APPENDIX E

Calculation of Site-Specific Background Concentration of Arsenic in Soil

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APPENDIX E

CALCULATION OF SITE-SPECIFIC BACKGROUND CONCENTRATION OF ARSENIC IN SOIL

Santa Cruz Branch Line
Santa Cruz County, California

1.0 INTRODUCTION

Site-specific background concentrations of arsenic in soil were calculated for the Santa Cruz Branch Line (the Branch Line) in Santa Cruz and Monterey Counties, California. This calculation was performed in support of the Supplemental Investigation and Human Health Risk Assessment for Arsenic in which concentrations of arsenic were evaluated along the Branch Line. The derivation of a site-specific background concentration (referred to as "ambient conditions," conditions unaffected by past *site-related* activities) was used to evaluate whether remedial action or risk management measures specific to arsenic in soil may be warranted prior to any future redevelopment of the Branch Line. The analysis presented herein has been prepared in accordance with several California Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC) guidance documents including but not limited to:

- *Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities, February 1997 and*
- *Arsenic Strategies, Determination of Arsenic Remediation, Development of Arsenic Cleanup Goals, January 16, 2009.*

Information regarding the history and geology of the Branch Line, along with a description of the sampling methodologies is presented in Sections 2.0 through 4.0 of the main report. A description of the approach and statistical methods used to derive a site-specific background concentration of arsenic in soil at the site is presented in the following sections.

2.0 DATA EVALUATION

The results of Phase II and supplemental soil sampling activities conducted in 2005 and 2009 were considered in this analysis. As part of these two sampling events, 228 soil samples were collected and analyzed for arsenic from 98 locations across the Branch Line at depths ranging from 0.5 to 10 feet below ground surface (bgs). This section describes the selection of soil

samples that are considered representative of background conditions for arsenic along the Branch Line.

Analytical data for arsenic in samples collected at depths greater than 1.5 feet bgs were considered representative of background because: 1) soil at depth is of the same geologic origin as soil from near surface (between 0 and 1.5 feet bgs); and 2) the deeper depth intervals are likely not affected by the former application of potential arsenic containing herbicides along the Branch Line (e.g. surface application). In addition, arsenic as background in deeper soil is valid because the chemical properties for arsenic suggest that the compound does not migrate through soil except for short distances and at high source soil concentrations, unless there was a transport mechanism to facilitate vertical migration. A total of 84 samples were collected at depths of greater than 1.5 feet bgs from 67 locations.

In addition to removing analytical results from shallow samples (depths less than or equal to 1.5 feet bgs), data was further screened to eliminate potential biases. Analytical results from samples collected at targeted locations to delineate potential impacts to soil were removed. Specifically, additional targeted samples were collected from borings SB-74 through SB-76 during the 2009 investigation to delineate elevated concentrations of arsenic in the vicinity of SB-23. Targeted samples also were collected from borings SB-77 through SB-82 to delineate elevated concentrations of polynuclear aromatic hydrocarbons (PAHs). During initial data evaluation, it was assumed that additional analytical data for arsenic at these locations would assist in evaluating background concentrations for the site; therefore, samples from SB-77 through SB-82 also were analyzed for arsenic. Although elevated concentrations of arsenic were not encountered at depths greater than 1.5 feet bgs in the vicinity of SB-10 and SB-23, inclusion of these additional samples (SB-74 through SB-82) would have provided overrepresentation towards the ambient conditions in these areas. Therefore, only the analytical results for samples collected at SB-10 and SB-23 were included in this analysis (i.e. additional samples SB-74 through SB-82 clustered around these points were not used) so that the each section of the Branch Line was equally represented in the background assessment.

After removing these data points, the dataset used to evaluate background concentrations of arsenic (referred to as “background dataset”) consisted of a total of 74 samples collected from depths greater than 1.5 feet bgs from 58 locations. The background dataset is presented in Table E-1.

3.0 STATISTICAL METHODS

The statistical methods applied to evaluate the ambient conditions of arsenic in soil along the Branch Line are described in this section. First, the analytical results for surficial samples

(0 to 1.5 feet bgs) and the background dataset were compared to test the hypothesis that the site-related arsenic impacts to soil were limited to surficial soil. Second, arsenic concentrations were evaluated by soil lithology. Third, the distribution of the background dataset was evaluated. Finally, the upper bound percentile of the background dataset was selected as a background threshold value to represent ambient conditions along the Branch Line.

