DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF AIR AND WASTE MANAGEMENT
SITE INVESTIGATION & RESTORATION BRANCH

MEMORANDUM

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Date: December 10, 2002

Re: Background Soil Metals Concentrations

I. Introduction

The Remediation Standards Guidance (Guidance) document, dated December 1999, represents an effort by the Delaware Department of Natural Resources and Environmental Control, Site Investigation and Restoration Branch (DNREC-SIRB) to establish remediation standards for hazardous substance releases considered under 7 Del. C., Chapter 91 HSCA. In order to provide flexibility within HSCA, the guidance presents three remedial standards options: 1) Background Standard, 2) Uniform-Risk Based Standard (URS), and 3) Site-Specific Standard.

Since the inception of the Guidance, some concern has arisen that the URS for several analytes were established below their naturally occurring, or background, concentrations. Statewide, this concern relates to inorganic (metallic) analytes, principally arsenic. However, in the more industrialized areas such as Wilmington, and the more geologically-complex Piedmont Province in northern New Castle County, questions have also arisen concerning lead and possibly other metals.

This memorandum represents the second technical memo which attempts to rectify the problem which exists with the present set of "Default Background" values, as stated above. In January 2002, the first memorandum was submitted to the Secretary of DNREC concerning arsenic, the most problematic of these metals. It recommended the establishment of a true background value of 11 mg/kg, which would replace the existing 0.4 mg/kg URS that is listed in the Guidance. This new arsenic value, along with the concentrations noted in this technical memo, was statistically calculated based upon two separate data sets for inorganics in soil.

The first data set represents a compilation of results from 49 background soil samples collected at HSCA and NPL Superfund sites in Delaware from 1988-1996. Samples were collected as part of initial Site Investigations and Facility Evaluations conducted by DNREC-SIRB, and as part of Remedial Investigations conducted by various parties. Samples were collected from 40+ different sites (and investigations) located in each of Delaware's three counties.

The second data set represents a series of soil samples collected from Delaware's Piedmont Province, from within the City of Wilmington boundaries. This study was designed and executed by DNREC-SIRB and Tetra Tech, Inc. in response to recent developments at the Former W.B. Clerk Co. Manufacturer/Compton Town House Apartment Site in Wilmington.

In the following section, this technical memo recaps the sampling methods, analytical protocols and results of the Wilmington investigation.

II. Scope and Location Selection Criteria

Eighteen surface soil samples, plus two duplicates, were collected from six locations within the Wilmington City boundaries. Each of the six locations represented "pristine" parkland that did not have a history of industrial usage. Property deeds and titles, and Sanborn Fire Insurance maps were used to screen locations regarding the above criteria.

In order to minimize (inasmuch as possible) any underlying geologic variability, the second selection criteria required that each chosen location be situated within the Wilmington Complex, the same geologic unit which underlies the W.B. Clerk site and most of the City of Wilmington. The Wilmington Complex is defined by the Delaware Geological Survey as: the metaigneous, metavolcanic and igneous rocks associated with an early Paleozoic magmatic arc that extends from Chester, Pennsylvania across to northeast Cecil County, Maryland. In Delaware, this includes the Marcus Hook, Wilmington North, Wilmington South, Newark East and Newark West quadrangles (Figure 1).

The final six location sites selected for soil sampling, as well as the W.B. Clerk/Compton Town House site can be found on Figures 1 and 2. The six locations are listed below, with the number in parentheses indicating the number of samples collected at that location:

- Brandywine Park and Zoo (3)
- Baynard Stadium (4)
- Kentmere Parkway (3)
- Rockford Park (4)
- Alapocas Woods (3)
- Seller's Park (3)

The eighteen sampling locations (duplicate samples were collected one each at Baynard Stadium and Alapocas Woods) were marked in the days preceding soil sample collection by Tetra Tech, Inc. personnel.

