Groundwater Sampling Report and Statistical Analysis

Prepared for

Wayne County Subtitle D Landfill
Dudley, North Carolina

February, 2006

Permit Number: 96-06
MESCO Project Number: G06016.0

Completed on August 29, 2006

Municipal Services Garner, NC
Engineering Company, P.A. Boone, NC

Municipal Engineering Services Company, P.A.
Garner, Boone and Morehead City, North Carolina

OPERATION/CONSTRUCTION MANAGERS

Municipal Services

CIVIL/SANITARY ENGINEERS

Engineering Company, P.A.

August 29, 2006

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

Re: Semi-Annual Groundwater Sampling Report and Statistical Analysis
Wayne County Subtitle D Lined Landfill
Permit No. 96-06
MESCO Project No. G6016.0

Dear Mr. Brown:

Municipal Engineering Services Company, P.A. (MESCO) completed the sampling report and statistical analyses for the Wayne County Subtitle D Lined Landfill located in Dudley, NC. Environment 1 Inc. of Greenville, NC, sampled and analyzed the Subtitle D Landfill for the Appendix I list of metals and volatile organic constituents (VOCs) on February 22, 2006 as part of the detection monitoring program. The laboratory results and statistical analysis are included herein.

The detection monitoring program for the Subtitle D Landfill consists of compliance wells (MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13), surface waters (SW-2, SW-3, SW-4, SW-5), background well (MW-1), the leachate lagoon (LE-1) and the forcemain from the phase 2 landfill sump (LE-2). All monitoring locations were sampled during this event.

All detected constituents were compared with North Carolina Groundwater Standards for regulatory exceedance. The results are shown in the enclosed table titled "Exceedance Scan". The following table (Table 1) summarizes those constituents that exceed the Standard.

Table 1. Exceedance Summary

Monitoring Location	Cadmium	Lead
MW-2		x
MW-12	x	x
SW-4	x	

x = concentration greater than groundwater standard

Lead was detected in concentrations above the Standard within compliance wells MW-2 and MW-12. Cadmium was also found in concentrations above the MCL within MW-12 and SW-4. No VOCs, which are more indicative of leachate contamination, were found within any of the monitoring locations with the exception of the leachate collection sites.

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MESCO also completed the statistical analysis as required by the Solid Waste Section. The statistical analysis was conducted upon all of the monitoring wells surrounding both the phase 1 and phase 2 lined landfills. The purpose of these analyses is to determine, in comparison to background levels, statistical significance of constituents detected during the February 2006 event.

Statistical Analysis Methodology

Metals

MESCO conducted an interwell statistical analysis on all of the detected metals. Monitoring well MW-1 was defined as the background well, and an upper tolerance limit (UTL) with 95% coverage was computed for each detected constituent from the background data at a 95% level of confidence. For each tested constituent, an appropriate statistical analysis method was selected based on the percentages of non-detects (%ND) in the historical background data. The following table (Table 2) summarizes the methods used for four different %ND ranges.

Table 2. 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.

A total of 7 metals were tested for statistical significance. For arsenic, barium, beryllium, and cadmium the Poisson tolerance limit was used on the original data with no ND substitution since the constituents had rarely been detected within the background well. For the remaining detected metals the non-parametric tolerance limit with ½ NDs was used on the original data as its %ND was not normally distributed or the Poisson Count exceeded the required amount.

Intrawell Analyses

Intrawell Analyses 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. 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 the lack of sampling events and the detection rate criteria neither MW-12 nor MW-2 could undergo intrawell analyses during this sampling event.

Results

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). Table 3 summarizes those metals that were found statistically significant by interwell comparison analysis.

Table 3. Interwell Analyses Summary

Well	Arsenic	Barium
MW-2	x	
MW-12	x	x

x=level significantly higher than the background level

The numbers of metal detections continue to be consistent with historical results and all concentrations were found within the historically identified range with the exception of arsenic within MW-2. Compliance wells MW-2 and MW-12 contained concentrations of arsenic in levels above the background but below the NCGW2L standard. MW-12 also contained concentrations of barium above the background according to interwell analysis. However,

Shewhart-CUSUM charts could not be constructed for either metal found to be elevated via interwell analysis therefore it is inconclusive if the increase can be attributed to spatial variability.

Conclusion

The statistical analysis results indicate no signs of contamination originating from the Wayne County Subtitle D Landfill. The metals are likely natural in origin as they also continue to be detected within the background well and are rarely detected within samples obtained from the leachate lagoon. MESCO completed the required potentiometric map with groundwater flow rates and direction for the sampling event. The flow directions and gradients are consistent with historical observations, showing no changes that would result in a different interpretation of the groundwater system. The facility is to continue detection monitoring and is scheduled to be sampled again for the Appendix 1 list of metals and VOCs in August 2006. 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 Specialist