3.1 COMPARISON OF SURFICIAL SAMPLES AND BACKGROUND DATASET

In order to test the hypothesis that concentrations of arsenic in samples collected at depths greater than 1.5 feet bgs were not related to site use, a data set comprised of surficial samples was compared to the background dataset with the Wilcox-Mann-Whitney (WMW) test (U.S. EPA, 2007). The surficial sample dataset was also screened to remove any potential biases associated with impacts related to railroad ties (SB-51 through SB-54) and the delineation of potential "hot spots" (SB-74 through SB-82) as discussed in section 2.0. The WMW test is a non-parametric statistical test that is used to evaluate whether there are differences between population distributions. The WMW test is used to "test whether or not measurements (location, central) from one population consistently tend to be larger (or smaller) than those from the other population based upon the assumption that the dispersion of the two distributions is roughly the same" (U.S. EPA, 2007).

The WMW test determines which, and/or if, population distributions are different by comparing the relative ranks of the two data sets. This is achieved by organizing the data sets into a single list and sorting (i.e., ranking) them by concentration. Advantages to using the WMW test include: (1) the two data sets are not required to be from known distributions, or of the same distribution; (2) the test allows for non-detect measurements to be present in the data sets by assigning the same rank to each non-detect result with the same detection limit; and (3) the test limits the influence of outliers because the analysis utilizes data ranks instead of the actual measured concentrations. Ultimately the test compares the probability (i.e., p-value) with the critical value (i.e., alpha) of 0.05 (set at a 95 percent confidence level). The WMW test allows for two-sided hypothesis testing where the null hypothesis (H_o) assumes the site population is less than or equal to the background population. If the p-value is less than or equal to alpha then the null hypothesis is rejected. The conclusion is then made that any difference between the distributions is due to "a shift in location (i.e., of the mean/median) of site concentrations to higher values due to the presence of contamination in addition to background" (U.S. EPA, 2007). Statistical software developed by the U.S. EPA, ProUCL version 4.00.04, was used for the WMW statistical test (U.S. EPA, 2009). A p-value of 6.52 E-13 was calculated, which is significantly less than 0.05, indicating that the two sample sets are from different distributions (see Attachment E-1). Therefore, site-related arsenic impacts to soil appear to be limited to the upper 1.5 feet bgs of soil and soil samples collected from depths greater than 1.5 feet bgs represent background conditions of arsenic along the Branch Line.

3.2 EVALUATION OF ARSENIC CONCENTRATIONS BY SOIL LITHOLOGY

Prior to estimating a background threshold value of arsenic for the Branch Line, soil samples in the background dataset were evaluated by lithology. Soil samples were classified by soil type based on field observations by an AMEC geologist as clay, sand, sandy clay, and sandy silt. The summary statistics for arsenic concentrations by soil lithology are presented below in Table E-2.

Table E-2. Summary Statistics for Arsenic in Soil Samples by Lithology

Soil Type	Clay	Sand	Sandy Clay
Count	7	48	19
Number of detects	7	45	18
Number of Non-Detects	0	3	1
Minimum Detection	1.2	1.2	1.5
Maximum Detection	33	46	14
Mean Concentration[1]	8.7	6.1	4.4
Standard Deviation[1]	11.2	8.0	3.1

The majority of samples were classified as sand (65%) or sandy clay (26%). The mean detected concentrations and standard deviations for the sand and sandy clay datasets are very similar. In addition, the WMW test was applied to the sand and sandy clay datasets with the critical value set at 0.05 for a 95 percent confidence level using ProUCL 4.00.04 (U.S. EPA; 2009). A p-value of 0.494 was calculated, which is significantly more than 0.05, indicating that the datasets are not from different distributions (See Attachment E-2).

There are not a sufficient number of samples to evaluate the distribution of the clay dataset. For completeness, the clay dataset was combined with the sandy clay dataset and compared to the sand dataset. This comparison is appropriate because all of the fine-grained soil types (i.e., clay and sandy clay) are compared to the coarse-grained soil types (i.e., sand). A p-value of 0.359 was calculated with the WMW test, which is significantly more than 0.05 (See Attachment E-3).

Based on an evaluation of summary statistics and the application of the WMW test, soil lithology does not appear to be a significant parameter in evaluating arsenic concentrations in the background dataset collected along the Branch Line. Therefore, soil lithology was not considered in the calculation of a background threshold value for the Branch Line.

