DEPARTMENT OF ECOLOGY

February 20, 2015

TO: Jason Shira, Hydrogeologist, TCP

FROM: Arthur Buchan, Toxicologist, TCP

SUBJECT: Comments on a Site-Specific Natural Background Calculation

The purpose of this memorandum is to memorialize an interpretation from the Toxics Cleanup Program (Policy and Technical Support Unit) regarding site-specific natural background calculations to be used as cleanup levels for upland soils. This memorandum is specific as it pertains to the Monte-Cristo Mining area found in Central Washington. This interpretation is derived from policy and procedures found in the Model Toxics Control Act, WAC 173-340.

Location of Sampling: Natural Background is defined in WAC 173-340-200 as:

"Natural Background" means the concentration of a hazardous substance consistently present in the environment that has not been influenced by localized human activities. For example, several metals and radionuclides naturally occur in the bedrock, sediments, and soils of Washington state due solely to geologic processes that formed these materials and the concentration of these hazardous substances would be considered natural background….

"Area Background" means the concentration of hazardous substances that are consistently present in the environment in the vicinity of a site which are the result of human activities unrelated to releases from the site (WAC 173-340-200).

To be considered "Natural Background" (under WAC 173-340-709(2)) the samples are collected from areas that have the same basic characteristics as the medium of concern at the site, have not been influenced by releases from the site, and have not been influenced by releases from other localized human activities. The samples collected for this evaluation are considered appropriately representative of natural background conditions.

Number of Samples: As per WAC 173-340-709(4), a sample size of ten (10) or more background soil samples shall be required when determining natural background concentrations in soil. Forty eight (48) background samples were analyzed for most of the metals. However, the background values calculated for cobalt, iron, and methylmercury were based on only eight (8) samples, and thus are less reliable.

Statistical Analysis: As per WAC 173-340-709, the distribution was calculated using department approved methods (MTCA*Stat*97 Background Module (Ecology, 1997), and Statistical Guidance for Site Managers (Ecology, 1992)). Non-detected observations (below the MDL) were assigned a value based on the Kaplan-Meyer (KM) Product Limit Estimator method as determined by ProUCL 5.0 (USEPA, 2002). This alternate statistical procedure for handling data below the practical quantitation limit was per WAC

173-340-709(5) (c). The true upper 90th percentile and four times the true 50th percentile (whichever is lower) were then calculated using MTCA*Stat*97 Background Module and the procedures listed in WAC 173-340-709(3) (a though e). The lower of these two values was selected as the natural background concentration. Please see appendix A (Monte Cristo BC) for statistical analysis.

Determination of a Background Concentration to be used as a Cleanup Level: Under WAC 173-340-700(6) (d), - when the risk based concentration is below natural background or the PQL, the cleanup level shall be established at a concentration equal to the practical quantitation limit or natural background concentration, whichever is higher. See WAC 173-340-707 and 173-340-709 for additional information. The interpretation of this citation is that the cleanup level would be equal to the calculated natural background concentration when that concentration is higher than the risk based concentration and the concentration that can be reliably measured.

Summary: A site-specific natural background concentration can be used as a cleanup level if it meets the following criteria:

- The areas sampled must not be influenced either by releases from the site, or by releases from other localized human activities.
- The samples must be collected from areas that have the same basic characteristics as the medium of concern at the site.
- The derivation of a natural background calculation requires at least ten samples.
- Department approved statistical methods must be used.
- The natural background calculation is used when it is the highest value among the risk based calculation, the concentration that can be reliably measured, and the natural background calculation.

References:

USEPA. (2002). ProUCL 5.0 based off of; Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9885.6-10, and Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites. EPA 540-R-01-003-OSWER 9285.7-41.

Washington State Department of Ecology. (1992). Statistical Guidance for Site Managers. Publication No. 92-54.

Washington State Department of Ecology. (1997). MTCAStat97 Background Module. No Publication No.

Washington State Department of Ecology. (2007). Model Toxics Control Act Statute and Regulation. Publication No. 94-06.

Appendix A. Monte Cristo BC

Background calculations

0.096	Antimony
0.24	
0.24101	
0.26	
0.32438	
0.32438	
0.32438	
0.36	
0.37	
0.41	
0.77	
1.2	
1.2	
1.3	
1.4	
1.6	
1.6	
1.65	
1.7	
1.88	
1.9	
1.9	
2.39	
2.4	
2.43	
2.5	
2.51	
2.7	
2.9	
2.9	
3	
4.03	
4.1	
4.28	
6.25	
6.5	
7.2	
7.6	
8.2	
8.23	
16.7	
20	
20	
20	
30	
31	
43	
46	

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	6.83
Censored	0	Lognormal mean	7.66
TOTAL	48	Std. devn.	10.85
		Median	2.415
		Min.	0.096
		Max.	46

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.62

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	18.07
1 = Lognormal	50th	2.44
2 = Normal	4 X 50th	9.77
3 = Nonparametric method	Coefficient of Variation = 3.23	