Analytical Protocols

Metals' analyses for Target Analyte List (TAL) metals were conducted by DNREC-Environmental Services Section (ESS) via Inductively-coupled Plasma and Atomic Absorption/Cold Vapor Atomic Absorption in accordance with the preferred methodology outlined in the SOPCAP of HSCA.

Field Activities

Sampling activities were conducted on April 15, 2001. Prior to sample collection, the immediate sampling area and soils were visually field-checked by DNREC-SIRB personnel for any signs of filling, dumping or other indications of anthropogenic activities. Once cleared, Tetra Tech personnel collected soil samples with DNREC-SIRB oversight. Samples were submitted to DNREC-ESS for laboratory analysis at the completion of business the same day. Three soil samples were collected from each location, plus one duplicate each at Baynard Stadium and Alapocas Woods.

Soil samples were collected, using dedicated stainless-steel spoons, from the upper six inches of the soil column, immediately underlying any root mat or leaf litter. Sample location, soil lithology, color, relative moisture, and any other pertinent observations were noted in a field logbook. Photographs were taken of each of the eighteen sampling locations.

Soil lithology was very similar at each of the locations, and can be described as a brown to medium reddish-brown sandy to silty loam, with trace amounts of clay or fine gravel, depending on the location.

III. Wilmington Study Analytical Results-General Trends

Silver was not detected in any of the soil samples. Low concentrations of antimony, beryllium, cobalt, selenium, thallium and cadmium were detected in most samples, with many "B" qualified results (i.e., result falls between the instrument detection limit and the reporting limit). Generally, concentrations of the remaining metals fell within a limited range, exhibiting only minor variation, as might be expected from native soils collected from areas of similar underlying geology. Two sample locations however, Rockford SS03 and Alapocas SS02 contained notably higher concentrations of metals, particularly cobalt and manganese.

IV. State-wide Study Analytical Results-General Trends

Not surprisingly, the variation exhibited by the analytical results from the state-wide data set was generally much greater than that of the Wilmington Study. Antimony was not detected in any of the soil samples. Selenium, silver and thallium were detected in only three samples, all in New Castle County samples, with only silver at concentrations greater than 1 mg/kg (maximum value of 1.1 mg/kg). Beryllium was detected in most samples, but generally at a concentration less than 1 mg/kg. The maximum concentration of 1.4 mg/kg was detected in one soil sample in each of the three counties. Detected concentrations of the remaining metals were found to generally decrease with latitude; i.e., with the highest concentrations in New Castle County, and the lowest in Sussex County. This is to be expected.

V. Statistical Analysis

Descriptive statistics were developed for each of the analyzed metals to include: mean, 95% upper confidence level (UCL) of the mean, median, variance, and standard deviation. The Shapiro-Wilk test was also performed on each set of values to test for normality. Finally, percentile values (25, 50, 75, and either 2.5/97.5 or 5/95) roughly equivalent to ± one and two standard deviations) were determined for each set of values.

For the Wilmington Study, only seven of the nineteen metals analyzed (V, Ni, Cu, Ba, Sb, As and Be) exhibited a normal distribution based upon the Shapiro-Wilks test for normality (with a 0.05 level of significance, or 95% confidence). These results may be influenced somewhat by the limited sample size (n=18). Thus, it is not appropriate to utilize parametric statistics such as the mean or the 95% UCL of the mean in developing a single "background" value for individual metals. Taking into account the non-normal distribution of many of the analytes, it would be more correct to utilize either a median or a percentile value of the population.

Select descriptive statistics for the Wilmington study results are presented in Table 1, and are compared to similar statistical measures performed for the State-wide background values accumulated from previous environmental investigations at sites located throughout Delaware in each of the three counties. Also included for comparison are the present Default Background Standards for the TAL metals as presently listed in the Remediation Standards Guidance (December 1999).