1. For the calculation of the mean concentration and standard deviation, non-detect results were represented by one-half the analytical detection limit.

3.3 EVALUATION OF DISTRIBUTION OF BACKGROUND DATASET

Consistent with DTSC guidance (DTSC, 1997), the distribution of the background dataset was assessed to evaluate if multiple distributions or outliers are present. Lilliefors test was applied to determine if the background dataset is distributed normally or lognormally. In addition, normal and lognormal probability plots were produced to evaluate the background dataset distribution graphically. Finally, Rosner's test was applied to quantitatively evaluate the presence of potential outliers.

Lilliefors Test is used to evaluate the normality or lognormality of a dataset. Such tests are referred to as "Goodness of Fit" tests. As described by the U.S. EPA (U.S. EPA, 2007), Lilliefors test is applied to datasets comprised of over 50 observations. Lilliefors test was applied using ProUCL 4.00.04 and the output of this evaluation is presented in Attachment E-4 (U.S. EPA, 2009). As shown, the background dataset was found to be lognormally distributed.

The distribution of the background dataset was also evaluated graphically with normal and lognormal probability plots generated using ProUCL 4.00.04 (Figures E-1 and E-2; U.S. EPA, 2009). Visual inspection of both plots indicates that the background dataset closely fits the theoretical lognormal line in the lognormal probability plot (Figure E-2). In addition, based on the absence of "jumps" or "breaks" in the lognormal probability plot, the background dataset is comprised of one population. As described by the DTSC (DTSC, 2009), "jumps" or "breaks" in a probability plot indicate the presence of multiple distributions.

Finally, the distribution of the background dataset was evaluated for the presence of outliers. Outliers should be removed from a dataset prior to the calculation of a background threshold value since an estimate for a background threshold value should not be overly influenced by one or two observations, but should "conform to the pattern established by the majority of values in the dataset" (DTSC, 2009). Although no obvious outliers are present based on a visual inspection of the lognormal probability plot (Figure E-2), Rosners test was applied with ProUCL 4.00.04 to qualitatively test for the presence of outliers (see Attachment E-5; U.S. EPA, 2009). The observed arsenic concentration of 46 milligrams per kilogram (mg/kg) in the sample SB-62-4.5 was found to be an outlier at a 1% confidence level. As a conservative measure, the observed arsenic concentration of 33 mg/kg was also evaluated as a potential outlier; the background threshold value was calculated with and without the observed value of 33 mg/kg as discussed below in section 3.4.

3.4 ESTIMATION OF ARSENIC BACKGROUND THRESHOLD VALUE

As recommended by the DTSC (DTSC, 2009), an upper bound percentile of the background data set was selected to represent background. Based on the sample mean (x_bar) and the sample standard deviation (sd), the upper bound concentration, based on a 95% UCL on the

95th percentile, was calculated as an upper tolerance limit (UTL) of the distribution of concentrations in background soil. The UTL was based on the following relationship:

$$UTL = x\_bar + K * sd$$

For the calculation of the mean and standard deviation of the background dataset, the four non-detect results were represented by one-half the detection limit. The value of K (the tolerance factor) is determined from a table in Gilbert (1987) and corresponds to the number of data points, the percentile of the population (95th), and the confidence level (95 percent). The concentration corresponding to the UTL is 16.80 mg/kg, including the potential outlier concentration of 33 mg/kg, and 14.40 mg/kg excluding this observed concentration. Since the observed concentration of 33 mg/kg had strong influence on the calculated UTL, this value was removed from the dataset as an outlier. Therefore, the value of 14.40 mg/kg was used as the background threshold value for arsenic in soil along the Branch Line.

4.0 SUMMARY

In support of the Supplemental Investigation and Human Health Risk Assessment for Arsenic, a site-specific background concentration of arsenic along the Branch Line was derived. The arsenic background threshold value was calculated to be 14.40 mg/kg based on the upper percentile of the background dataset.

5.0 REFERENCES

Department of Toxic Substances Control (DTSC), 1997, Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessment at Hazardous Waste Sites and Permitted Facilities, February.

DTSC, 2009, Arsenic Strategies, Determination of Arsenic Remediation, Development Arsenic Cleanup Goals, January 16.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Co. New York.