Enclosures

cc: Mr. Lloyd Cook
Wayne County

Exceedance Scan
Wayne County Subtitle D Landfill

Well ID	Parameter Name[1]	Sample Date	Result	Unit	PQL[2]	NCGW2L[3]	Exceedance
MW-1	Chromium	02/22/2006	0.012	mg/l	0.01	0.05	
MW-1	Lead	02/22/2006	0.011	mg/l	0.01	0.015	
MW-12	**Cadmium**	**02/22/2006**	**0.002**	**mg/l**	**0.001**	**0.0018**	**0.0003**
MW-12	Beryllium	02/22/2006	0.005	mg/l	0.002		
MW-12	Barium	02/22/2006	0.757	mg/l	0.5	2	
MW-12	**Lead**	**02/22/2006**	**0.021**	**mg/l**	**0.01**	**0.015**	**0.006**
MW-12	Zinc	02/22/2006	0.112	mg/l	0.05	1.05	
MW-12	Arsenic	02/22/2006	0.02	mg/l	0.01	0.05	
MW-12	Chromium	02/22/2006	0.024	mg/l	0.01	0.05	
MW-2	Arsenic	02/22/2006	0.022	mg/l	0.01	0.05	
MW-2	Chromium	02/22/2006	0.044	mg/l	0.01	0.05	
MW-2	**Lead**	**02/22/2006**	**0.046**	**mg/l**	**0.01**	**0.015**	**0.031**
MW-8	Zinc	02/22/2006	0.077	mg/l	0.05	1.05	
SW-4	Lead	02/22/2006	0.012	mg/l	0.01	0.015	
SW-4	**Cadmium**	**02/22/2006**	**0.002**	**mg/l**	**0.001**	**0.0018**	**0.0003**
SW-5	Zinc	02/22/2006	0.089	mg/l	0.05	1.05	
LE-1	Total Phosphorus	02/22/2006	0.55	mg/l			
LE-2	Zinc	02/22/2006	0.326	mg/l	0.05	1.05	
LE-2	Total Phosphorus	02/22/2006	0.87	mg/l			
LE-2	Chromium	02/22/2006	0.014	mg/l	0.01	0.05	
LE-2	Arsenic	02/22/2006	0.013	mg/l	0.01	0.05	
LE-1	1,1-Dichloroethane	02/22/2006	5.6	ug/l	5	70	
LE-1	Xylenes	02/22/2006	109	ug/l	5	530	
LE-1	**1,4-Dichlorobenzene**	**02/22/2006**	**12.2**	**ug/l**	**5**	**1.4**	**10.8**
LE-1	Ethylbenzene	02/22/2006	42.3	ug/l	5	550	
LE-1	**Benzene**	**02/22/2006**	**5**	**ug/l**	**5**	**1**	**4**
LE-1	Toluene	02/22/2006	6.5	ug/l	5	1000	
LE-2	**1,2-Dichloroethane**	**02/22/2006**	**6.2**	**ug/l**	**5**	**0.38**	**5.82**
LE-2	Toluene	02/22/2006	248	ug/l	5	1000	
LE-2	Ethylbenzene	02/22/2006	9.3	ug/l	5	550	
LE-2	Xylenes	02/22/2006	25.5	ug/l	5	530	
LE-2	**Acetone**	**02/22/2006**	**1090**	**ug/l**	**100**	**700**	**390**
LE-2	**Methylene Chloride**	**02/22/2006**	**38.1**	**ug/l**	**10**	**5**	**33.1**
LE-2	2-Butanone	02/22/2006	3470	ug/l	100	4200	
LE-2	**Benzene**	**02/22/2006**	**5.5**	**ug/l**	**5**	**1**	**4.5**

[1] Table only contains detected constituents.
[2] PQL = Practical Quantitation Limit
[3] NCGW2L = North Carolina Ground Water 2L Standard

Hydrologic Properties at Monitoring Well Locations
Wayne County Subtitle D Landfill

Monitoring Well	Hydraulic Conductivity (cm/sec)	Effective Porosity (%)	Hydraulic Gradient	Flow Rate (ft/yr)	Flow Direction
MW-1	3.21E-04	31%	0.011	11.45	S78W
MW-2	1.37E-03	31%	0.006	28.00	N72W
MW-3	9.72E-04	31%	0.007	23.89	S86W
MW-4	2.33E-04	9%	0.014	36.62	N54W
MW-5	1.45E-04	9%	0.015	25.46	N89W
MW-6	8.38E-05	31%	0.011	3.14	S87W
MW-7	6.84E-05	9%	0.017	13.74	N56W
MW-8	1.68E-04	9%	0.015	28.43	S74W
MW-9	6.37E-04	31%	0.004	7.75	S89W
MW-10	4.74E-04	31%	0.132	208.59	S9W
MW-11	1.46E-04	22%	0.009	6.19	S89W
MW-12	1.63E-04	22%	0.011	8.22	N78W
MW-13	2.14E-03	22%	0.010	104.98	S80W

NOTE: Data for effective porosity obtained from Design Hydrogeologic Study for Wayne County.
Hydraulic Conductivity values were obtained from slug tests performed on each monitoring well.
Hydrologic Gradient taken from the February 22, 2006 sampling event.
Flow rate (Q) is defined by the equation:

where

$$Q = -\frac{K}{n_e} \cdot \frac{dh}{dl}$$

K= hydraulic conductivity
ne= effective porosity
dh= head difference
dl= horizontal distance

Statistical Analysis Results Summary

Inter-Well Analysis Summary
Wayne County Subtitle D Lined Landfill

Background Well: MW-1

Arsenic, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
94.74	-	Poisson tolerance interval	ND	17.5	ug/l

Well	Result	Significance
MW-2	22	yes
MW-12	20	yes

Barium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100	-	Non-Parametric Tolerance interval	ND	250	ug/l

Well	Result	Significance
MW-12	757	yes

Beryllium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
94.74	-	Poisson tolerance interval	ND	5.5	ug/l

Well	Result	Significance
MW-12	5	no

Cadmium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
100.00	-	Poisson tolerance interval	ND	3.5	ug/l

Well	Result	Significance
MW-12	2	no

Chromium, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
31.58	-	Non-Parametric Tolerance interval	1/2ND	129	ug/l

Well	Result	Significance
MW-2	44	no
MW-12	24	no

Lead, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
52.63	-	Non-Parametric Tolerance interval	1/2ND	76	ug/l

Well	Result	Significance
MW-2	46	no
MW-12	21	no

Zinc, total

%ND	Normality	Method	ND Adj.	Upper Limit (a = 95%)	Unit
94.74	-	Non-Parametric Tolerance interval	ND	148.0	ug/l