Table 1: Comparative Statistics Between Wilmington and Statewide Soil Metals Concentrations

	State Mean	Wilm Mean	State 95% UCL[1]	Wilm. 95% UCL[1]	NC Mean	Kent Mean	Sussex Mean	State Median	Wilm. Median	State 75%[2]	Wilm. 75%[2]	State 95%[2]	Wilm. 95%[2]	Present Default Background Standard[4]
Analyte														
Aluminum	**9409**	**16243**	**11031**	**19914**	**11936**	**8749**	4854	**8625**	**13950**	**11525**	**20425**	**21578**	**27390**	7800[5]
Antimony	ND	**2.48**	ND	**2.84**	ND	ND	ND	ND	**2.10**	**ND**	3.10	ND	**3.98**	<0.5
Arsenic	**8.14**	**9.83**	**11.0**	**10.99**	**10.7**	**7.81**	**8.71**	**5.1**	**9.30**	**9.15**	**11.53**	**29.40**	**11.53**	0.4[5]
Barium	71.2	**92.9**	**82.6**	**104.3**	76.1	**82.2**	44.8	74	**87.1**	**96.1**	**108.25**	**146.4**	**108.25**	82
Beryllium	0.80	0.70	0.98	0.79	0.88	0.66	0.94	0.81	0.67	1.1	0.83	1.4	1.09	1.0[5]
Cadmium	2.8	0.43	**3.7**	0.51	**3.1**	2.4	1.6	2.3	0.39	**3.23**	**0.53**	**3.23**	0.83	3
Chromium	**17.6**	**26.5**	**22.2**	**30.9**	**26.4**	**12.5**	**7.1**	**13.5**	**23.6**	**25**	**34.2**	**43.08**	**47.16**	0.4
Cobalt	8.3	16.92	11.8	**31.43**	12.0	4.2	3.7	5.6	9.0	8.75	**12.05**	**34.26**	**140.87**	20
Copper	28.8	17.7	40.7	21.6	38.8	23.3	17.9	16	18.5	34.2	22.70	**94.4**	28.94	50
Iron	**14746**	**25305**	**18118**	**29921**	**21620**	**12129**	**3811**	**12450**	**22100**	**19725**	**29700**	**34945**	**45170**	2300[5]
Lead	**70.2**	**49.8**	**99.3**	**65.9**	**59.9**	**111.1**	35.8	40.8	37.2	**76**	**60.8**	**344.5**	**162.5**	41
Manganese	**286.8**	**512.1**	**376.5**	**770.2**	**359.1**	**328.1**	61.2	**238**	**435.5**	**411.8**	**580.8**	**674.4**	**2626**	180[5]
Mercury	**0.42**	**0.23**	**0.30**	**0.28**	**0.21**	**0.26**	**2.5[3]**	**0.2**	**0.19**	**0.23**	**0.27**	**0.75**	**0.64**	0.0005
Nickel	13.1	11.3	16.6	12.4	16.3	11.2	5.0	10.8	11.2	15.6	13.4	**41**	14.9	30
Selenium	**0.5[3]**	**0.86**	**0.5[3]**	**0.94**	**0.5[3]**	ND	ND	**0.5[3]**	**0.8**	**0.5[3]**	**0.95**	**0.5[3]**	**1.39**	0.2
Silver	1.1[3]	ND	1.1[3]	ND	1.1[3]	ND	ND	1.1[3]	ND	1.1[3]	ND	1.1[3]	1.1[3]	2
Thallium	0.88[3]	**1.17**	0.88[3]	**1.53**	**0.88[3]**	ND	ND	0.88[3]	0.89	0.88[3]	**1.18**	0.88[3]	**3.54**	1
Vanadium	**27.2**	**55**	**31.9**	**64.9**	**36.5**	**19.6**	**15.6**	**21**	**56**	**36.6**	**65.1**	**57**	**106**	2[5]
Zinc	**76.2**	**44.2**	**99.7**	**52.5**	**86.7**	**67.6**	**67.0**	**48.2**	**51.7**	**86**	**51.8**	**257.5**	**93.15**	8[5]

[1] 95% Upper Confidence Limit of the Mean
[2] 75th/95th Percentile of the Population
[3] Data set contains less than 3 values.
[4] From Remediation Standards Guidance, December 1999 Update
[5] Value presented is the most stringent soil URS value because the upper value of the concentration range exceeds the unrestricted soil URS.
ND All values were non-detect at 0.5 mg/kg.
* High value significantly higher than others in data set, and may represent outlier. Second highest value presented in parentheses.
Note: Emboldened values indicate a value exceeding the present Default Background Standard.

