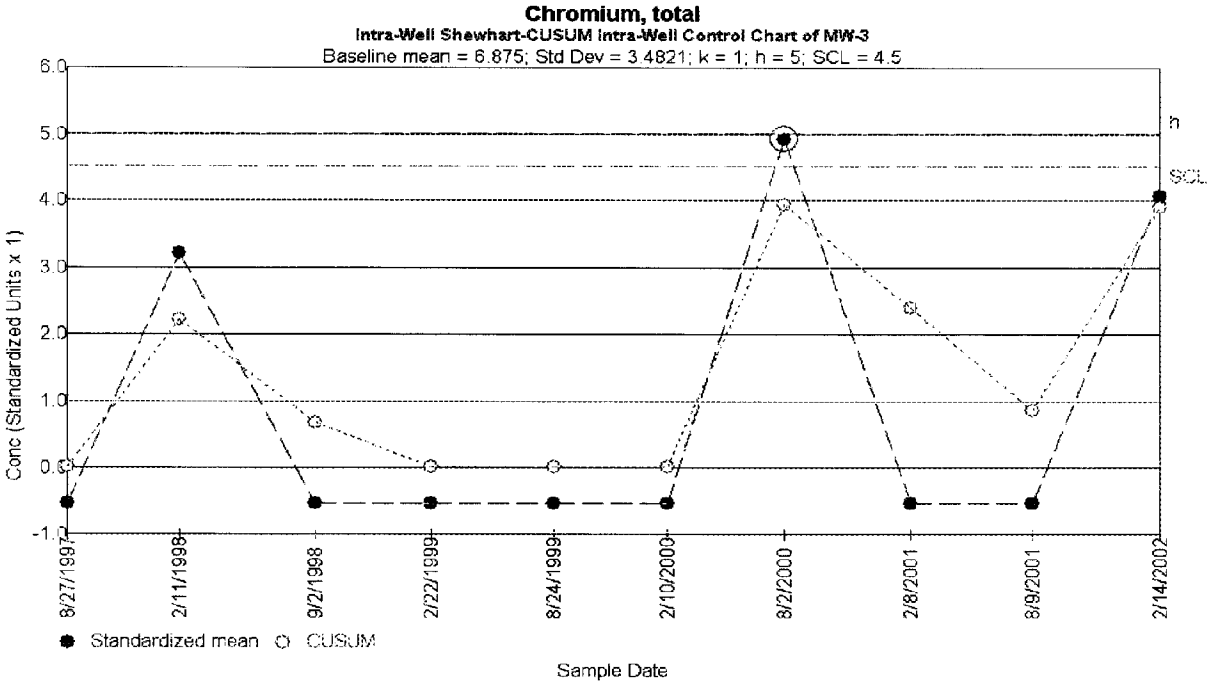


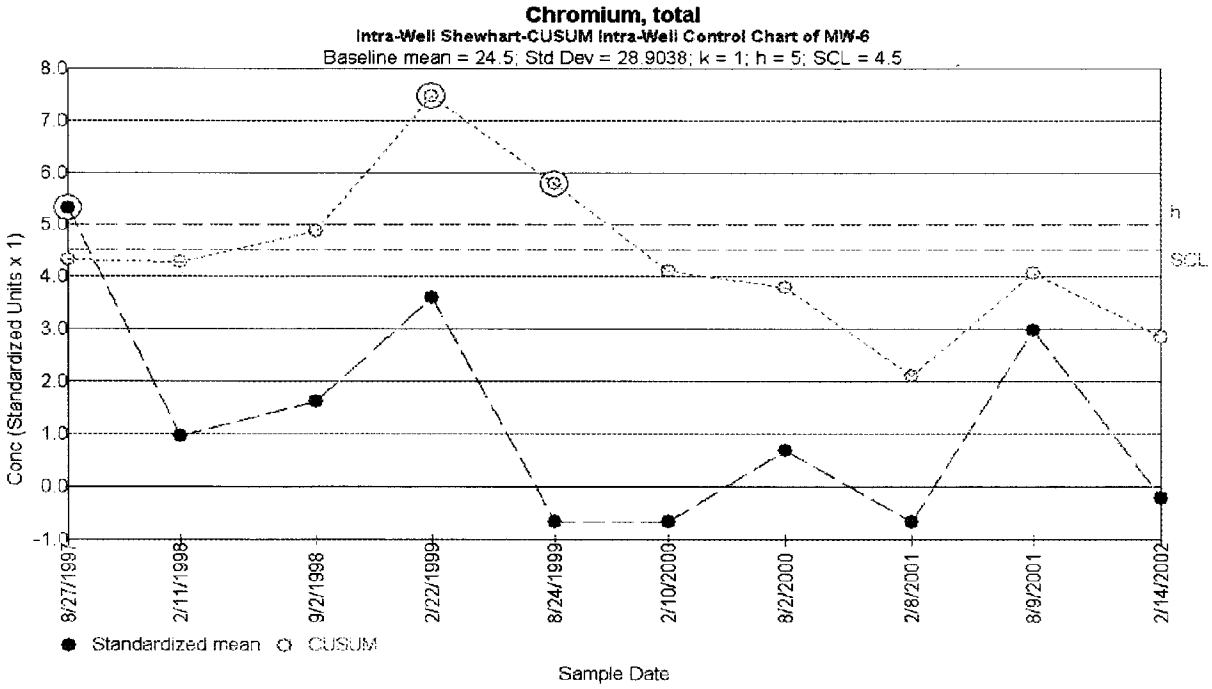
Time Series Plots for Select Constituents
Wayne County Closed Sanitary Landfill (Dudley)





Shewhart-CUSUM charts for selected constituents
Wayne County Closed Sanitary Landfill (Dudley)





Basic Statistics

Basic Statistics

Parameter: Cadmium, total

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

	Total Observations
143	
Total Non-Detects	131
Pooled Mean	1.22378
Pooled Std Dev	1.4163
Background Mean	1
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	17	17	100	17

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	1	0	0	1122	66

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-5	18	9	50	45
MW-2	18	18	100	18
MW-3	18	16	88.8889	23
MW-4	18	18	100	18
MW-6	18	17	94.4444	18
MW-7	18	18	100	18
MW-8	18	18	100	18

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-5	2.5	3.71404	1.5	0.460334	1829	101.611
MW-2	1	0	0	0.460334	1188	66
MW-3	1.27778	0.95828	0.277778	0.460334	1335	74.1667
MW-4	1	0	0	0.460334	1188	66
MW-6	1	0	0	0.460334	1258	69.8889
MW-7	1	0	0	0.460334	1188	66
MW-8	1	0	0	0.460334	1188	66

Analysis of Variance Statistics