U.S. Environmental Protection Agency (U.S. EPA), 2007, ProUCL Version 4.0, Technical Guide, Office of Research and Development, Washington DC, April.

U.S. EPA, 2009, ProUCL, Version 4.00.04, http://www.epa.gov/esd/tsc/software.htm.

TABLE E-1

BACKGROUND DATASET FOR ARSENIC
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)	Lithology
Targeted Samples				
SB-01-5	4/25/2005	5	4.2	SAND
SB-01-10	4/25/2005	10	4.2	SAND
SB-02-5	4/25/2005	5	4.3	SANDY CLAY
SB-02-10	4/25/2005	10	6.4	SANDY CLAY
SB-03-5	4/25/2005	5	5.7	SANDY CLAY
SB-03-10	4/25/2005	10	5	SANDY CLAY
SB-04-5	4/28/2005	5	1.5	SANDY CLAY
SB-04-10	4/28/2005	10	<1	SANDY CLAY
SB-05-5	4/28/2005	5	2.3	SANDY CLAY
SB-05-10	4/28/2005	10	14	SANDY CLAY
SB-10-3	4/25/2005	3	1.6	SANDY CLAY
SB-12-5	4/28/2005	5	2.4	SAND
SB-12-10	4/28/2005	10	1.8	SAND
SB-13-5	4/28/2005	5	2.5	SAND
SB-13-10	4/28/2005	10	2	SAND
SB-14-5	4/28/2005	5	4.4	SANDY CLAY
SB-14-10	4/28/2005	10	3.7	SAND
SB-15-5	4/25/2005	5	6.1	SAND
SB-15-10	4/25/2005	10	4.2	SAND
SB-16-5	4/28/2005	5	1.8	SAND
SB-16-10	4/28/2005	10	<1	SAND
SB-17-5	4/28/2005	5	3.8	SAND
SB-17-10	4/28/2005	10	1.2	SAND
SB-22-5	4/27/2005	5	6.2	SANDY CLAY
SB-22-10	4/27/2005	10	3	SAND
SB-23-5	4/27/2005	5	5.2	SANDY CLAY
SB-23-10	4/27/2005	10	8.4	SANDY CLAY
SB-32-3	4/27/2005	3	5.4	CLAY
SB-42-5	4/26/2005	5	8.3	SAND
SB-42-10	4/26/2005	10	5	CLAY
SB-43-3	4/26/2005	3	1.7	SANDY CLAY
SB-44-3	4/26/2005	3	2.2	CLAY
SB-45-3	4/26/2005	3	1.2	CLAY
SB-46-3	4/26/2005	3	1.9	SANDY CLAY
SB-47-3	4/26/2005	3	3.3	CLAY
SB-48-3	4/26/2005	3	3.7	SANDY CLAY
SB-49-5	4/28/2005	5	<1	SAND
SB-49-10	4/26/2005	10	3.8	SAND
SB-50-5	4/26/2005	5	<1	SAND
SB-50-10	4/26/2005	10	3.2	SANDY CLAY
SB-52-3	4/29/2005	3	5.2	SANDY CLAY
SB-53-3	4/29/2005	3	1.9	SAND