VI. Determination of "Background"

As can be seen in Table 1, there is notable variation in the statistical values generated between, and even within, the two data sets. The likely causes for this variation are:

1) Limited and differing sample sizes. The Wilmington Background Study consisted of 20 samples (18 plus 2 duplicates). The State-wide background values represent a two-fold increase in the number of sampling points, and consist of "background" samples collected as part of 46 CERCLA, HSCA or VCP investigations.

2) Questions regarding the true "background" nature of the sampling locations. Sampling locations for the Wilmington Background Study underwent a thorough deed and background search to ensure that the locations did not represent areas of known industrial, particularly tannery, activities. Locations from the State-wide data set were collected as part of 46 different investigations conducted fewer than three different regulatory programs, a variety of project managers, and over a 10-year time span. It is unlikely that deed and background searches were conducted at many of these locations, but rather that they represented samples collected off-site from the particular facility that was being investigated at the time.

3) Differences in the underlying geology (e.g., Piedmont vs. Coastal Plain). Samples gathered as part of the Wilmington Background Study were collected from a geographically limited area of the Delaware Piedmont that is underlain by the Wilmington Complex of igneous and metamorphic rocks. Samples gathered from the environmental investigations, which comprise the State-wide data set, were collected from a more diverse range of geographic and geologic settings within Delaware, from the geochemically more complex Piedmont rocks to the simpler quartzose sands of the Delaware seashore.

However, for some metals, statistical measures were found to be relatively similar between the two data sets, such as similar means and medians. This suggests that, of the potential causes for the differences listed above, size of the sample data set is potentially the most important factor in assessing the differences.

In the case of limited sample size and non-normal distribution such as that exhibited by many of the metals analytical data in this project, it is often recommended that non-parametric measures such as the median or percentiles (e.g., 50^{th}, 75^{th}, 95^{th}) be used. It is inherent in the use of either the median or the 50^{th} percentile however, that half of the expected results (in this case half of the expected background samples collected) would exceed the given value, thus requiring potential remedial measures for soil metals' concentrations that are still well within the range of background values. Conversely, use of a 95^{th} percentile can sometimes be disproportionately affected by one or two outlier points, although to a lesser extent.

VII. Selection of Background

For purposes of selecting one Default Background Standard to be used in the Remediation Standards Guidance, and in consideration of the above discussion, I recommend the following:

1) For each metal whereupon at least one of the analytical data sets (i.e., either state-wide or Wilmington) exhibits a normal distribution, that the 95% UCL of the mean be utilized as the default background value. At least one of the two data sets for Sb, Ba, Be, Cu, Ni and V exhibit a normal distribution. Where both populations exhibit a normal distribution, and thus there are two 95% UCL values, the higher of the two values would be selected.

   In a review of the various statistical measure presented in Table 1, it should be noted that for each of these metals the value which represents the 95% UCL of the mean statistic for a particular data set is very nearly the same as the value of the 75th percentile of that same data.

2) Unlike the situation with the aforementioned six metals, in the case of the remaining metals with non-normal distributions, the statistical values for the 75th percentile and 95%UCL are not very similar. For these remaining metals, the 75th percentile should be utilized as the default background value, per the argument given in Section VI above. Where the values for the 75th percentile differ between the two data sets, the higher value would be selected.

   While it could be argued that through log-transformation of this data a log-normal data set could be generated, from which a mean and 95%UCL could be determined, use of the 75th percentile is both consistent with #1 above, and does not involve any manipulation of the data set.