Page 1

1.5
6.1
6.2
6.6
8.4
9.6
9.6
14
19
23.3
25
27
31
44.7
48
48
60
64.5
65
65
69
69
69.9
70
74.8
78.9
81.5
100
100
110
110
110
127
150
160
180
230
260
292
330
380
400
430
430
430
450
590
700

Arsenic

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	149.26
Censored	0	Lognormal mean	191.28
TOTAL	48	Std. devn.	170.25
		Median	72.4
		Min.	1.5
		Max.	700

Lognormal distribution?	Normal distribution?
r-squared is: 0.96	r-squared is: 0.78

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	462.87
1 = Lognormal	50th	70.88
2 = Normal	4 X 50th	283.54
3 = Nonparametric method	Coefficient of Variation = 2.74	

2.9
7.1
8.1
9.6
9.74
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12
12.1
14
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16
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21
23
24.4
26
28
30
30
31
34.2
36
38
40
40.2
43
47
51
52
58.8
65.8
66
66
70.7
72
73
83.1
84.1

Barium

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	40	Mean	35.25
Censored	0	Lognormal mean	37.20
TOTAL	40	Std. devn.	23.26
		Median	30
		Min.	2.9
		Max.	84.1

Lognormal distribution?	Normal distribution?
r-squared is: 0.96	r-squared is: 0.93

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	78.32
1 = Lognormal	50th	27.24
2 = Normal	4 X 50th	108.95
3 = Nonparametric method	Coefficient of Variation = 0.99	

Background calculations

0.051
0.057
0.065
0.08985
0.13
0.14
0.14
0.16
0.16
0.18
0.2
0.21
0.22
0.22
0.23
0.25
0.25
0.26
0.28
0.28
0.3
0.3
0.32
0.33
0.35
0.37
0.39
0.4
0.44
0.45
0.48
0.54
0.59
0.59
0.61
0.62
0.7
0.7
0.73
0.77
0.78
0.8
0.9
0.9
0.95
1
1.1
1.13

Cadmium

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	0.44
Censored	0	Lognormal mean	0.46
TOTAL	48	Std. devn.	0.30
		Median	0.34
		Min.	0.051
		Max.	1.13

Lognormal distribution? r-squared is: 0.97

Normal distribution? r-squared is: 0.93

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	0.96
1 = Lognormal	50th	0.34
2 = Normal	4 X 50th	1.35
3 = Nonparametric method	Coefficient of Variation = 0.98	

0.9 Chromium
3.1
4.5
4.6 MTCA*Stat* 3.0
4.8 Number of samples | Uncensored values
5.1 Uncensored 48 | Mean 23.08
5.2 Censored 0 | Lognormal mean 24.34
6.5 TOTAL 48 | Std. devn. 20.91
6.7 Median 15.5
7.3 Min. 0.9
7.4 Max. 93.5
8.6
9.3 Lognormal distribution? | Normal distribution?
9.7
10 r-squared is: 0.97 | r-squared is: 0.82
11
11 Recommendations:
11
11.2
11.4
12 Use lognormal distribution.
12
14
15
16 Distribution selection | Value corresponding
16 Enter percentile | to that percentile is:
17 1 | 90 | 54.43
17.8 1 = Lognormal | 50th | 15.59
19 2 = Normal | 4 X 50th | 62.35
19 3 = Nonparametric method | Coefficient of Variation = 1.26
19
21
25
26
27
36
39.2
40
40.9
42.7
42.8
47.4
48.9
49.9
53.2
71
77
93.5

Background calculations

2.3	Cobalt
2.9	
3	
3.7	
5.1	
18.8	
29.1	
29.8	

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	8	Mean	11.84
Censored	0	Lognormal mean	12.81
TOTAL	8	Std. devn.	12.13
		Median	4.4
		Min.	2.3
		Max.	29.8

Lognormal distribution?	Normal distribution?
r-squared is: 0.85	r-squared is: 0.77

Recommendations:

Use nonparametric method.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
3	90	N/A
1 = Lognormal	50th	4.40
2 = Normal	4 X 50th	17.60
3 = Nonparametric method	Coefficient of Variation = N/A	

1.1
7.5
8.2
8.9
12
12.9
13
13
13
13.3
14
16
16
16
17
18.5
19
19.7
20
22.4
23.2
24.2
26
27
28
28
28.5
30
31.5
33
33
34.6
40.1
44
51
53.6
73
76
78.7
88
88.7
93.2
130
140
190
200
400
480

Copper

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	59.48
Censored	0	Lognormal mean	56.84
TOTAL	48	Std. devn.	92.07
		Median	27.5
		Min.	1.1
		Max.	480

Lognormal distribution?	Normal distribution?
r-squared is: 0.94	r-squared is: 0.54

Recommendations:

Use lognormal distribution.