Well	Result	Significance
MW-8	77	no
MW-12	112	no

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

Intra-Well Analysis Summary (Metals)
Wayne County Subtitle D Lined Landfill

Well	Arsenic	Barium
MW-2	n/a	
MW-12	n/a	n/a

EXPLANATION

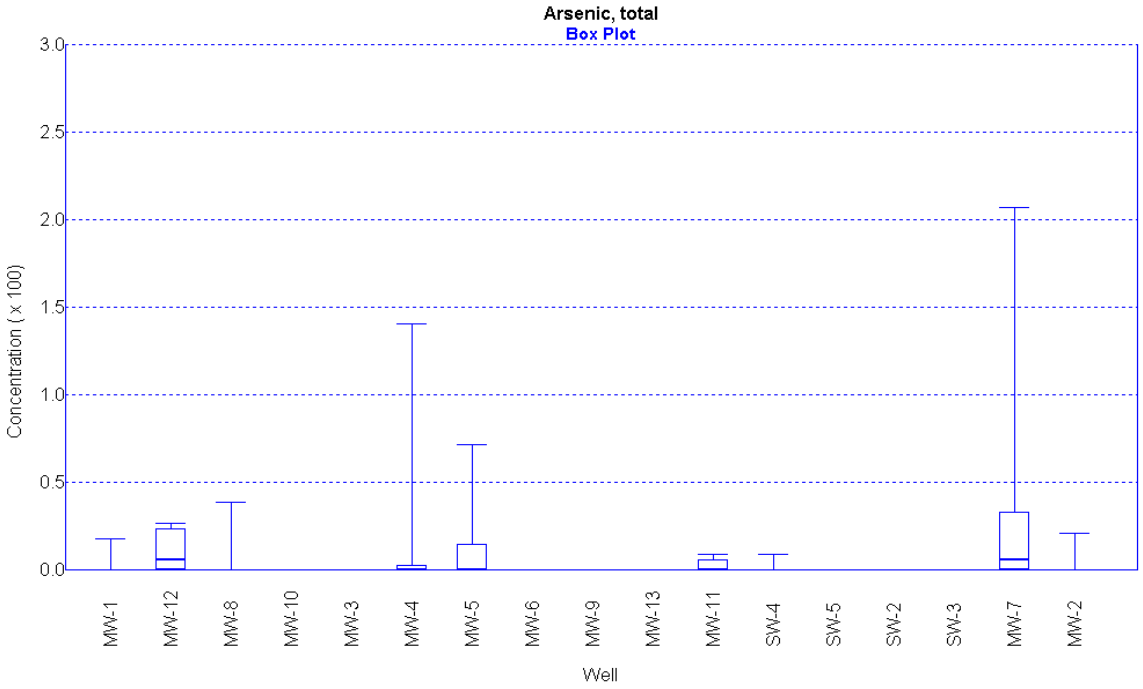
yes=detection statistically significant by intrawell analysis

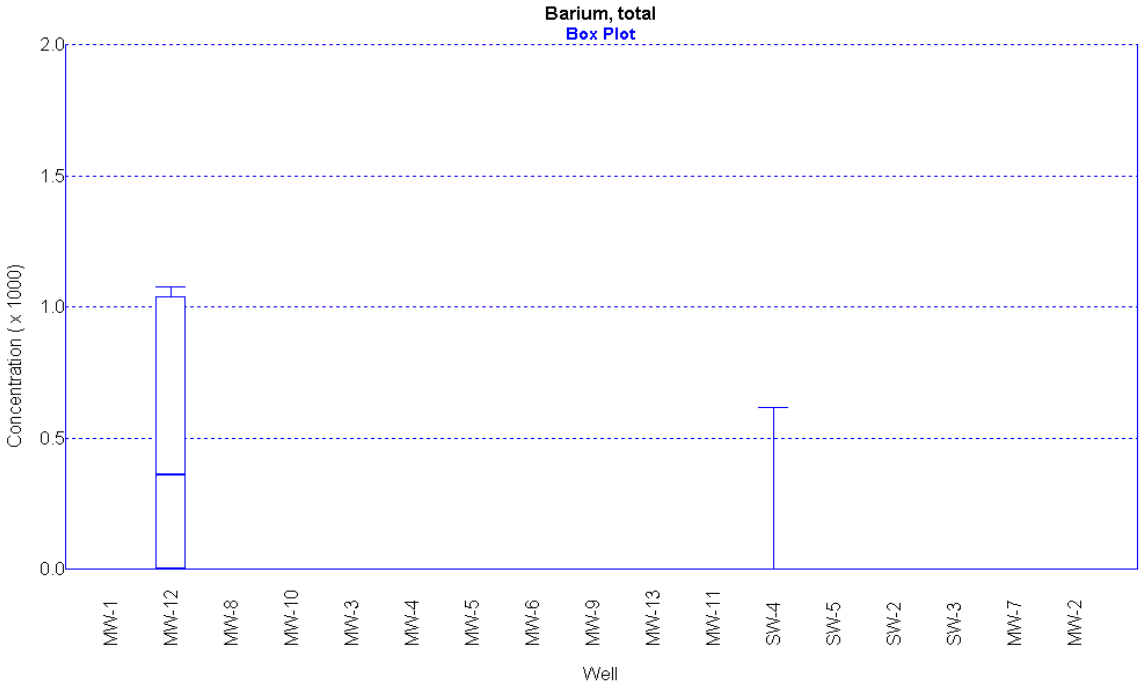
no=detection not statistically significant by intrawell analysis

n/a=Intrawell analysis could not be conducted due to the lack of sampling events or detection rate.

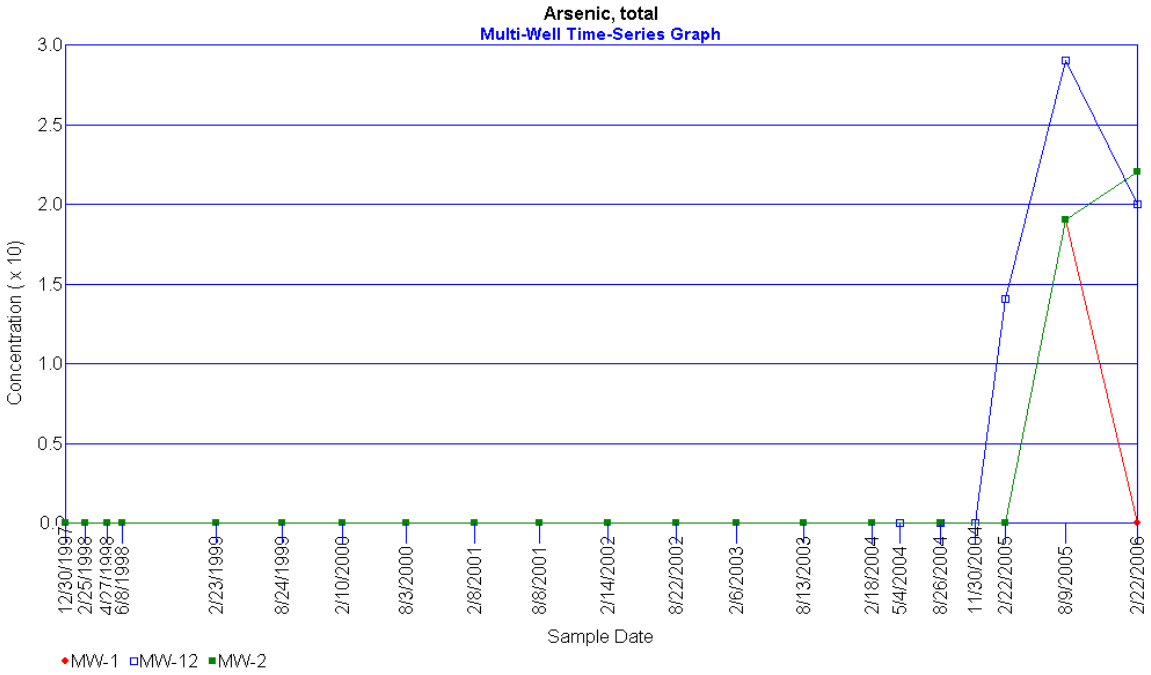
Unable to determine if metals have Increased according to Intrawell Analysis