TABLE E-1

BACKGROUND DATASET FOR ARSENIC
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Sample ID	Sample Date	Depth (feet bgs)	Arsenic (mg/kg)	Lithology
Systematic Samples				
SB-83-4.5	2/12/2009	4.5	2.1	SAND
SB-84-4.5	2/12/2009	4.5	10	SAND
SB-85-4.5	2/12/2009	4.5	3.0	SAND
SB-86-4.5	2/12/2009	4.5	15	SAND
SB-87-4.5	2/12/2009	4.5	3.0	SAND
SB-88-4.5	2/12/2009	4.5	1.4	SAND
SB-89-4.5	2/12/2009	4.5	4.4	SAND
SB-90-4.5	2/12/2009	4.5	14	SAND
SB-91-4.5	2/12/2009	4.5	3.7	SAND
SB-92-4.5	2/12/2009	4.5	11	SAND
SB-93-4.5	2/12/2009	4.5	2.9	SAND
SB-94-4.5	2/12/2009	4.5	1.9	SANDY CLAY
SB-59-4.5	2/10/2009	4.5	3.4	SAND
SB-60-4.5	2/10/2009	4.5	4.7	SAND
SB-61-4.5	2/10/2009	4.5	6.9	SAND
SB-62-4.5	2/10/2009	4.5	46	SAND
SB-63-4.5	2/10/2009	4.5	22	SAND
SB-64-4.5	2/10/2009	4.5	2.5	SAND
SB-65-4.5	2/10/2009	4.5	3.5	SAND
SB-66-4.5	2/10/2009	4.5	2.0	SAND
SB-67-4.5	2/10/2009	4.5	2.2	SAND
SB-68-4.5	2/10/2009	4.5	2.9	SAND
SB-69-4.5	2/10/2009	4.5	2.8	SAND
SB-70-4.5	2/10/2009	4.5	2.5	SAND
SB-55-4.5	2/9/2009	4.5	11	SAND
SB-56-4.5	2/9/2009	4.5	21	SAND
SB-57-4.5	2/9/2009	4.5	11	CLAY
SB-58-3.5	2/9/2009	3.5	33	CLAY
SB-71-4.5	2/11/2009	4.5	2	SAND
SB-72-4.5	2/11/2009	4.5	2.0	SAND
SB-73-4.5	2/10/2009	4.5	6.7	SAND
SB-103-4.5	4/13/2009	4.5	23	SAND

Abbreviations
"<" = not detected at the indicated concentration
bgs = below ground surface
mg/kg = milligram per kilogram

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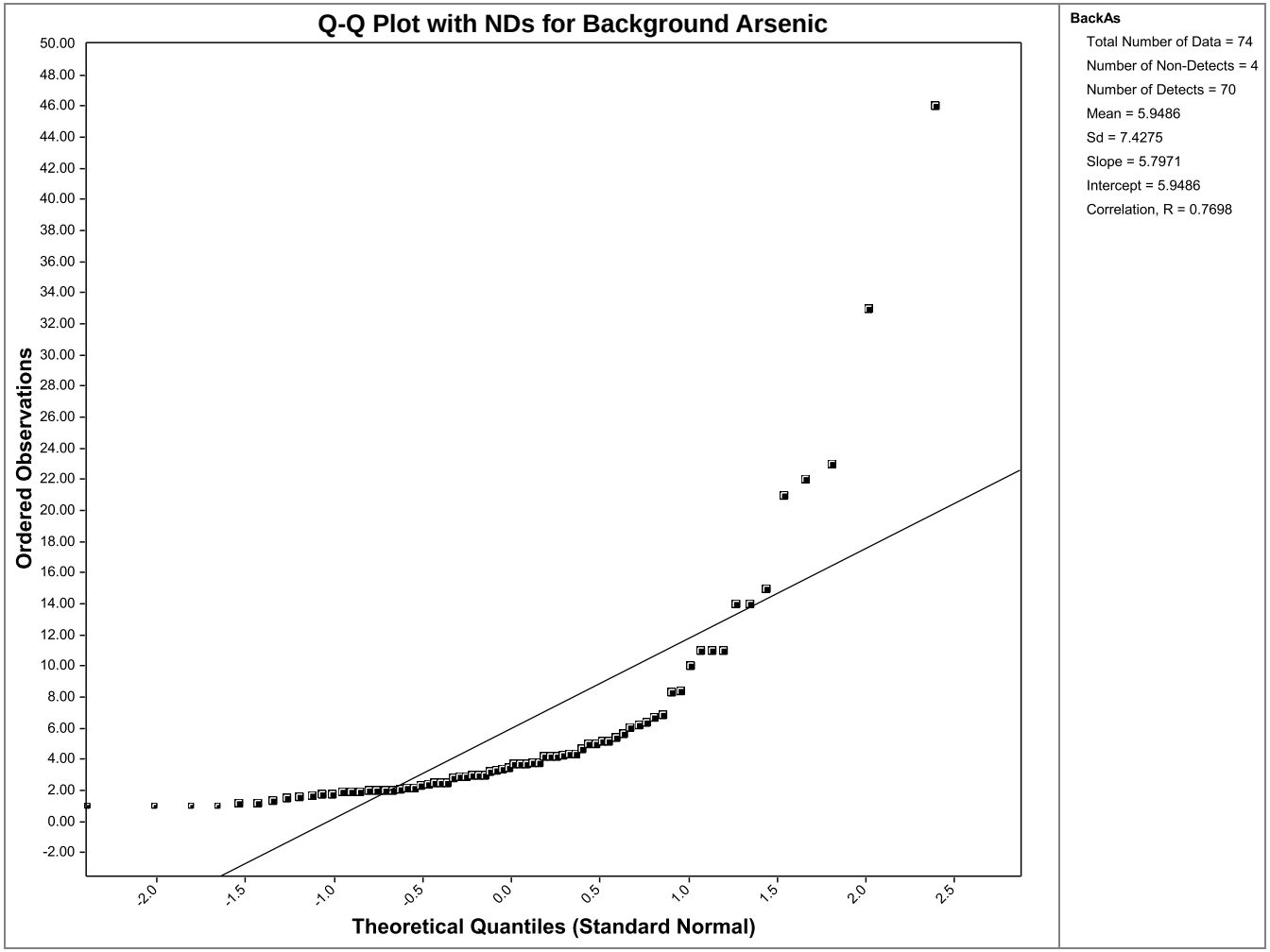