SS Wells	34.728
SS Total	284.839

Kruskal-Wallis Statistics

Non-Detect Rank	66
Background Rank Sum	1122
Background Rank Mean	66
H Statistic	11.1605
H Adjusted for Ties	48.2678

Basic Statistics

Parameter: Chromium, total

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

	Total Observations
143	
Total Non-Detects	94
Pooled Mean	23.3497
Pooled Std Dev	39.0789
Background Mean	10
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	17	17	100	170

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	10	0	0	807.5	47.5

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-5	18	11	61.1111	272
MW-2	18	13	72.2222	194
MW-3	18	13	72.2222	218
MW-4	18	17	94.4444	181
MW-6	18	7	38.8889	847
MW-7	18	7	38.8889	888
MW-8	18	9	50	569

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-5	15.1111	11.1666	5.11111	12.377	1300.5	72.25
MW-2	10.7778	2.0738	0.777778	12.377	1130.5	62.8056
MW-3	12.1111	4.29622	2.11111	12.377	1169.5	64.9722
MW-4	10.0556	0.235702	0.0555556	12.377	908.5	50.4722
MW-6	47.0556	49.4481	37.0556	12.377	1746.5	97.0278
MW-7	49.3333	81.7888	39.3333	12.377	1686.5	93.6944
MW-8	31.6111	36.7938	21.6111	12.377	1546.5	85.9167