As recommended, the resultant changes (rounded to the nearest whole number, with the exception of mercury) to the Default Background Standards for metals within the Remediation Standards Guidance would be reflected in Table 2 below. As can be seen in Table 3, the proposed values are higher than the existing standard for 12 of the 19 metals, lower for 4 of the metals, and there would be no change for 3 metals.

Table 2: Comparison Between Present and Proposed Default Background Standards (mg/kg)

	Present Default Background Standard[1]	Proposed New Default Background Standard
Analyte		
Aluminum	7,800	20,400
Antimony	<0.5	3
Arsenic	0.4	11
Barium	82	104
Beryllium	1	1
Cadmium	3	3
Chromium	0.4	34
Cobalt	20	12
Copper	50	22
Iron	2,300	29,700
Lead	41	76
Manganese	180	580
Mercury	0.0005	0.3
Nickel	30	12
Selenium	0.2	1
Silver	2	1
Thallium	1	1
Vanadium	2	65
Zinc	8	86

[1] From Remediation Standards Guidance, December 1999 Update

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APPENDIX A

Statewide Background Metals Results

	Site No.							
Analyte	DE-080	DE-196	DE-196	DE-190	DE-283	DE-281	DE-211	DE-176
	Duck Creek L/F	Middletown L/F	Middletown L/F	Lewes C/G	Old Airport Rd.	Diamond State	All Rite New	Ametek
	"FE"	"FE"	"SI"	"RI"	"SI"	Salvage "SI"	"SI"	"SI"
	Kent	Kent	Kent	Sussex	New Castle	New Castle	Kent	New Castle
Aluminum	10987	6050	9010		15000	12900	5510	18300
Antimony								
Arsenic			3.9	3.6		8	1.1	4.5
Barium	108	75.7	96.1		77.2	69.1	45.8	153
Beryllium					0.06	1.1	1.1	
Cadmium			2		4	3.6	6.4	3
Chromium	15.3	9.8	14.5	10.1	35.9	23.9	10	37.3
Cobalt			3.5		22.2	12.5	2.07	11
Copper	6.2		10.3	5.4	14.6	38.4	8.6	34.2
Iron	12500	12300	13100		33500	26300	35800	19900
Lead	8	62.5	65.7	14.2	9.2	91.3	71.9	52
Manganese	318	1,900	277		657	464	366	623
Mercury			0.23		0.11		0.22	
Nickel			10.8		17.6	13		13.4
Selenium					0.17	0.83		
Silver					1.1			
Thallium					0.88			
Vanadium	19.2	25	20.8		57.6	46.9	12.6	42.7
Zinc	27	20.9	56.5		42.2	84.5	46.3	174
Tin								
"N/A" not available								
"(x)" # of samples used to calculate that statistic								

DE-57	DE-192	DE-95	DE-94	DE-169	DE-66	DE-127	DE-18	DE-165	DE-154
Atlantic Aviation	Castle Ford	Clayville	Container Corp	DE Contracting	Eastern Disposal	Ennis Dump	FMC Co.	Forbes Steel	Frazier's Pit
"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"
New Castle	New Castle	New Castle	New Castle	New Castle	Kent	Kent	New Castl	New Castle	Kent
	7150	8040	8990	17110	8160	8890	18937	4130	23000
	4			26	5.1	2.6	5.1	13.3	9.2
	82.8	47	78	109	117	74	63	16	131
	0.7				1.2	0.4			
		2.7		8				3.1	4.2
10.59	11.4	15	23	45	8.5	8	30	29.8	31
	2.2		5.7	49	4.3	3.5		9.8	8.4
	13.6		28	228	55.5	5.9	16	62	20
10857	15400	17000	12400	33900	7786	8350	22767	62800	25200
9.63	40.8	39	79	386	194	36	16	81.4	94
161	314	149	244	670	450	156	218	678	284
		0.2		0.8			0.33		0.14
12.52	4.4		14	40	6.1	6.5	18	16.9	23
	19	26	27	56	14.4	15	45	17.5	54
13.49	23.2	26	72	421	28.4	57	49	106	121
			8.8						