Reference: U.S. EPA, 2009, ProUCL version 4.00.04

NORMAL PROBABILITY PLOT OF
BACKGROUND DATASET
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

By: PS	Date: 7/24/2009	Project No. 6257.000.9
AMEC Geomatrix		Figure **E1**

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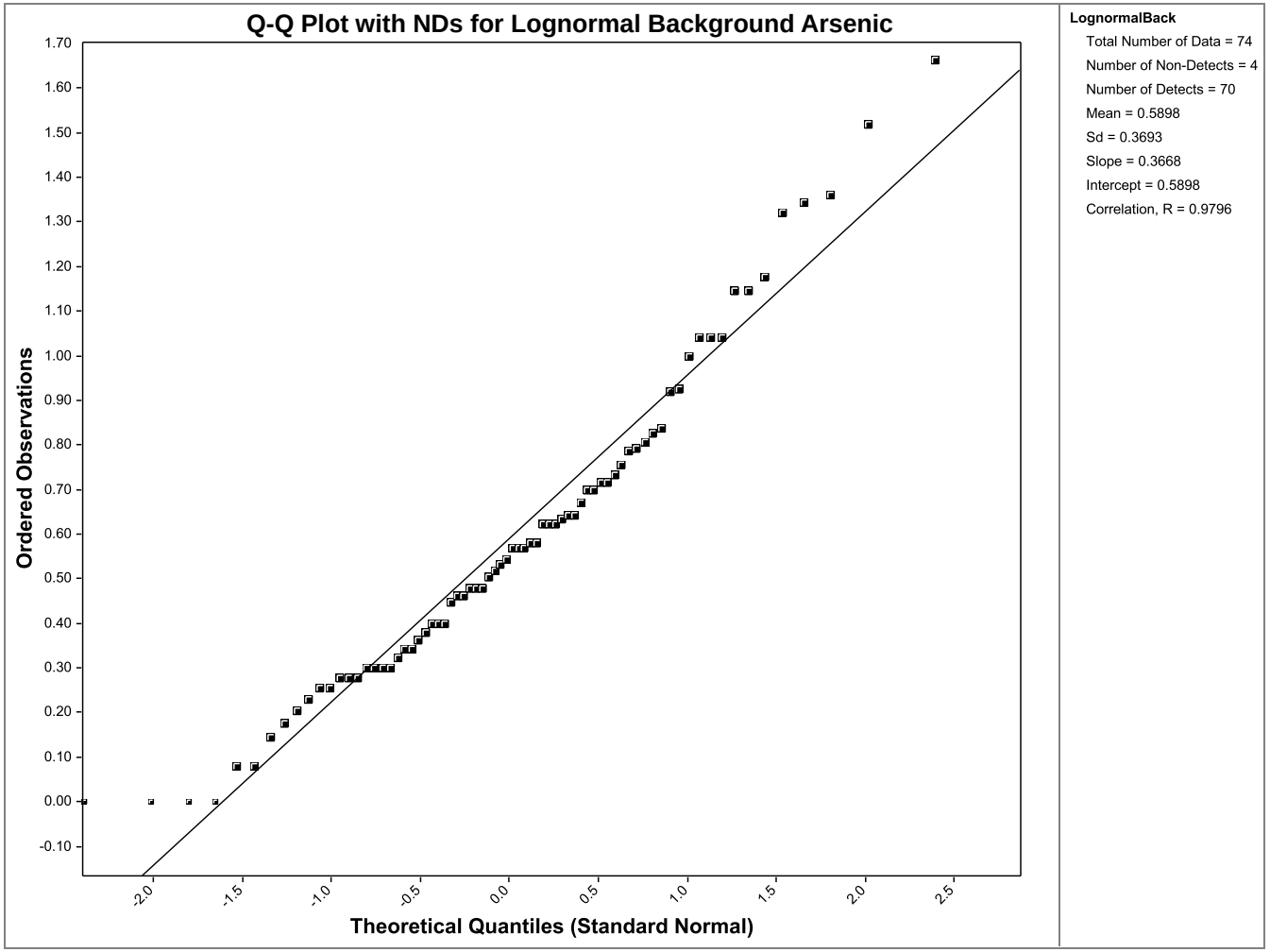