Analysis of Variance Statistics

SS Wells	36047.7
SS Total	216857

Kruskal-Wallis Statistics

Non-Detect Rank	47.5
Background Rank Sum	807.5
Background Rank Mean	47.5
H Statistic	25.7523
H Adjusted for Ties	35.9678

Basic Statistics

Parameter: Mercury

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

	Total Observations
80	
Total Non-Detects	71
Pooled Mean	1.155
Pooled Std Dev	0.955716
Background Mean	1
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	6	6	100	6

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	1	0	0	216	36

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-5	7	7	100	7
MW-2	12	12	100	12
MW-3	7	7	100	7
MW-4	12	11	91.6667	12
MW-6	12	12	100	12
MW-7	11	11	100	11
MW-8	13	5	38.4615	25.4

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-5	1	0	0	0.517319	252	36
MW-2	1	0	0	0.464923	432	36
MW-3	1	0	0	0.517319	252	36
MW-4	1	0	0	0.464923	468	39
MW-6	1	0	0	0.464923	432	36
MW-7	1	0	0	0.471915	396	36
MW-8	1.95385	2.27765	0.953846	0.458924	792	60.9231

Analysis of Variance Statistics

SS Wells	9.90569
SS Total	72.158

Kruskal-Wallis Statistics

Non-Detect Rank	36
Background Rank Sum	216
Background Rank Mean	36
H Statistic	12.1538
H Adjusted for Ties	40.3803

Basic Statistics

Parameter: Tin, total

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

	Total Observations
37	
Total Non-Detects	36
Pooled Mean	110
Pooled Std Dev	60.8276
Background Mean	100
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	2	2	100	200

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	100	0	0	37	18.5

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-5	3	3	100	300
MW-2	6	5	83.3333	970
MW-3	3	3	100	300
MW-4	6	6	100	600
MW-6	6	6	100	600
MW-7	5	5	100	500
MW-8	6	6	100	600

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-5	100	0	0	57.2561	55.5	18.5
MW-2	161.667	151.052	61.6667	51.2114	129.5	21.5833
MW-3	100	0	0	57.2561	55.5	18.5
MW-4	100	0	0	51.2114	111	18.5
MW-6	100	0	0	51.2114	111	18.5
MW-7	100	0	0	52.476	92.5	18.5
MW-8	100	0	0	51.2114	111	18.5

Analysis of Variance Statistics

SS Wells	19116.7
SS Total	133200

Kruskal-Wallis Statistics

Non-Detect Rank	18.5
Background Rank Sum	37
Background Rank Mean	18.5
H Statistic	0.407895
H Adjusted for Ties	5.16667

Basic Statistics

Parameter: Vanadium

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

	Total Observations
143	
Total Non-Detects	111
Pooled Mean	62.7622
Pooled Std Dev	96.3979
Background Mean	40
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	17	17	100	680

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	40	0	0	952	56

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-5	18	10	55.5556	1129
MW-2	18	17	94.4444	733
MW-3	18	16	88.8889	813
MW-4	18	18	100	720
MW-6	18	10	55.5556	1531
MW-7	18	9	50	2369
MW-8	18	14	77.7778	1000

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-5	62.7222	56.5122	22.7222	31.7778	1545	85.8333
MW-2	40.7222	3.06413	0.722222	31.7778	1071	59.5
MW-3	45.1667	16.7481	5.16667	31.7778	1148	63.7778
MW-4	40	0	0	31.7778	1008	56
MW-6	85.0556	96.8033	45.0556	31.7778	1600	88.8889
MW-7	131.611	236.566	91.6111	31.7778	1672	92.8889
MW-8	55.5556	35.9628	15.5556	31.7778	1300	72.2222

Analysis of Variance Statistics

SS Wells	127655
SS Total	1.31954e+006

Kruskal-Wallis Statistics

Non-Detect Rank	56
Background Rank Sum	952
Background Rank Mean	56
H Statistic	17.1464
H Adjusted for Ties	32.2106

Basic Statistics

Parameter: Chlorobenzene

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

	Total Observations
151	
Total Non-Detects	103
Pooled Mean	9.82119
Pooled Std Dev	9.33728
Background Mean	5
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	18	18	100	90