Distribution selection		Enter percentile	Value corresponding to that percentile is:
1		90	136.28
1 = Lognormal		50th	31.20
2 = Normal		4 X 50th	124.81
3 = Nonparametric method		Coefficient of Variation = 1.66	

1 Lead
7.4
7.5
7.6 MTCA*Stat* 3.0

Number of samples		Uncensored values	
9.3 Uncensored	48	Mean	45.45
11 Censored	0	Lognormal mean	47.49
11 TOTAL	48	Std. devn.	49.94
11.6		Median	24.5
12		Min.	1
13		Max.	210

13.9
14 Lognormal distribution? Normal distribution?
14.6
15 r-squared is: 0.96 r-squared is: 0.73
17
18.3 Recommendations:
19
20
20
21 Use lognormal distribution.
21.5
22
24

25 Distribution selection		Value corresponding
27	Enter percentile	to that percentile is:
28.2 1	90	110.57
32 1 = Lognormal	50th	27.86
32 2 = Normal	4 X 50th	111.43
34.6 3 = Nonparametric method	Coefficient of Variation = 1.48	

43
45
52.3
53
53
53
59
59
60
66
80
88
91
116
170
170
194
210

Background calculations

10800	Iron
11300	
20200	
22500	
24000	
31000	
37500	
47100	

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	8	Mean	25550.00
Censored	0	Lognormal mean	26176.81
TOTAL	8	Std. devn.	12523.46
		Median	23250
		Min.	10800
		Max.	47100

Lognormal distribution?	Normal distribution?
r-squared is: 0.95	r-squared is: 0.96

Recommendations:

Use lognormal distribution.

Distribution selection		Value corresponding to that percentile is:
1	Enter percentile 90	47852.40
1 = Lognormal	50th	22794.64
2 = Normal	4 X 50th	91178.54
3 = Nonparametric method	Coefficient of Variation = 0.63	

10 Mangenese
19
54
62
66
78
92
94
94
95
101
106
128
130
130
140
160
170
180
190
240
291
300
323
403
466
470
482
560
635
699
783
950
980
986
1010
1200
1200
1300
1300
1400
1500
1540
1700
1800
2260
2400
4680

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	707.44
Censored	0	Lognormal mean	848.44
TOTAL	48	Std. devn.	860.84
		Median	363
		Min.	10
		Max.	4680

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.73

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	2047.79
1 = Lognormal	50th	337.94
2 = Normal	4 X 50th	1351.76
3 = Nonparametric method	Coefficient of Variation = 2.49	

0.033
0.0333
0.037
0.043
0.052
0.056
0.057
0.0583
0.0583
0.064
0.0683
0.081
0.09
0.094
0.098
0.1
0.1
0.11
0.11
0.11
0.11
0.11
0.12
0.12
0.14
0.147
0.16
0.17
0.177
0.19
0.2
0.2
0.2
0.2
0.2
0.21
0.21
0.23
0.26
0.26
0.338
0.35
0.47
0.56
0.72
0.773
0.81
0.83

Mercury

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	0.21
Censored	0	Lognormal mean	0.20
TOTAL	48	Std. devn.	0.21
		Median	0.13
		Min.	0.033
		Max.	0.83

Lognormal distribution? r-squared is: 0.97

Normal distribution? r-squared is: 0.72

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	0.43
1 = Lognormal	50th	0.14
2 = Normal	4 X 50th	0.57
3 = Nonparametric method	Coefficient of Variation = 1.06	

Background calculations

0.033	Methylmercury
0.044	
0.064	
0.155	
0.236	
0.254	
0.26	
0.339	

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	8	Mean	0.17
Censored	0	Lognormal mean	0.19
TOTAL	8	Std. devn.	0.12
		Median	0.1955
		Min.	0.033
		Max.	0.339

Lognormal distribution?	Normal distribution?
r-squared is: 0.88	r-squared is: 0.92

Recommendations:

Use normal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
2	90	0.34
1 = Lognormal	50th	0.17
2 = Normal	4 X 50th	0.69
3 = Nonparametric method	Coefficient of Variation = 0.75	

Page 1

0.68
0.96
1.2
3.2
3.3
3.5
3.6
4
4.1
4.3
5
5
5
5.2
5.3
6.2
6.6
7
7.2
7.2
8
8
8.2
8.2
8.8
8.9
9
9.7
10
10
10.2
11
11
12
13
14
14.1
15.9
20
21.2
22.4
22.9
31
33
36.7
38.6
49
81

Nickel

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	13.22
Censored	0	Lognormal mean	13.56
TOTAL	48	Std. devn.	14.52
		Median	8.5
		Min.	0.68
		Max.	81

Lognormal distribution?	Normal distribution?
r-squared is: 0.97	r-squared is: 0.68

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	☆ 90	30.49
1 = Lognormal	50th	8.63
2 = Normal	4 X 50th	34.51
3 = Nonparametric method	Coefficient of Variation = 1.28	