Reference: U.S. EPA, 2009, ProUCL version 4.00.04

LOGNORMAL PROBABILITY PLOT OF
BACKGROUND DATASET
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

By: PS	Date: 7/24/09	Project No. 6257.000.9
AMEC Geomatrix		Figure **E2**

ATTACHMENT E-1

ProUCL 4.00.02 OUTPUT—WILCOX-MANN-WHITNET TEST FOR SURFICIAL AND BACKGROUND DATASETS[1]

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Area of Concern Data: siteAs
Background Data: BackAs

Raw Statistics

	Site	Background
Number of Valid Data	133	74
Number of Non-Detect Data	2	4
Number of Detect Data	131	70
Minimum Non-Detect	1	1
Maximum Non-Detect	1	1
Percent Non detects	1.50%	5.41%
Minimum Detected	1.4	1.2
Maximum Detected	240	46
Mean of Detected Data	30.34	6.231
Median of Detected Data	13	3.7
SD of Detected Data	41.3	7.541

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	16763
WMW Test U-Stat	7.094
WMW Critical Value (0.050)	1.645
P-Value	**6.52E-13**

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Notes
1. Statistical output from ProUCL version 4.00.04 (U.S. EPA, 2009).

ATTACHMENT E-2

ProUCL 4.00.02 OUTPUT—WILCOX-MANN-WHITNET TEST FOR SAND AND SANDY CLAY DATASETS[1]

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Area of Concern Data: Sand
Background Data: Sandy Clay

Raw Statistics

	Site	Background
Number of Valid Data	48	19
Number of Non-Detect Data	3	1
Number of Detect Data	45	18
Minimum Non-Detect	1	1
Maximum Non-Detect	1	1
Percent Non detects	6.25%	5.26%
Minimum Detected	1.2	1.5
Maximum Detected	46	14
Mean of Detected Data	6.5	4.589
Median of Detected Data	3.5	4.35
SD of Detected Data	8.146	3.072

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	1632
WMW Test U-Stat	-0.0139
WMW Critical Value (0.050)	1.645
P-Value	**4.94E-01**

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Notes
1. Statistical output from ProUCL version 4.00.04 (U.S. EPA, 2009).

ATTACHMENT E-3

ProUCL 4.00.02 OUTPUT—WILCOX-MANN-WHITNET TEST FOR COARSE GRAINED AND FINE GRAINED DATASETS[1]

Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Area of Concern Data: Coarse Grain
Background Data: Fine Grain

Raw Statistics

	Site	Background
Number of Valid Data	48	26
Number of Non-Detect Data	3	1
Number of Detect Data	45	25
Minimum Non-Detect	1	1
Maximum Non-Detect	1	1
Percent Non detects	6.25%	3.85%
Minimum Detected	1.2	1.2
Maximum Detected	46	33
Mean of Detected Data	6.5	5.748
Median of Detected Data	3.5	4.4
SD of Detected Data	8.146	6.438

Wilcoxon-Mann-Whitney Site vs Background Test
Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Site or AOC <= Mean/Median of Background

Site Rank Sum W-Stat	1769
WMW Test U-Stat	-0.362
WMW Critical Value (0.050)	1.645
P-Value	**3.59E-01**

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Notes
1. Statistical output from ProUCL version 4.00.04 (U.S. EPA, 2009).