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	5	0	0	936	52

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-5	19	19	100	95
MW-2	19	2	10.5263	402
MW-3	19	19	100	95
MW-4	19	18	94.7368	97.3
MW-6	19	7	36.8421	140.7
MW-7	19	19	100	95
MW-8	19	1	5.26316	468

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-5	5	0	0	1.78135	988	52
MW-2	21.1579	8.7131	16.1579	1.78135	2360	124.211
MW-3	5	0	0	1.78135	988	52
MW-4	5.12105	0.527656	0.121053	1.78135	1044	54.9474
MW-6	7.40526	2.56395	2.40526	1.78135	1689	88.8947
MW-7	5	0	0	1.78135	988	52
MW-8	24.6316	12.2575	19.6316	1.78135	2483	130.684

Analysis of Variance Statistics

SS Wells	8883.42
SS Total	13077.7

Kruskal-Wallis Statistics

Non-Detect Rank	52
Background Rank Sum	936
Background Rank Mean	52
H Statistic	81.435
H Adjusted for Ties	119.295

Basic Statistics

Parameter: 1,4-Dichlorobenzene

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

	Total Observations
151	
Total Non-Detects	120
Pooled Mean	7.67152
Pooled Std Dev	7.24022
Background Mean	5
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	18	18	100	90

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	5	0	0	1089	60.5

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-5	19	19	100	95
MW-2	19	17	89.4737	100
MW-3	19	19	100	95
MW-4	19	18	94.7368	99
MW-6	19	4	21.0526	175.4
MW-7	19	19	100	95
MW-8	19	6	31.5789	409

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-5	5	0	0	1.606	1149.5	60.5
MW-2	5.26316	0.805682	0.263158	1.606	1277.5	67.2368
MW-3	5	0	0	1.606	1149.5	60.5
MW-4	5.21053	0.917663	0.210526	1.606	1219	64.1579
MW-6	9.23158	4.82816	4.23158	1.606	2197	115.632
MW-7	5	0	0	1.606	1149.5	60.5
MW-8	21.5263	12.8295	16.5263	1.606	2245	118.158

Analysis of Variance Statistics

SS Wells	4453.95
SS Total	7863.13

Kruskal-Wallis Statistics

Non-Detect Rank	60.5
Background Rank Sum	1089
Background Rank Mean	60.5
H Statistic	44.8344
H Adjusted for Ties	90.0077

Basic Statistics

Parameter: Dieldrin

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

	Total Observations
37	
Total Non-Detects	35
Pooled Mean	0.11
Pooled Std Dev	0.0575423
Background Mean	0.1
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	2	2	100	0.2

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	0.1	0	0	36	18

Compliance Wells

There are 7 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-5	3	3	100	0.3
MW-2	6	5	83.3333	0.62
MW-3	3	3	100	0.3
MW-4	6	5	83.3333	0.95
MW-6	6	6	100	0.6
MW-7	5	5	100	0.5
MW-8	6	6	100	0.6

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-5	0.1	1.69967e-017	1.38778e-017	0.0542495	54	18
MW-2	0.103333	0.00816497	0.00333333	0.0485222	126	21
MW-3	0.1	1.69967e-017	1.38778e-017	0.0542495	54	18
MW-4	0.158333	0.142887	0.0583333	0.0485222	127	21.1667
MW-6	0.1	1.52024e-017	-1.38778e-017	0.0485222	108	18
MW-7	0.1	0	0	0.0497205	90	18
MW-8	0.1	1.52024e-017	-1.38778e-017	0.0485222	108	18

Analysis of Variance Statistics

SS Wells	0.0167833
SS Total	0.1192

Kruskal-Wallis Statistics

Non-Detect Rank	18
Background Rank Sum	36
Background Rank Mean	18
H Statistic	0.658606
H Adjusted for Ties	4.28704

Interwell Analyses for Metals

Poisson Tolerance Limit

Parameter: Cadmium, total

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Poisson Count of 17 background Samples = 17
Degrees of Freedom = 36