0.17015
0.19494
0.20122
0.20122
0.22879
0.26846
0.33
0.33
0.33402
0.34
0.37
0.38
0.39818
0.44
0.46384
0.48
0.51
0.53303
0.56
0.65
0.66
0.7
0.72
0.73174
0.74
0.78
0.87
0.92
1
1.1
1.1
1.17
1.2
1.2
1.2
1.3
1.5
1.53
1.7
1.8
1.82
1.82
2
2.1
2.45
2.8
3.8

Selenium

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	47	Mean	0.98
Censored	0	Lognormal mean	1.00
TOTAL	47	Std. devn.	0.77
		Median	0.731738
		Min.	0.1701524
		Max.	3.8

Lognormal distribution?	Normal distribution?
r-squared is: 0.99	r-squared is: 0.85

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	2.07
1 = Lognormal	50th	0.73
2 = Normal	4 X 50th	2.94
3 = Nonparametric method	Coefficient of Variation = 0.96	

Note: Sample # 47 was excluded because there was no value associated with the "0" = ND in Pro UCL

0.044
0.058
0.07054
0.07185
0.073
0.07571
0.07826
0.07965
0.08701
0.08909
0.096
0.09687
0.09892
0.09892
0.10058
0.10309
0.11071
0.11339
0.11593
0.11884
0.128
0.13
0.13529
0.13664
0.13668
0.14026
0.14138
0.16045
0.164
0.18917
0.19
0.2
0.2
0.21
0.22639
0.27
0.27
0.28
0.28023
0.3
0.3
0.31
0.31
0.31
0.33
0.37811
0.5
0.6

Thallium (Ln for ND)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	0.18
Censored	0	Lognormal mean	0.18
TOTAL	48	Std. devn.	0.12
		Median	0.1366635
		Min.	0.044
		Max.	0.6

Lognormal distribution?	Normal distribution?
r-squared is: 0.98	r-squared is: 0.85

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	0.33
1 = Lognormal	50th	0.15
2 = Normal	4 X 50th	0.61
3 = Nonparametric method	Coefficient of Variation = 0.68	

-0.0198
0.02069
0.02449
0.03531
0.04216
0.044
0.04578
0.06407
0.06895
0.073
0.08625
0.09058
0.09058
0.09402
0.096
0.0991
0.11384
0.1188
0.12337
0.128
0.1285
0.13
0.1553
0.15735
0.15741
0.16276
0.164
0.1644
0.19
0.19055
0.2
0.2
0.21
0.22459
0.26171
0.27
0.27
0.28
0.3
0.3
0.3058
0.31
0.31
0.31
0.33
0.36772
0.5
0.6

Thallium (Normal for ND)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	0.18
Censored	0	Lognormal mean	N/A
TOTAL	48	Std. devn.	0.13
		Median	0.1573804
		Min.	-0.019765
		Max.	0.6

Lognormal distribution?	Normal distribution?
r-squared is:	r-squared is: 0.92

Recommendations:

Unable to analyze probability plot for lognormal case.

Use normal distribution.

Distribution selection		Value corresponding
	Enter percentile	to that percentile is:
2	A 90	0.35
1 = Lognormal	50th	0.18
2 = Normal	4 X 50th	0.72
3 = Nonparametric method	Coefficient of Variation = 0.74	

0.0298
0.044
0.05049
0.05259
0.05872
0.06271
0.06486
0.073
0.07611
0.07923
0.09067
0.09363
0.09363
0.096
0.09601
0.09957
0.11021
0.1139
0.11734
0.12125
0.128
0.13
0.14267
0.14438
0.14443
0.14892
0.15032
0.164
0.17333
0.19
0.2
0.2
0.2057
0.21
0.24421
0.27
0.27
0.28
0.29443
0.3
0.3
0.31
0.31
0.31
0.33
0.37346
0.5
0.6

Thallium (Gamma for ND)

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	0.18
Censored	0	Lognormal mean	0.18
TOTAL	48	Std. devn.	0.12
		Median	0.1444067
		Min.	0.0297996
		Max.	0.6

Lognormal distribution?	Normal distribution?
r-squared is: 0.99	r-squared is: 0.88

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	0.35
1 = Lognormal	50th	0.15
2 = Normal	4 X 50th	0.58
3 = Nonparametric method	Coefficient of Variation = 0.78	

4.18717	Zinc
4.18717	
4.8	
8.3	
9.4	
11	
11	
14.4	
15	
19	
19	
19	
23	
26	
26	
27	
29	
29.6	
30.6	
31	
32	
34	
38	
45	
55	
61	
63.6	
68	
71	
72.7	
73	
75	
75.5	
79	
99.1	
110	
114	
120	
120	
132	
150	
160	
180	
210	
210	
242	
268	
270	

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	48	Mean	74.78
Censored	0	Lognormal mean	83.29
TOTAL	48	Std. devn.	72.52
		Median	50
		Min.	4.1871672
		Max.	270

Lognormal distribution?	Normal distribution?
r-squared is: 0.98	r-squared is: 0.84

Recommendations:

Use lognormal distribution.