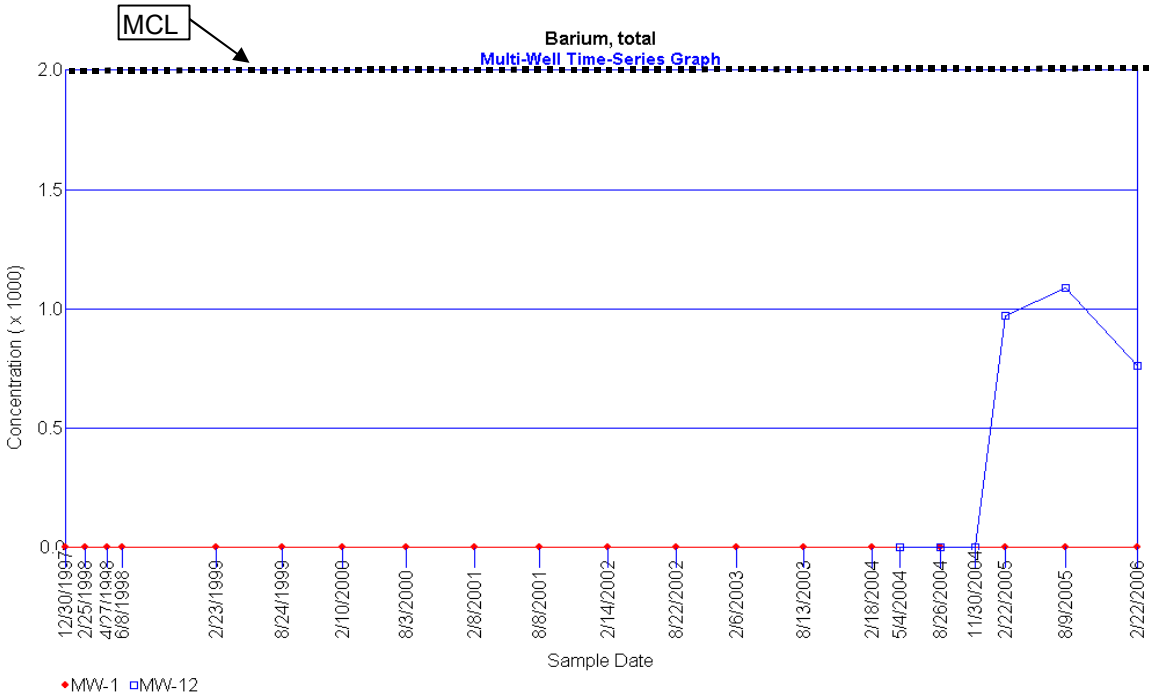
Box Plots for Select Constituents
Wayne County Subtitle D Lined Landfill





Time Series Plots for Select Constituents
Wayne County Subtitle D Lined Landfill





Basic Statistics

Basic Statistics

Parameter: Beryllium, total

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

	Total Observations
274	
Total Non-Detects	260
Pooled Mean	1.18996
Pooled Std Dev	0.970483
Background Mean	1.11105
Background Std Dev	0.484067

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	19	18	94.7368	21.11

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	1.11105	0.484067	0	2614	137.579

Compliance Wells

There are 16 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-10	21	21	100	21
MW-2	19	17	89.4737	23.91
MW-3	20	20	100	20
MW-4	20	19	95	21
MW-5	20	20	100	20
MW-6	19	19	100	19
MW-7	22	17	77.2727	47.33
MW-8	19	17	89.4737	25.7
MW-9	20	20	100	20
MW-13	6	6	100	6
MW-12	6	3	50	18
MW-11	6	6	100	6
SW-4	19	19	100	19
SW-5	4	4	100	4
SW-2	15	15	100	15
SW-3	19	19	100	19

Well	Mean	Std Dev	Dif From Bk	Std Err	Rank Sum	Rank Mean
MW-10	1	0	-0.111053	0.286163	2740.5	130.5
MW-2	1.25842	0.913457	0.147368	0.29323	2748.5	144.658
MW-3	1	0	-0.111053	0.289541	2610	130.5
MW-4	1.05	0.223607	-0.0610526	0.289541	2741.5	137.075
MW-5	1	0	-0.111053	0.289541	2610	130.5
MW-6	1	0	-0.111053	0.29323	2479.5	130.5
MW-7	2.15136	2.55804	1.04031	0.283057	3564.5	162.023
MW-8	1.35263	1.06268	0.241579	0.29323	2753.5	144.921
MW-9	1	0	-0.111053	0.289541	2610	130.5
MW-13	1	0	-0.111053	0.423241	783	130.5
MW-12	3	2.52982	1.88895	0.423241	1198.5	199.75
MW-11	1	0	-0.111053	0.423241	783	130.5
SW-4	1	0	-0.111053	0.29323	2479.5	130.5
SW-5	1	0	-0.111053	0.497195	522	130.5
SW-2	1	0	-0.111053	0.312167	1957.5	130.5
SW-3	1	0	-0.111053	0.29323	2479.5	130.5

Analysis of Variance Statistics

SS Wells	47.1922
SS Total	257.121

Kruskal-Wallis Statistics

Non-Detect Rank	130.5
Background Rank Sum	2614
Background Rank Mean	137.579
H Statistic	7.45082
H Adjusted for Ties	51.1777

Basic Statistics

Parameter: Barium, total

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

	Total Observations
274	
Total Non-Detects	270
Pooled Mean	258.898
Pooled Std Dev	76.2802
Background Mean	250
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	19	19	100	4750

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	250	0	0	2574.5	135.5

Compliance Wells

There are 16 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-10	21	21	100	5250
MW-2	19	19	100	4750
MW-3	20	20	100	5000
MW-4	20	20	100	5000
MW-5	20	20	100	5000
MW-6	19	19	100	4750
MW-7	22	22	100	5500
MW-8	19	19	100	4750
MW-9	20	20	100	5000
MW-13	6	6	100	1500
MW-12	6	3	50	3557
MW-11	6	6	100	1500
SW-4	19	18	94.7368	5131
SW-5	4	4	100	1000
SW-2	15	15	100	3750
SW-3	19	19	100	4750