DE-188	DE-48	DE-67		DE-30	DE-149	DE-126	DE-108	DE-132	DE-110
Georgetown C/G	Globe Union	Halby Chem. A	Halby Chem. B	Industrial Prod.	Jackson Pit	Juliano	Kenton L/F	Lebanon Rd L/F	Litton Ind.
"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"
Sussex	Kent	New Castle	New Castle	New Castle	Sussex	New Castl	Kent	Sussex	Kent
5350	12700	12700	17400	7124	3310	14100	4090	5730	8740
1.9	3.3	4.4	14.7		1.4	5.5		22	13
124	111	63.4	111	34	21	75		42	82
0.33	0.55	1.4	0		1.4				
	0.68	0.89	1.4	2.2				1.6	1.3
10.1	12.7	28.3	29.8	13	4.2	22		7.5	10
	7.9	16.3	19.9		1.9				3.8
19.6	10.2	37.3	49.7	16	56			53	30
5360	7600	25300	27500	12694	2120	20000	3140	7360	10300
133	76	16.5	96.3	72	12	37	9.9	23	43
62.3	173	359	581	145	24	425	16	82	289
	0.2	0.1	0.11	0.1			0.13		
9.2	11.3	13.7	15.6	6	2.3	33			8.07
9.7	20.8	35.2	42.9	23	45	38		11	19
251	160	81.6	207	43	30	58		36	50
	2.4			9					

DE-150	DE-123	DE-128	DE-202	DE-39	DE-199	DE-81	DE-104	DE-109	DE-74
Metcalf Pit	Middletown Sewer	Mill St. Dump	Moore Dump	Newark L/F	NVF Newark	NVF Stateline	Pearson's Corner	Seaford Drum	Summit L/F
"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"
Sussex	Kent	Kent	Sussex	New Castle	New Castle	New Castle	Kent	Sussex	New Castle
5880	4520	7830	5070	11900	9140	25500	6430	7120	9217
6.7	1.77	29	1.6	31	5.1	23	7.8	0.63	
28.1	33.2	27	16.4	78	91.3	155	77	20	70
	0.81			1.2	1.4		0.51		1
	1.4								
	6.3		7.5	18	32.2	76	11	5.8	25
6.9	3.5			7.3	4.4	11	2.8		6
6.3	12.9		4.3	33	16	48	28		23
5500	17000	5320	3510	15700	12900	29800	7920	2030	18607
44.9	303	26	12.4	17	25.6	29	562	4.9	26
22.6	61	72	24	291	433	468	104	8.1	372
0.2	0.2				0.19	0.08	0.16		0.14
2.3	6.7		6.3	11	15.6	45	6.8		
11.3	14.7	12	12.4	35	59.9	58	14	8.8	32.3
24.6	38	32	18.7	54	86	120	86	6.7	40

DE-142	DE-266	DE-146	DE-82	DE-193	DE-137	DE-153	DE-189
Townsend Dump	Amtrack WRF	Wilson Contracting	Whittington S&G	Salem Church Dump	Selbyville Dump	Scull Prop	Smyrna C/G
"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"	"SI"
Kent	New Castle	New Castle	New Castle	New Castle	Sussex	Kent	Kent
3180	11400	10300	2810	8510		9590	11300
	7.5	4.3		3.4		9.1	
45	62.5	57		28.9	118	120	89.6
0.2	0.11	0.92					0.53
0.7				2.4			
4.8	18.8	16		13.9	9.6	7.9	25
1.7	5.5	6.3		3.6			4.9
98	13.8	18		8.3	23	6	11.5
5140	16000	19200	4035	19100	5560	11600	11000
58	72.5	18	9.4	44.1	123	56	111
41	208	344	52	45.5	83	514	232
		0.24	0.07	0.22		0.5	0.57
3.9	9.1	7.1		3.27		32	7.6
11	32	22	20	30.7		21	21
121	47.3	39		34.2	261	83	86.4
			18				