Distribution selection		Enter percentile	Value corresponding to that percentile is:
	1	90	195.49
1 = Lognormal		50th	44.58
2 = Normal		4 X 50th	178.32
3 = Nonparametric method		Coefficient of Variation = 1.67	

Background calculations

4.33	pH
4.48	
4.63	
4.74	
4.76	
4.96	
4.98	
5.31	

MTCA*Stat* 3.0

Number of samples		Uncensored values	
Uncensored	8	Mean	4.77
Censored	0	Lognormal mean	4.77
TOTAL	8	Std. devn.	0.31
		Median	4.75
		Min.	4.33
		Max.	5.31

Lognormal distribution?	Normal distribution?
r-squared is: 0.98	r-squared is: 0.98

Recommendations:

Use lognormal distribution.

Distribution selection	Enter percentile	Value corresponding to that percentile is:
1	90	5.21
1 = Lognormal	50th	4.77
2 = Normal	4 X 50th	19.06
3 = Nonparametric method	Coefficient of Variation = 0.07	

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	0	1	2	3	4	5	6	7
	Location_ID	Site_ID	Field_Collection_Start_Date	Sample_ID	Antimony	d_Antimony	Arsenic	d_Arsenic
1	MC-BKG	BKG	9/7/2005	BKG-03-0.5	2.39	1	44.7	1
2	MC-BKG	BKG	9/7/2005	BKG-04-0.5	6.25	1	69.9	1
3	MC-BKG	BKG	9/7/2005	BKG-05-0.5	16.7	1	74.8	1
4	MC-BKG	BKG	9/8/2005	BKG-01-0.5	4.03	1	110	1
5	MC-BKG	BKG	9/8/2005	BKG-02-0.5	4.28	1	127	1
6	MC-BKG	BKG	9/8/2005	BKG-08-0.5	1.65	1	81.5	1
7	MC-BKG	BKG	9/8/2005	BKG-09-0.5	1.9	1	78.9	1
8	MC-BKG	BKG	9/8/2005	BKG-10-0.5	2.43	1	64.5	1
9	MC-BKG	BKG	9/9/2005	BKG-06-0.5	2.51	1	23.3	1
10	MC-BKG	BKG	9/10/2005	BKG-07-0.5	8.23	1	700	1
11	MC-BKG	BKG	8/25/2011	G-1	1.3	1	110	1
12	MC-BKG	BKG	8/25/2011	G-2	1.4	1	60	1
13	MC-BKG	BKG	8/25/2011	G-3	0.26	1	6.2	1
14	MC-BKG	BKG	8/25/2011	G-4	0.37	1	19	1
15	MC-BKG	BKG	8/25/2011	G-5	0.36	1	9.6	1
16	MC-BKG	BKG	9/13/2011	76-1	46	1	430	1
17	MC-BKG	BKG	9/13/2011	76-3	31	1	100	1
18	MC-BKG	BKG	9/14/2011	G-10	4.1	1	180	1
19	MC-BKG	BKG	9/14/2011	G-11	8.2	1	230	1
20	MC-BKG	BKG	9/14/2011	G-12	6.5	1	260	1
21	MC-BKG	BKG	9/14/2011	G-6	2.7	1	100	1
22	MC-BKG	BKG	9/14/2011	G-7	2.9	1	150	1
23	MC-BKG	BKG	9/14/2011	G-8	2.9	1	160	1
24	MC-BKG	BKG	9/14/2011	G-9	7.2	1	380	1
25	MC-BKG	BKG	9/15/2011	76-11	43	1	400	1
26	MC-BKG	BKG	9/15/2011	76-2	20	1	430	1
27	MC-BKG	BKG	9/16/2011	76-10	1.6	1	69	1
28	MC-BKG	BKG	9/16/2011	76-12	2.4	1	430	1
29	MC-BKG	BKG	9/16/2011	76-13	0.41	1	8.4	1
30	MC-BKG	BKG	9/16/2011	76-14	1.9	1	65	1
31	MC-BKG	BKG	9/16/2011	76-15	1.7	1	48	1
32	MC-BKG	BKG	9/16/2011	76-16	0.24	1	6.6	1
33	MC-BKG	BKG	9/16/2011	76-17	2.5	1	110	1
34	MC-BKG	BKG	9/16/2011	76-18	1.2	1	27	1
35	MC-BKG	BKG	9/16/2011	76-4	3	1	69	1
36	MC-BKG	BKG	9/16/2011	76-5	1.6	1	14	1
37	MC-BKG	BKG	9/16/2011	76-6	1.2	1	9.6	1
38	MC-BKG	BKG	9/16/2011	76-9	7.6	1	330	1
39	MC-BKG	BKG	9/29/2011	76-7	0.096	1	1.5	1
40	MC-BKG	BKG	9/29/2011	76-8	0.77	1	48	1
41	MC-BKG	BKG	8/22/2013	MC-76G-01	0.44	0	31	1
42	MC-BKG	BKG	8/22/2013	MC-76G-02	0.37	0	6.1	1
43	MC-BKG	BKG	8/25/2013	MC-76G-03	0.42	0	65	1
44	MC-BKG	BKG	8/25/2013	MC-76G-04	0.5	0	25	1
45	MC-BKG	BKG	9/1/2013	MC-GC-07	20	1	70	1
46	MC-BKG	BKG	9/1/2013	MC-GC-08	1.88	1	292	1
47	MC-BKG	BKG	8/31/2013	MC-GC-GB1	30	1	590	1
48	MC-BKG	BKG	9/2/2013	MC-GC-GB2	20	1	450	1