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-10	250	0	0	18.7092	2845.5	135.5
MW-2	250	0	0	19.1712	2574.5	135.5
MW-3	250	0	0	18.9301	2710	135.5
MW-4	250	0	0	18.9301	2710	135.5
MW-5	250	0	0	18.9301	2710	135.5
MW-6	250	0	0	19.1712	2574.5	135.5
MW-7	250	0	0	18.5061	2981	135.5
MW-8	250	0	0	19.1712	2574.5	135.5
MW-9	250	0	0	18.9301	2710	135.5
MW-13	250	0	0	27.6713	813	135.5
MW-12	592.833	389.825	342.833	27.6713	1225.5	204.25
MW-11	250	0	0	27.6713	813	135.5
SW-4	270.053	87.4074	20.0526	19.1712	2710	142.632
SW-5	250	0	0	32.5064	542	135.5
SW-2	250	0	0	20.4093	2032.5	135.5
SW-3	250	0	0	19.1712	2574.5	135.5

Analysis of Variance Statistics

SS Wells	691155
SS Total	1.5885e+006

Kruskal-Wallis Statistics

Non-Detect Rank	135.5
Background Rank Sum	2574.5
Background Rank Mean	135.5
H Statistic	4.49577
H Adjusted for Ties	104.166

Basic Statistics

Parameter: Arsenic, total

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

	Total Observations
274	
Total Non-Detects	241
Pooled Mean	8.59489
Pooled Std Dev	16.6353
Background Mean	5.73684
Background Std Dev	3.21182

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	19	18	94.7368	109

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	5.73684	3.21182	0	2429	127.842

Compliance Wells

There are 16 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-10	21	21	100	105
MW-2	19	17	89.4737	126
MW-3	20	20	100	100
MW-4	20	15	75	312
MW-5	20	14	70	251
MW-6	19	19	100	95
MW-7	22	11	50	552
MW-8	19	16	84.2105	172
MW-9	20	20	100	100
MW-13	6	6	100	30
MW-12	6	3	50	78
MW-11	6	5	83.3333	35
SW-4	19	18	94.7368	100
SW-5	4	4	100	20
SW-2	15	15	100	75
SW-3	19	19	100	95

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-10	5	0	-0.736842	5.07626	2541	121
MW-2	6.63158	4.91269	0.894737	5.20161	2565	135
MW-3	5	0	-0.736842	5.13618	2420	121
MW-4	15.6	31.2265	9.86316	5.13618	3113	155.65
MW-5	12.55	16.0901	6.81316	5.13618	3246	162.3
MW-6	5	0	-0.736842	5.20161	2299	121
MW-7	25.0909	43.4083	19.3541	5.02116	4199	190.864
MW-8	9.05263	10.2224	3.31579	5.20161	2723	143.316
MW-9	5	0	-0.736842	5.13618	2420	121
MW-13	5	0	-0.736842	7.50788	726	121
MW-12	13	9.97998	7.26316	7.50788	1128	188
MW-11	5.83333	2.04124	0.0964912	7.50788	847	141.167
SW-4	5.26316	1.14708	-0.473684	5.20161	2421	127.421
SW-5	5	0	-0.736842	8.81976	484	121
SW-2	5	0	-0.736842	5.53754	1815	121
SW-3	5	0	-0.736842	5.20161	2299	121

Analysis of Variance Statistics

SS Wells	9488.89
SS Total	75548

Kruskal-Wallis Statistics

Non-Detect Rank	121
Background Rank Sum	2429
Background Rank Mean	127.842
H Statistic	21.5225
H Adjusted for Ties	67.3529

Basic Statistics

Parameter: Cadmium

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

	Total Observations
274	
Total Non-Detects	256
Pooled Mean	0.605474
Pooled Std Dev	0.448856
Background Mean	0.5
Background Std Dev	0

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	19	19	100	9.5

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	0.5	0	0	2441.5	128.5

Compliance Wells

There are 16 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-10	21	21	100	10.5
MW-2	19	19	100	9.5
MW-3	20	20	100	10
MW-4	20	19	95	12.5
MW-5	20	19	95	10.6
MW-6	19	19	100	9.5
MW-7	22	20	90.9091	12
MW-8	19	17	89.4737	12.3
MW-9	20	19	95	11.5
MW-13	6	5	83.3333	4.5
MW-12	6	4	66.6667	6
MW-11	6	6	100	3
SW-4	19	16	84.2105	15
SW-5	4	3	75	3.5
SW-2	15	11	73.3333	16.5
SW-3	19	19	100	9.5

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-10	0.5	0	0	0.136434	2698.5	128.5
MW-2	0.5	0	0	0.139804	2441.5	128.5
MW-3	0.5	0	0	0.138045	2570	128.5
MW-4	0.625	0.559017	0.125	0.138045	2711.5	135.575
MW-5	0.53	0.134164	0.03	0.138045	2701.5	135.075
MW-6	0.5	0	0	0.139804	2441.5	128.5
MW-7	0.545455	0.147122	0.0454545	0.134954	3085	140.227
MW-8	0.647368	0.442679	0.147368	0.139804	2707.5	142.5
MW-9	0.575	0.33541	0.075	0.138045	2704.5	135.225
MW-13	0.75	0.612372	0.25	0.201789	906.5	151.083
MW-12	1	0.774597	0.5	0.201789	1045	174.167
MW-11	0.5	0	0	0.201789	771	128.5
SW-4	0.789474	0.713283	0.289474	0.139804	2862	150.632
SW-5	0.875	0.75	0.375	0.237049	654.5	163.625
SW-2	1.1	1.18322	0.6	0.148832	2491.5	166.1
SW-3	0.5	0	0	0.139804	2441.5	128.5

Analysis of Variance Statistics

SS Wells	7.28248
SS Total	55.0018

Kruskal-Wallis Statistics

Non-Detect Rank	128.5
Background Rank Sum	2441.5
Background Rank Mean	128.5
H Statistic	6.10692
H Adjusted for Ties	33.1145

Basic Statistics

Parameter: Chromium

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

	Total Observations
274	
Total Non-Detects	159
Pooled Mean	20.2445
Pooled Std Dev	32.0007
Background Mean	40.2632
Background Std Dev	39.4572

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	19	6	31.5789	765

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	40.2632	39.4572	0	3548	186.737