95% Confidence Values

Chi-Squared Value (95% Confidence) = 50.9985
Lambda (from Zack's formula) = 1.49996
Smallest Degrees of Freedom = 9
Upper Tolerance Limit (95%) = 3.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 58.6192
Lambda (from Zack's formula) = 1.72409
Smallest Degrees of Freedom = 12
Upper Tolerance Limit (99%) = 5

	Date	Result	Impacted 95%	Impacted 99%
MW-5	9/8/1994	7	TRUE	TRUE
	10/20/1994	4	TRUE	FALSE
	1/5/1995	ND<1	FALSE	FALSE
	3/23/1995	1	FALSE	FALSE
	7/18/1995	16	TRUE	TRUE
	2/20/1996	2	FALSE	FALSE
	8/29/1996	ND<1	FALSE	FALSE
	2/4/1997	1	FALSE	FALSE
	8/27/1997	3	FALSE	FALSE
	2/11/1998	1	FALSE	FALSE
	9/2/1998	ND<1	FALSE	FALSE
	2/22/1999	ND<1	FALSE	FALSE
	8/24/1999	ND<1	FALSE	FALSE
	2/10/2000	ND<1	FALSE	FALSE
	8/2/2000	ND<1	FALSE	FALSE
	2/8/2001	ND<1	FALSE	FALSE
	8/9/2001	ND<1	FALSE	FALSE
	2/14/2002	1	FALSE	FALSE

Poisson Tolerance Limit

Parameter: Chromium, total

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Poisson Count of 17 background Samples = 170
Degrees of Freedom = 342

95% Confidence Values

Chi-Squared Value (95% Confidence) = 386.125
Lambda (from Zack's formula) = 11.3566
Smallest Degrees of Freedom = 36
Upper Tolerance Limit (95%) = 17

99% Confidence Values

Chi-Squared Value (99% Confidence) = 405.766
Lambda (from Zack's formula) = 11.9343
Smallest Degrees of Freedom = 43
Upper Tolerance Limit (99%) = 20.5

	Date	Result	Impacted 95%	Impacted 99%
MW-3	9/8/1994	ND<10	FALSE	FALSE
	10/20/1994	ND<10	FALSE	FALSE
	1/5/1995	ND<10	FALSE	FALSE
	3/23/1995	ND<10	FALSE	FALSE
	7/18/1995	ND<10	FALSE	FALSE
	2/20/1996	ND<10	FALSE	FALSE
	8/29/1996	12	FALSE	FALSE
	2/4/1997	13	FALSE	FALSE
	8/27/1997	ND<10	FALSE	FALSE
	2/11/1998	18	TRUE	FALSE
	9/2/1998	ND<10	FALSE	FALSE
	2/22/1999	ND<10	FALSE	FALSE
	8/24/1999	ND<10	FALSE	FALSE
	2/10/2000	ND<10	FALSE	FALSE
	8/2/2000	24	TRUE	TRUE
	2/8/2001	ND<10	FALSE	FALSE
	8/9/2001	ND<10	FALSE	FALSE
	2/14/2002	21	TRUE	TRUE
MW-6	9/8/1994	ND<10	FALSE	FALSE
	10/20/1994	ND<10	FALSE	FALSE
	1/5/1995	ND<10	FALSE	FALSE
	3/23/1995	ND<10	FALSE	FALSE
	7/18/1995	15	FALSE	FALSE
	2/20/1996	40	TRUE	TRUE
	8/29/1996	87	TRUE	TRUE
	2/4/1997	34	TRUE	TRUE
	8/27/1997	178	TRUE	TRUE
	2/11/1998	52	TRUE	TRUE
	9/2/1998	71	TRUE	TRUE
	2/22/1999	128	TRUE	TRUE
	8/24/1999	ND<10	FALSE	FALSE
	2/10/2000	ND<10	FALSE	FALSE
	8/2/2000	44	TRUE	TRUE
	2/8/2001	ND<10	FALSE	FALSE
	8/9/2001	110	TRUE	TRUE
	2/14/2002	18	TRUE	FALSE