	8	9	10	11	12	13	14	15	16	17
	Barium	d-Barium	Cadmium	d_Cadmium	Chromium	d_Chromium	Cobalt	d_Cobalt	Copper	d_Copper
1	84.1	1	0.45	1	42.8	1			16	1
2	65.8	1	0.61	1	47.4	1			24.2	1
3	40.2	1	0.59	1	48.9	1			22.4	1
4	24.4	1	0.77	1	42.7	1			18.5	1
5	70.7	1	0.95	1	40.9	1			78.7	1
6	34.2	1	0.39	1	53.2	1			19.7	1
7	83.1	1	0.73	1	93.5	1			40.1	1
8	12.1	1	0.54	1	36	1			13.3	1
9	9.74	1	0.25	1	49.9	1			8.2	1
10	58.8	1	1.13	1	39.2	1			53.6	1
11	51	1	0.33	1	77	1			400	1
12	66	1	0.44	1	40	1			88	1
13	19	1	0.057	1	6.7	1			13	1
14	66	1	0.21	1	27	1			73	1
15	21	1	0.18	1	9.7	1			12	1
16	15	1	0.23	1	21	1			17	1
17	30	1	0.22	1	16	1			16	1
18	47	1	0.48	1	11	1			130	1
19	52	1	0.78	1	11	1			140	1
20	73	1	0.59	1	11	1			200	1
21	23	1	0.37	1	25	1			51	1
22	19	1	0.2	1	7.4	1			26	1
23	36	1	0.28	1	71	1			76	1
24	72	1	0.62	1	12	1			190	1
25	28	1	1.1	1	15	1			28	1
26	43	1	1	1	26	1			27	1
27	20	1	0.14	1	8.6	1			14	1
28	14	1	0.16	1	9.3	1			33	1
29	9.6	1	0.26	1	5.2	1			20	1
30	8.1	1	0.35	1	4.6	1			30	1
31	31	1	0.14	1	12	1			28	1
32	40	1	0.16	1	10	1			13	1
33	30	1	0.28	1	19	1			44	1
34	12	1	0.22	1	7.3	1			33	1
35	26	1	0.065	1	17	1			19	1
36	7.1	1	0.13	1	3.1	1			7.5	1
37	11	1	0.32	1	5.1	1			13	1
38	38	1	0.9	1	19	1			480	1
39	2.9	1	0.051	1	0.9	1			1.1	1
40	16	1	0.25	1	4.5	1			16	1
41			0.3	1	11.4	1	5.1	1	28.5	1
42			0.3	1	6.5	1	2.3	1	12.9	1
43			0.8	1	11.2	1	29.1	1	34.6	1
44			0.4	1	4.8	1	2.9	1	8.9	1
45			0.7	1	19	1	3	1	23.2	1
46			0.139	0	17.8	1	3.7	1	31.5	1
47			0.9	1	14	1	29.8	1	93.2	1
48			0.7	1	16	1	18.8	1	88.7	1