Compliance Wells

There are 16 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-10	21	9	42.8571	230
MW-2	19	6	31.5789	1384
MW-3	20	18	90	141
MW-4	20	13	65	402
MW-5	20	7	35	455
MW-6	19	9	47.3684	290
MW-7	22	10	45.4545	429
MW-8	19	10	52.6316	416
MW-9	20	11	55	337
MW-13	6	4	66.6667	59
MW-12	6	3	50	158
MW-11	6	4	66.6667	58
SW-4	19	17	89.4737	138
SW-5	4	4	100	20
SW-2	15	10	66.6667	160
SW-3	19	18	94.7368	105

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-10	10.9524	6.82991	-29.3108	8.87744	2907	138.429
MW-2	72.8421	71.5008	32.5789	9.09666	3764	198.105
MW-3	7.05	7.02233	-33.2132	8.98224	1867	93.35
MW-4	20.1	31.8647	-20.1632	8.98224	2566	128.3
MW-5	22.75	24.2593	-17.5132	8.98224	3311	165.55
MW-6	15.2632	13.9994	-25	9.09666	2809	147.842
MW-7	19.5	23.8342	-20.7632	8.78108	3342	151.909
MW-8	21.8947	32.9678	-18.3684	9.09666	2767	145.632
MW-9	16.85	19.3425	-23.4132	8.98224	2829	141.45
MW-13	9.83333	7.49444	-30.4298	13.1299	733	122.167
MW-12	26.3333	29.4324	-13.9298	13.1299	951	158.5
MW-11	9.66667	8.16497	-30.5965	13.1299	715	119.167
SW-4	7.26316	6.83002	-33	9.09666	1801	94.7895
SW-5	5	0	-35.2632	15.4241	320	80
SW-2	10.6667	10.8012	-29.5965	9.68414	1813	120.867
SW-3	5.52632	2.29416	-34.7368	9.09666	1632	85.8947

Analysis of Variance Statistics

SS Wells	77532.2
SS Total	279565

Kruskal-Wallis Statistics

Non-Detect Rank	80
Background Rank Sum	3548
Background Rank Mean	186.737
H Statistic	46.0498
H Adjusted for Ties	57.2333

Basic Statistics

Parameter: Lead

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

	Total Observations
274	
Total Non-Detects	208
Pooled Mean	9.91971
Pooled Std Dev	12.2316
Background Mean	13.7895
Background Std Dev	16.5448

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	19	10	52.6316	262

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	13.7895	16.5448	0	3159	166.263

Compliance Wells

There are 16 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-10	21	19	90.4762	136
MW-2	19	7	36.8421	537
MW-3	20	18	90	130
MW-4	20	17	85	162
MW-5	20	14	70	189
MW-6	19	12	63.1579	169
MW-7	22	18	81.8182	173
MW-8	19	15	78.9474	154
MW-9	20	17	85	144
MW-13	6	4	66.6667	66
MW-12	6	2	33.3333	147
MW-11	6	4	66.6667	55
SW-4	19	16	84.2105	166
SW-5	4	4	100	20
SW-2	15	12	80	113
SW-3	19	19	100	95

Well	Mean	Std Dev	Dif From Bkg	Std Err	Rank Sum	Rank Mean
MW-10	6.47619	4.97613	-7.31328	3.49616	2465.5	117.405
MW-2	28.2632	27.5738	14.4737	3.5825	3833.5	201.763
MW-3	6.5	4.66228	-7.28947	3.53743	2361	118.05
MW-4	8.1	9.21041	-5.68947	3.53743	2505.5	125.275
MW-5	9.45	7.75598	-4.33947	3.53743	2881	144.05
MW-6	8.89474	6.34993	-4.89474	3.5825	2839	149.421
MW-7	7.86364	7.07979	-5.92584	3.45821	2840	129.091
MW-8	8.10526	6.65745	-5.68421	3.5825	2523.5	132.816
MW-9	7.2	5.80925	-6.58947	3.53743	2491.5	124.575
MW-13	11	12	-2.78947	5.17089	897	149.5
MW-12	24.5	17.6607	10.7105	5.17089	1244	207.333
MW-11	9.16667	7.05455	-4.62281	5.17089	887	147.833
SW-4	8.73684	12.4715	-5.05263	3.5825	2390	125.789
SW-5	5	0	-8.78947	6.07442	418	104.5
SW-2	7.53333	6.05766	-6.25614	3.81386	1954	130.267
SW-3	5	0	-8.78947	3.5825	1985.5	104.5

Analysis of Variance Statistics

SS Wells	9509.28
SS Total	40844.2

Kruskal-Wallis Statistics

Non-Detect Rank	104.5
Background Rank Sum	3159
Background Rank Mean	166.263
H Statistic	28.8723
H Adjusted for Ties	51.3244

Basic Statistics

Parameter: Zinc

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

	Total Observations
274	
Total Non-Detects	234
Pooled Mean	50.1204
Pooled Std Dev	120.435
Background Mean	31.4737
Background Std Dev	28.2181

Background Wells

There is 1 background well

Well	Samples	Non-Detects	% ND	Total
MW-1	19	18	94.7368	598

Well	Mean	Std Dev	Std Err	Rank Sum	Rank Mean
MW-1	31.4737	28.2181	0	2374	124.947

Compliance Wells

There are 16 compliance wells

Well	Samples	Non-Detects	% ND	Total
MW-10	21	20	95.2381	575
MW-2	19	17	89.4737	573
MW-3	20	20	100	500
MW-4	20	19	95	620
MW-5	20	18	90	595
MW-6	19	19	100	475
MW-7	22	17	77.2727	1051
MW-8	19	7	36.8421	2115
MW-9	20	20	100	500
MW-13	6	6	100	150
MW-12	6	2	33.3333	591
MW-11	6	6	100	150
SW-4	19	18	94.7368	557
SW-5	4	3	75	164
SW-2	15	8	53.3333	3723
SW-3	19	16	84.2105	796

Well	Mean	Std Dev	Dif From Bk	Std Err	Rank Sum	Rank Mean
MW-10	27.381	10.9109	-4.09273	35.2788	2596	123.619
MW-2	30.1579	16.3444	-1.31579	36.15	2487.5	130.921
MW-3	25	0	-6.47368	35.6953	2350	117.5
MW-4	31	26.8328	-0.473684	35.6953	2490.5	124.525
MW-5	29.75	16.199	-1.72368	35.6953	2604	130.2
MW-6	25	0	-6.47368	36.15	2232.5	117.5
MW-7	47.7727	47.8131	16.299	34.8959	3269.5	148.614
MW-8	111.316	157.434	79.8421	36.15	3841.5	202.184
MW-9	25	0	-6.47368	35.6953	2350	117.5
MW-13	25	0	-6.47368	52.178	705	117.5
MW-12	98.5	70.9359	67.0263	52.178	1260	210
MW-11	25	0	-6.47368	52.178	705	117.5
SW-4	29.3158	18.8121	-2.15789	36.15	2371	124.789
SW-5	41	32	9.52632	61.2953	603.5	150.875
SW-2	248.2	428.638	216.726	38.4846	2796	186.4
SW-3	41.8947	52.4117	10.4211	36.15	2639	138.895