Poisson Tolerance Limit

Parameter: Mercury

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Poisson Count of 6 background Samples = 6
Degrees of Freedom = 14

95% Confidence Values

Chi-Squared Value (95% Confidence) = 23.6848
Lambda (from Zack's formula) = 1.97373
Smallest Degrees of Freedom = 11
Upper Tolerance Limit (95%) = 4.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 29.1412
Lambda (from Zack's formula) = 2.42843
Smallest Degrees of Freedom = 15
Upper Tolerance Limit (99%) = 6.5

	Date	Result	Impacted 95%	Impacted 99%
MW-8	7/18/1995	4	FALSE	FALSE
	2/20/1996	9	TRUE	TRUE
	3/12/1998	ND<1	FALSE	FALSE
	9/2/1998	ND<1	FALSE	FALSE
	10/29/1998	ND<1	FALSE	FALSE
	12/2/1998	1	FALSE	FALSE
	2/22/1999	ND<1	FALSE	FALSE
	8/24/1999	1	FALSE	FALSE
	2/10/2000	ND<1	FALSE	FALSE
	8/2/2000	2	FALSE	FALSE
	2/8/2001	1.2	FALSE	FALSE
	8/9/2001	1.2	FALSE	FALSE
	2/14/2002	1	FALSE	FALSE

Poisson Tolerance Limit

Parameter: Tin, total

Original Data (Not Transformed)
Non-Detects Replaced with Detection Limit

Poisson Count of 2 background Samples = 200
Degrees of Freedom = 402

95% Confidence Values

Chi-Squared Value (95% Confidence) = 449.749
Lambda (from Zack's formula) = 112.437
Smallest Degrees of Freedom = 262
Upper Tolerance Limit (95%) = 130

99% Confidence Values

Chi-Squared Value (99% Confidence) = 470.889
Lambda (from Zack's formula) = 117.722
Smallest Degrees of Freedom = 289
Upper Tolerance Limit (99%) = 143.5

	Date	Result	Impacted 95%	Impacted 99%
MW-2	7/18/1995	ND<100	FALSE	FALSE
	3/12/1998	ND<100	FALSE	FALSE
	2/22/1999	ND<100	FALSE	FALSE
	2/10/2000	ND<100	FALSE	FALSE
	2/8/2001	ND<100	FALSE	FALSE
	2/14/2002	470	TRUE	TRUE

Poisson Tolerance Limit

Parameter: Vanadium

Original Data (Not Transformed)
Non-Detects Replaced with 1/2 DL

Poisson Count of 17 background Samples = 340
Degrees of Freedom = 682

95% Confidence Values

Chi-Squared Value (95% Confidence) = 743.864
Lambda (from Zack's formula) = 21.8784
Smallest Degrees of Freedom = 61
Upper Tolerance Limit (95%) = 29.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 770.846
Lambda (from Zack's formula) = 22.672
Smallest Degrees of Freedom = 70
Upper Tolerance Limit (99%) = 34

	Date	Result	Impacted 95%	Impacted 99%
MW-3	9/8/1994	ND<20	FALSE	FALSE
	10/20/1994	ND<20	FALSE	FALSE
	1/5/1995	ND<20	FALSE	FALSE
	3/23/1995	ND<20	FALSE	FALSE
	7/18/1995	ND<20	FALSE	FALSE
	2/20/1996	ND<20	FALSE	FALSE
	8/29/1996	ND<20	FALSE	FALSE
	2/4/1997	ND<20	FALSE	FALSE
	8/27/1997	ND<20	FALSE	FALSE
	2/11/1998	ND<20	FALSE	FALSE
	9/2/1998	ND<20	FALSE	FALSE
	2/22/1999	ND<20	FALSE	FALSE
	8/24/1999	ND<20	FALSE	FALSE
	2/10/2000	ND<20	FALSE	FALSE
	8/2/2000	65	TRUE	TRUE
	2/8/2001	ND<20	FALSE	FALSE
	8/9/2001	ND<20	FALSE	FALSE
	2/14/2002	108	TRUE	TRUE