DE-13									
Sussex Co. L/F #5	Sussex Co. L/F #5	Sum of values	No. of data points	DE mean		NC mean	Kent mean	Sussex mean	
"RI	"RI								
Sussex	Sussex								
1710	1190	426005	45	9466.78		11936.1	8749.19	4420.00	
		0	0	0.00		"N/A"	"N/A"	"N/A"	
0.67	0.58	284.75	35	8.14		10.65333	7.806364	4.34222222	
18.3	15.4	3156.8	44	71.75		76.06	82.16	44.8	
		14.92	20	0.75		0.88	0.66	0.865	
		49.57	18	2.75		3.13	2.38	1.60	
2.1		786.59	43	18.29		26.42	12.49	7.11	
		247.87	29	8.55		12.04	4.22	4.40	
5.6	1.5	1175.7	40	29.39		38.77	23.32	19.41	
1200	1260	703616	47	14970.55		21620.91	12128.50	3766.67	
4.3	4.3	3420.73	48	71.27		59.93	111.06	37.60	
30.3	17.5	13508.3	47	287.41		359.16	328.31	39.31	
		5.24	23	0.23		0.21	0.26	2.5 "(2)"	
		452.06	34	13.30		16.27	11.16	5.03	
		1	2	0.50		0.5 "(2)"	"N/A"	"N/A"	
		1.1	1	1.10		1.1 "(1)"	"N/A"	"N/A"	
		0.88	1	0.88		0.88 "(1)"	"N/A"	"N/A"	
		1159.4	42	27.60		36.51	19.63	16.37	
11.6	7.5	3482.09	45	77.38		86.74	67.57	71.90	
		38.2	4	9.55		11.93	2.4 "(1)"	"N/A"	

NC med	Kent med	Sussex med		NC min	Kent min	Sussex min		NC max	Kent max	Sussex max
11900	8160	8335		2810	2810	3180		36900	25500	25500
0	0	0		0	0	0		0	0	0
5.5	8	4.5		3.4	1.1	0.63		31	48	26
76.1	82.8	77.5		16	16	20		217.5	155	155
0.96	1.1	0.53		0	0	0		1.4	1.43	1.4
2.85	2.9	2.4		0	0	0		8	8	8
25	14.45	11.2		10.59	4.2	4.2		94.8	76	76
9.1	5.7	3.6		2.2	1.9	0		49	49	49
25.5	25.5	21.5		8.3	4.5	0		228	228	228
19550	14150	12000		4035	2120	2120		62800	62800	35800
39.9	71.95	57		9.2	9.4	12		386	580	562
351.5	271	164.5		45.5	16	24		678	678	670
0.14	0.19	0.2		0.07	0.07	0.07		0.8	4.8	0.8
14	13	8		3.27	2.3	0		54.1	45	45
0.17	0.415	0		0	0	0		0.83	0.83	0
0.55	0	0		0	0	0		1.1	0	0
0.44	0	0		0	0	0		0.88	0	0
35.2	27	23		17.5	9.7	9.7		90	59.9	58
58	78.25	65		13.49	13.49	6.7		421	421	421
8.9	8.9	8.9		0	0	2.4		18	18	18
0	0	0		0	0	0		0	0	0

APPENDIX B

Wilmington Background Metals Results

Wilmington Background Sampling Analytical Results (mg/kg)