Analysis of Variance Statistics

SS Wells	769143
SS Total	3.95975e+006

Kruskal-Wallis Statistics

Non-Detect Rank	117.5
Background Rank Sum	2374
Background Rank Mean	124.947
H Statistic	30.9177
H Adjusted for Ties	81.9803

Interwell Analyses for Metals

Poisson Tolerance Limit

Parameter: Cadmium

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

Poisson Count of 19 background Samples = 19
Degrees of Freedom = 40

95% Confidence Values

Chi-Squared Value (95% Confidence) = 55.7585
Lambda (from Zack's formula) = 1.46733
Smallest Degrees of Freedom = 9
Upper Tolerance Limit (95%) = 3.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 63.6908
Lambda (from Zack's formula) = 1.67607
Smallest Degrees of Freedom = 12
Upper Tolerance Limit (99%) = 5

	Date	Result	Impacted 95%	Impacted 99%
MW-12	5/4/2004	ND<1	FALSE	FALSE
	8/26/2004	ND<1	FALSE	FALSE
	11/30/2004	ND<1	FALSE	FALSE
	2/22/2005	ND<1	FALSE	FALSE
	8/9/2005	2	FALSE	FALSE
	2/22/2006	2	FALSE	FALSE

Poisson Tolerance Limit

Parameter: Barium, total

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

Poisson Count of 19 background Samples = 9500
The Poisson count of background samples (9500) exceeds the maximum of 420
Degrees of Freedom = 19002

95% Confidence Values

Chi-Squared Value (95% Confidence) = 0
Lambda (from Zack's formula) = 0
Smallest Degrees of Freedom = 1
Upper Tolerance Limit (95%) = -0.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 0
Lambda (from Zack's formula) = 0
Smallest Degrees of Freedom = 1
Upper Tolerance Limit (99%) = -0.5

	Date	Result	Impacted 95%	Impacted 99%
MW-12	5/4/2004	ND<500	TRUE	TRUE
	8/26/2004	ND<500	TRUE	TRUE
	11/30/2004	ND<500	TRUE	TRUE
	2/22/2005	967	TRUE	TRUE
	8/9/2005	1083	TRUE	TRUE
	2/22/2006	757	TRUE	TRUE

Non-Parametric Tolerance Interval

Parameter: Barium, total

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

Total Percent Non-Detects = 88%
Background Samples (n) = 19
Maximum Background Concentration = 250
Minimum Coverage = 85.4%
Average Coverage = 95%

Well	Sample	Result	Impacted
MW-12	5/4/2004	ND<250	FALSE
MW-12	8/26/2004	ND<250	FALSE
MW-12	11/30/2004	ND<250	FALSE
MW-12	2/22/2005	967	TRUE
MW-12	8/9/2005	1083	TRUE
MW-12	2/22/2006	757	TRUE

Poisson Tolerance Limit

Parameter: Beryllium, total

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

Poisson Count of 19 background Samples = 39.11
Degrees of Freedom = 80

95% Confidence Values

Chi-Squared Value (95% Confidence) = 101.879
Lambda (from Zack's formula) = 2.68104
Smallest Degrees of Freedom = 13
Upper Tolerance Limit (95%) = 5.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 112.329
Lambda (from Zack's formula) = 2.95602
Smallest Degrees of Freedom = 17
Upper Tolerance Limit (99%) = 7.5

	Date	Result	Impacted 95%	Impacted 99%
MW-12	5/4/2004	ND<2	FALSE	FALSE
	8/26/2004	3	FALSE	FALSE
	11/30/2004	ND<2	FALSE	FALSE
	2/22/2005	ND<2	FALSE	FALSE
	8/9/2005	7	TRUE	FALSE
	2/22/2006	5	FALSE	FALSE

Poisson Tolerance Limit

Parameter: Arsenic, total

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

Poisson Count of 19 background Samples = 199
Degrees of Freedom = 400

95% Confidence Values

Chi-Squared Value (95% Confidence) = 447.632
Lambda (from Zack's formula) = 11.7798
Smallest Degrees of Freedom = 37
Upper Tolerance Limit (95%) = 17.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 468.724
Lambda (from Zack's formula) = 12.3349
Smallest Degrees of Freedom = 44
Upper Tolerance Limit (99%) = 21

	Date	Result	Impacted 95%	Impacted 99%
MW-12	5/4/2004	ND<10	FALSE	FALSE
	8/26/2004	ND<10	FALSE	FALSE
	11/30/2004	ND<10	FALSE	FALSE
	2/22/2005	14	FALSE	FALSE
	8/9/2005	29	TRUE	TRUE
	2/22/2006	20	TRUE	FALSE
MW-2	12/30/1997	ND<10	FALSE	FALSE
	2/25/1998	ND<10	FALSE	FALSE
	4/27/1998	ND<10	FALSE	FALSE
	6/8/1998	ND<10	FALSE	FALSE
	2/23/1999	ND<10	FALSE	FALSE
	8/24/1999	ND<10	FALSE	FALSE
	2/10/2000	ND<10	FALSE	FALSE
	8/3/2000	ND<10	FALSE	FALSE
	2/8/2001	ND<10	FALSE	FALSE
	8/8/2001	ND<10	FALSE	FALSE
	2/14/2002	ND<10	FALSE	FALSE
	8/22/2002	ND<10	FALSE	FALSE
	2/6/2003	ND<10	FALSE	FALSE
	8/13/2003	ND<10	FALSE	FALSE
	2/18/2004	ND<10	FALSE	FALSE
	8/26/2004	ND<10	FALSE	FALSE
	2/22/2005	ND<10	FALSE	FALSE
	8/9/2005	19	TRUE	FALSE
	2/22/2006	22	TRUE	TRUE

Non-Parametric Tolerance Interval

Parameter: Chromium

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

Total Percent Non-Detects = 34.0909%
Background Samples (n) = 19
Maximum Background Concentration = 129
Minimum Coverage = 85.4%
Average Coverage = 95%