	18	19	20	21	22	23	24	25	26	27	28
	Lead	d_Lead	Iron	d_Iron	Manganese	d_Manganese	Mercury	d_Mercury	MM	d_MM	Nickel
1	11.6	1			783	1	0.72	1			33
2	11	1			1500	1	0.773	1			22.9
3	13.9	1			1010	1	0.338	1			22.4
4	28.2	1			699	1	0.177	1			21.2
5	34.6	1			986	1	0.0683	1			36.7
6	18.3	1			323	1	0.0333	0			14.1
7	21.5	1			466	1	0.0583	1			38.6
8	32	1			291	1	0.147	1			10.2
9	14.6	1			101	1	0.033	1			7.2
10	52.3	1			403	1	0.0583	1			15.9
11	43	1			470	1	0.043	1			81
12	32	1			1700	1	0.17	1			31
13	9.3	1			94	1	0.056	1			4.1
14	15	1			170	1	0.081	1			14
15	9	1			140	1	0.064	1			5.2
16	210	1			950	1	0.83	1			13
17	59	1			1300	1	0.47	1			8.9
18	53	1			980	1	0.098	1			5.3
19	88	1			1300	1	0.11	1			8.2
20	80	1			1800	1	0.11	1			6.6
21	59	1			180	1	0.23	1			10
22	20	1			190	1	0.037	1			3.3
23	53	1			1200	1	0.19	1			49
24	91	1			2400	1	0.1	1			7.2
25	170	1			1200	1	0.56	1			11
26	170	1			1400	1	0.81	1			20
27	20	1			92	1	0.21	1			5
28	25	1			78	1	0.14	1			5
29	7.5	1			19	1	0.2	1			3.6
30	17	1			560	1	0.2	1			0.96
31	22	1			130	1	0.2	1			6.2
32	13	1			240	1	0.094	1			8.8
33	27	1			160	1	0.26	1			9.7
34	66	1			94	1	0.26	1			4.3
35	21	1			130	1	0.12	1			8.2
36	7.6	1			54	1	0.052	1			1.2
37	7.4	1			66	1	0.1	1			3.2
38	60	1			300	1	0.35	1			11
39	1	1			10	1	0.057	0			0.68
40	24	1			95	1	0.11	1			3.5
41	11	1	22500	1	482	1	0.09	1	0.044	1	10
42	12	1	10800	1	128	1	0.11	1	0.254	1	5
43	53	1	31000	1	1540	1	0.2	1	0.339	1	8
44	19	1	11300	1	62	1	0.12	1	0.155	1	4
45	14	1	24000	1	106	1	0.16	1	0.064	1	8
46	45	1	20200	1	635	1	0.11	1	0.26	1	7
47	194	1	47100	1	4680	1	0.21	1	0.236	1	9
48	116	1	37500	1	2260	1	0.2	1	0.033	1	12

	29	30	31	32	33	34	35	36	37	38
*	d_Nickel	Selenium	d_Selenium	Thallium	d_Thallium	Zinc	d_Zinc	pH	d_pH	LnROS_Antimony
1	1	0.6	0	1.5	0	63.6	1			2.39
2	1	0.6	0	1.5	0	72.7	1			6.25
3	1	0.6	0	1.5	0	75.5	1			16.7
4	1	0.6	0	1.5	0	99.1	1			4.03
5	1	0.6	0	1.5	0	132	1			4.28
6	1	0.6	0	1.5	0	29.6	1			1.65
7	1	6	0	1.5	0	114	1			1.9
8	1	1.53	1	1.5	0	30.6	1			2.43
9	1	0.78	1	1.5	0	14.4	1			2.51
10	1	0.7	1	1.5	0	110	1			8.23
11	1	1.7	1	0.27	1	120	1			1.3
12	1	0.92	1	0.21	1	75	1			1.4
13	1	0.33	1	0.13	0	15	1			0.26
14	1	0.66	1	0.13	1	26	1			0.37
15	1	0.33	1	0.14	0	19	1			0.36
16	1	0.23	0	0.19	1	79	1			46
17	1	0.48	1	0.2	1	68	1			31
18	1	2.1	1	0.33	1	71	1			4.1
19	1	1.2	1	0.31	1	160	1			8.2
20	1	2	1	0.27	1	150	1			6.5
21	1	1.1	1	0.3	1	61	1			2.7
22	1	0.34	1	0.13	0	55	1			2.9
23	1	1.2	1	0.31	1	180	1			2.9
24	1	1.8	1	0.28	1	270	1			7.2
25	1	0.21	0	0.2	1	210	1			43
26	1	0.56	1	0.31	1	210	1			20
27	1	0.44	1	0.21	0	23	1			1.6
28	1	1.3	1	0.24	0	9.4	1			2.4
29	1	1.2	1	0.34	0	2.9	0			0.41
30	1	1.5	1	0.21	0	26	1			1.9
31	1	1.1	1	0.19	0	34	1			1.7
32	1	0.37	1	0.17	0	32	1			0.24
33	1	1	1	0.2	0	31	1			2.5
34	1	0.72	1	0.2	0	11	1			1.2
35	1	0.51	1	0.2	0	1.7	0			3
36	1	0.28	0	0.18	0	11	1			1.6
37	1	0.38	1	0.24	0	8.3	1			1.2
38	1	3.8	1	0.22	0	120	1			7.6
39	1	0.21	0	0.14	0	4.8	1			0.096
40	1	0.65	1	0.19	0	29	1			0.77
41	1	2.45	1	0.096	1	38	1	4.48	1	0.324378708928852
42	1	0.74	1	0.128	1	19	1	4.63	1	0.241010204209311
43	1	2.8	1	0.164	1	73	1	4.76	1	0.324378708928852
44	1	0.87	1	0.044	1	19	1	4.98	1	0.324378708928852
45	1	1.82	1	0.3	1	45	1	5.31	1	20
46	1	1.17	1	0.073	1	27	1	4.33	1	1.88
47	1		0	0.6	1	268	1	4.74	1	30
48	1	1.82	1	0.5	1	242	1	4.96	1	20