Analyte	Kentmere SS01	Kentmere SS02	Kentmere SS03	Rockford SS01	Rockford SS02	Rockford SS03	Rockford SS04 (Dup)	Alapocas SS01	Alapocas SS02	Alapocas SS03
Aluminum	11100	9650	12000	10300	12500	27400	13700	17000	18400	26000
Antimony	1.8 B	2.1 B	2.1 B	2.1 B	2 B	3.1 B	2 B	3.3 B	2.9 B	3.5 B
Arsenic	7.7	8.6	8.9	8.3	9.8	10.3	8.7	9.3	11.6	9.3
Barium	79.9	103	109	69.5	108	119	79.9	51.2 B	63.2	99.9
Beryllium	0.76 B	0.64 B	0.87 B	0.49 B	0.65 B	1.1 B	0.58 B	0.54 B	0.97 B	0.75 B
Cadmium	0.42	0.28 B	0.22 B	0.25 B	0.32 B	0.76 B	0.28 B	0.38 B	0.55 B	0.47 B
Chromium	20.9	22.2	22.3	18.6	19.8	39.1	21.2	47.4	42.5	27.1
Cobalt	7 B	7 B	5.0 B	5.1 B	11.9 B	147	7.8 B	7.2 B	24.3	9.5 B
Copper	12.2	15.1	14.6	8.2	11.5	25.9	9.7	14.7	19	23.5
Iron	16500	16700	18800	16000	17500	41200	16900	27000	37800	29900
Lead	43.6	56.5	35	23.1	34.9	26.9	32.2	29	26.5	30.5
Manganese	460	455	139	325	635	2730	585	88.7	503	416
Mercury	0.15	0.19	0.16	0.14	0.18	0.16	0.14	0.19	0.29	0.15
Nickel	10.1	9.8 B	9.4 B	7.5 B	10.5	13.4	9.6 B	14.9	10.8	11.5
Selenium	ND	ND	ND	ND	0.85 B	1.4	ND	0.8 B	0.84 B	1 B
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	0.73 B	0.85 B	0.67 B	ND	0.75 B	3.6	ND	0.76 B	2.1 B	1.1 B
Vanadium	36.1	36.8	32.6	30.8	38.8	83.8	35	75.7	107	65.3
Zinc	45.5	51.8	35.5	27.3	48.4	43.6	34.4	30.5	27.8	42.5

Analyte	Baynard SS01	Baynard SS02	Baynard SS03	Baynard SS04 (Dup)	Brandywine SS01	Brandywine SS02	Brandywine SS03	Sellers SS01	Sellers SS02	Sellers SS03
Aluminum	13700	14200	24800	27200	11500	7920	16200	11600	18700	21000
Antimony	1.9 B	1.9 B	4 B	3.1 B	2.1 B	0.82 B	3.4 B	2 B	2.9 B	2.6 B
Arsenic	11.1	6.5	14.7	8.9	13.2	5.6	19.4	5.7	13	11.3
Barium	150	53.2	86.2	84.4	109	88	83.1	47.1 B	77.2	110
Beryllium	0.83 B	0.52 B	0.67 B	0.75	0.66 B	0.54 B	0.63 B	0.33 B	0.82 B	0.97 B
Cadmium	0.83 B	0.28 B	0.65 B	0.4 B	0.39 B	0.2 B	0.72 B	0.31 B	0.46 B	0.35 B
Chromium	36.3	16.5	39.3	25.2	21.4	15.5	26.6	15.7	24.9	27.9
Cobalt	12.1 B	7.9 B	5.0 B	20.5	15.9	9.2 B	9.6 B	8.1 B	8.8 B	9.4 B
Copper	25	15.3	18.6	22.8	29.1	8.4 B	22.4	20.7	18.4	19.5
Iron	26500	20300	44600	29100	20300	13900	45200	19200	24800	23900
Lead	96.6	34.5	19.6	53.3	166	28.5	80.2	39.4	73.1	62.2
Manganese	568	198	80.5	503	660	329	302	288	367	610
Mercury	0.27	0.28	0.26	0.24	0.66	0.14	0.27	0.21	0.18	0.27
Nickel	14.2	7.2 B	10.1 B	14.8	13.2	12.1	13.1	8.8 B	11.8	13.8
Selenium	ND	ND	ND	1.2	0.97 B	ND	ND	ND	1.1 B	0.88 B
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	0.83 B	0.67 B	2.1 B	1.2 B	ND	2.3 B	0.73 B	0.98 B	1 B	0.93 B
Vanadium	64.3	39.1	87	58.9	56.4	28.5	60.6	55.6	57.1	49.7
Zinc	94.1	23.6	22.7	39.4	75	26.9	51.7	49.9	57.6	55.4