Well	Sample	Result	Impacted
MW-12	5/4/2004	ND<5	FALSE
MW-12	8/26/2004	ND<5	FALSE
MW-12	11/30/2004	ND<5	FALSE
MW-12	2/22/2005	79	FALSE
MW-12	8/9/2005	40	FALSE
MW-12	2/22/2006	24	FALSE
MW-2	12/30/1997	144	TRUE
MW-2	2/25/1998	126	FALSE
MW-2	4/27/1998	46	FALSE
MW-2	6/8/1998	ND<5	FALSE
MW-2	2/23/1999	ND<5	FALSE
MW-2	8/24/1999	ND<5	FALSE
MW-2	2/10/2000	ND<5	FALSE
MW-2	8/3/2000	119	FALSE
MW-2	2/8/2001	15	FALSE
MW-2	8/8/2001	94	FALSE
MW-2	2/14/2002	ND<5	FALSE
MW-2	8/22/2002	ND<5	FALSE
MW-2	2/6/2003	221	TRUE
MW-2	8/13/2003	173	TRUE
MW-2	2/18/2004	36	FALSE
MW-2	8/26/2004	143	TRUE
MW-2	2/22/2005	166	TRUE
MW-2	8/9/2005	27	FALSE
MW-2	2/22/2006	44	FALSE

Non-Parametric Tolerance Interval

Parameter: Lead

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

Total Percent Non-Detects = 43.1818%
Background Samples (n) = 19
Maximum Background Concentration = 76
Minimum Coverage = 85.4%
Average Coverage = 95%

Well	Sample	Result	Impacted
MW-12	5/4/2004	ND<5	FALSE
MW-12	8/26/2004	37	FALSE
MW-12	11/30/2004	ND<5	FALSE
MW-12	2/22/2005	49	FALSE
MW-12	8/9/2005	30	FALSE
MW-12	2/22/2006	21	FALSE
MW-2	12/30/1997	108	TRUE
MW-2	2/25/1998	23	FALSE
MW-2	4/27/1998	30	FALSE
MW-2	6/8/1998	ND<5	FALSE
MW-2	2/23/1999	ND<5	FALSE
MW-2	8/24/1999	ND<5	FALSE
MW-2	2/10/2000	ND<5	FALSE
MW-2	8/3/2000	25	FALSE
MW-2	2/8/2001	28	FALSE
MW-2	8/8/2001	ND<5	FALSE
MW-2	2/14/2002	ND<5	FALSE
MW-2	8/22/2002	ND<5	FALSE
MW-2	2/6/2003	53	FALSE
MW-2	8/13/2003	36	FALSE
MW-2	2/18/2004	23	FALSE
MW-2	8/26/2004	14	FALSE
MW-2	2/22/2005	42	FALSE
MW-2	8/9/2005	74	FALSE
MW-2	2/22/2006	46	FALSE

Poisson Tolerance Limit

Parameter: Zinc

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

Poisson Count of 19 background Samples = 1048
The Poisson count of background samples (1048) exceeds the maximum of 420
Degrees of Freedom = 2098

95% Confidence Values

Chi-Squared Value (95% Confidence) = 0
Lambda (from Zack's formula) = 0
Smallest Degrees of Freedom = 1
Upper Tolerance Limit (95%) = -0.5

99% Confidence Values

Chi-Squared Value (99% Confidence) = 0
Lambda (from Zack's formula) = 0
Smallest Degrees of Freedom = 1
Upper Tolerance Limit (99%) = -0.5

	Date	Result	Impacted 95%	Impacted 99%
MW-12	5/4/2004	ND<50	TRUE	TRUE
	8/26/2004	69	TRUE	TRUE
	11/30/2004	ND<50	TRUE	TRUE
	2/22/2005	177	TRUE	TRUE
	8/9/2005	183	TRUE	TRUE
	2/22/2006	112	TRUE	TRUE
MW-8	12/30/1997	481	TRUE	TRUE
	2/25/1998	599	TRUE	TRUE
	4/27/1998	70	TRUE	TRUE
	6/8/1998	ND<50	TRUE	TRUE
	2/23/1999	ND<50	TRUE	TRUE
	8/24/1999	ND<50	TRUE	TRUE
	2/10/2000	ND<50	TRUE	TRUE
	8/3/2000	75	TRUE	TRUE
	2/8/2001	52	TRUE	TRUE
	8/8/2001	85	TRUE	TRUE
	2/14/2002	ND<50	TRUE	TRUE
	8/22/2002	ND<50	TRUE	TRUE
	2/6/2003	189	TRUE	TRUE
	8/13/2003	94	TRUE	TRUE
	2/18/2004	ND<50	TRUE	TRUE
	8/26/2004	63	TRUE	TRUE
	2/22/2005	70	TRUE	TRUE
	8/9/2005	85	TRUE	TRUE
	2/22/2006	77	TRUE	TRUE

Non-Parametric Tolerance Interval

Parameter: Zinc

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

Total Percent Non-Detects = 61.3636%
Background Samples (n) = 19
Maximum Background Concentration = 148
Minimum Coverage = 85.4%
Average Coverage = 95%

Well	Sample	Result	Impacted
MW-12	5/4/2004	ND<25	FALSE
MW-12	8/26/2004	69	FALSE
MW-12	11/30/2004	ND<25	FALSE
MW-12	2/22/2005	177	TRUE
MW-12	8/9/2005	183	TRUE
MW-12	2/22/2006	112	FALSE
MW-8	12/30/1997	481	TRUE
MW-8	2/25/1998	599	TRUE
MW-8	4/27/1998	70	FALSE
MW-8	6/8/1998	ND<25	FALSE
MW-8	2/23/1999	ND<25	FALSE
MW-8	8/24/1999	ND<25	FALSE
MW-8	2/10/2000	ND<25	FALSE
MW-8	8/3/2000	75	FALSE
MW-8	2/8/2001	52	FALSE
MW-8	8/8/2001	85	FALSE
MW-8	2/14/2002	ND<25	FALSE
MW-8	8/22/2002	ND<25	FALSE
MW-8	2/6/2003	189	TRUE
MW-8	8/13/2003	94	FALSE
MW-8	2/18/2004	ND<25	FALSE
MW-8	8/26/2004	63	FALSE
MW-8	2/22/2005	70	FALSE
MW-8	8/9/2005	85	FALSE
MW-8	2/22/2006	77	FALSE