	39	40	41	42	43
	LnROS_Cadmium	LnROS_Mercury	LnROS_Selenium	GROS_Thallium	NROS_Thallium
1	0.45	0.72	0.194940875745379	0.0297996326284909	-0.0197648252488515
2	0.61	0.773	0.268463050438897	0.0627120701057805	0.0421553067086159
3	0.59	0.338	0.334017281539909	0.0906716435542647	0.0862494023603805
4	0.77	0.177	0.398175449268248	0.11733939484244	0.123372130773358
5	0.95	0.0683	0.463842757907397	0.144431352404536	0.157409988625319
6	0.39	0.0244117712340568	0.533028842635528	0.173332090121533	0.190548208938597
7	0.73	0.0583	0.731737999665329	0.205702187430203	0.224586066790558
8	0.54	0.147	1.53	0.244209009441481	0.261708795203535
9	0.25	0.033	0.78	0.294429309879041	0.3058028908553
10	1.13	0.0583	0.7	0.373457616248676	0.367723022812767
11	0.33	0.043	1.7	0.27	0.27
12	0.44	0.17	0.92	0.21	0.21
13	0.057	0.056	0.33	0.0504940093095913	0.0206942277810677
14	0.21	0.081	0.66	0.13	0.13
15	0.18	0.064	0.33	0.0587211341353447	0.0353143174018697
16	0.23	0.83	0.201224822474754	0.19	0.19
17	0.22	0.47	0.48	0.2	0.2
18	0.48	0.098	2.1	0.33	0.33
19	0.78	0.11	1.2	0.31	0.31
20	0.59	0.11	2	0.27	0.27
21	0.37	0.23	1.1	0.3	0.3
22	0.2	0.037	0.34	0.0960117648376078	0.0940202750422745
23	0.28	0.19	1.2	0.31	0.31
24	0.62	0.1	1.8	0.28	0.28
25	1.1	0.56	0.170152449496913	0.2	0.2
26	1	0.81	0.56	0.31	0.31
27	0.14	0.21	0.44	0.0761147646438069	0.0640661355927874
28	0.16	0.14	1.3	0.0792311550292997	0.0689468099102699
29	0.26	0.2	1.2	0.150317435298106	0.164400308471046
30	0.35	0.2	1.5	0.142672531190558	0.15529521487716
31	0.14	0.2	1.1	0.0648624513207548	0.0457779668641134
32	0.16	0.094	0.37	0.0936304040694743	0.0905776518626939
33	0.28	0.26	1	0.0525917188418227	0.0244916218171373
34	0.22	0.26	0.72	0.099572428851893	0.0991018303384627
35	0.065	0.12	0.51	0.144381987277974	0.157350798803284
36	0.13	0.052	0.201224822474754	0.0936304040694743	0.0905776518626939
37	0.32	0.1	0.38	0.148922169553967	0.162755192236709
38	0.9	0.35	3.8	0.113896706934824	0.118801992244891
39	0.051	0.0387440751081412	0.228789417137291	0.110210017982941	0.113839784821591
40	0.25	0.11	0.65	0.121253110887871	0.128495566936602
41	0.3	0.09	2.45	0.096	0.096
42	0.3	0.11	0.74	0.128	0.128
43	0.8	0.2	2.8	0.164	0.164
44	0.4	0.12	0.87	0.044	0.044
45	0.7	0.16	1.82	0.3	0.3
46	0.0898470320255599	0.11	1.17	0.073	0.073
47	0.9	0.21	1.82	0.6	0.6
48	0.7	0.2		0.5	0.5

	44	45
	LnROS_Thallium	LnROS_Zt oc
1	0.0580021389376773	63.6
2	0.0782613739901361	72.7
3	0.09687144068595 01	75.5
4	0.115930087522673	99.1
5	0.136683091883318	132
6	0.160451267389095	29.6
7	0.189174146177103	114
8	0.226392579361311	30.6
9	0.280227322946089	14.4
10	0.378106320301448	110
11	0.27	120
12	0.21	75
13	0.070543098486407	15
14	0.13	26
15	0.075713535525686	19
16	0.19	79
17	0.2	68
18	0.33	71
19	0.31	160
20	0.27	150
21	0.3	61
22	0.100582754438655	55
23	0.31	180
24	0.28	270
25	0.2	210
26	0.31	210
27	0.0870132513981724	23
28	0.0890923519197557	9.4
29	0.141384728406214	3721695986
30	0.135291757461076	26
31	0.0796451288382777	34
32	0.0989213553858557	32
33	0.0718511004871891	31
34	0.103086224085164	11
35	0.136643956255491	3721695986
36	0.0989213553858557	11
37	0.140263885939234	8.3
38	0.113394925262454	120
39	0.110705010914918	4.8
40	0.11883962411078	29
41	0.096	38
42	0.128	19
43	0.164	73
44	0.044	19
45	0.3	45
46	0.073	27
47	0.6	268
48	0.5	242