ATTACHMENT E-4

ProUCL 4.00.02 OUTPUT—LILLIEFORS TEST FOR BACKGROUND DATASET [1]
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Background Dataset

	Num Obs	Num Miss	Num Valid	Detects	NDs	% NDs
Raw Statistics	74	0	74	70	4	5.41%
	Number	Minimum	Maximum	Mean	Median	SD
Statistics (Non-Detects Only)	4	1	1	1	1	0
Statistics (Detects Only)	70	1.2	46	6.231	3.7	7.541
Statistics (All: NDs treated as DL value)	74	1	46	5.949	3.6	7.427
Statistics (All: NDs treated as DL/2 value)	74	0.5	46	5.922	3.6	7.447
Statistics (Normal ROS Estimated Data)	74	-10.4	46	5.455	3.6	8.036
Statistics (Gamma ROS Estimated Data)	74	1.00E-09	46	5.895	3.6	7.467
Statistics (Lognormal ROS Estimated Data)	74	0.462	46	5.929	3.6	7.441
	K Hat	K Star	Theta Hat	Log Mean	Log Stdv	Log CV
Statistics (Detects Only)	1.413	1.365	4.41	1.436	0.808	0.562
Statistics (NDs = DL)	1.318	1.274	4.513	1.358	0.85	0.626
Statistics (NDs = DL/2)	1.232	1.191	4.807	1.321	0.923	0.699
Statistics (Gamma ROS Estimates)	0.424	0.416	13.89	--	--	--
Statistics (Lognormal ROS Estimates)	--	--	--	1.333	0.898	0.674

Normal Distribution Test Results

	No NDs	NDs = DL	NDs = DL/2	Normal ROS
Correlation Coefficient R	0.77	0.77	0.775	0.839

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Lilliefors (Detects Only)	0.265	0.106	Data Not Normal
Lilliefors (NDs = DL)	0.26	0.103	Data Not Normal
Lilliefors (NDs = DL/2)	0.259	0.103	Data Not Normal
Lilliefors (Normal ROS Estimates)	0.244	0.103	Data Not Normal

Gamma Distribution Test Results

	No NDs	NDs = DL	NDs = DL/2	Gamma ROS
Correlation Coefficient R	0.935	0.937	0.942	0.986

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Anderson-Darling (Detects Only)	3.277	0.771	
Kolmogorov-Smirnov (Detects Only)	0.169	0.109	Data Not Gamma Distributed
Anderson-Darling (NDs = DL)	2.968	0.774	
Kolmogorov-Smirnov (NDs = DL)	0.161	0.106	Data Not Gamma Distributed
Anderson-Darling (NDs = DL/2)	2.454	0.776	
Kolmogorov-Smirnov (NDs = DL/2)	0.151	0.106	Data Not Gamma Distributed
Anderson-Darling (Gamma ROS Estimates)	9.558	0.836	
Kolmogorov-Smirnov (Gamma ROS Est.)	0.335	0.111	Data Not Gamma Distributed

Lognormal Distribution Test Results

	No NDs	NDs = DL	NDs = DL/2	Log ROS
Correlation Coefficient R	0.971	0.98	0.985	0.988

	Test value	Crit. (0.05)	Conclusion with Alpha(0.05)
Lilliefors (Detects Only)	0.106	0.106	Data Not Lognormal
Lilliefors (NDs = DL)	0.0909	0.103	**Data Appear Lognormal**
Lilliefors (NDs = DL/2)	0.0794	0.103	**Data Appear Lognormal**
Lilliefors (Lognormal ROS Estimates)	0.0828	0.103	**Data Appear Lognormal**

Note: Substitution methods such as DL or DL/2 are not recommended.

Notes
1. Statistical output from ProUCL version 4.00.04 (U.S. EPA, 2009).

ATTACHMENT E-5

ProUCL 4.00.02 OUTPUT—ROSNER'S TEST FOR BACKGROUND DATASET[1]
Santa Cruz Branch Line
Santa Cruz and Monterey Counties, California

Rosner's Outlier Test for Deep

Mean	5.922
Standard Deviation	7.447
Number of data	74
Number of suspected outliers	1

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	5.922	7.396	46	58	5.419	3.28	3.64

For 5% Significance Level, there is 1 Potential Outlier
Therefore, Observation 46 is a Potential Statistical Outlier

For 1% Significance Level, there is 1 Potential Outlier
Therefore, Observation 46 is a Potential Statistical Outlier

Notes

1. For the purpose of this evaluation, non-detects were represented by one-half the detection limit; statistical output from ProUCL version 4.00.04 (U.S. EPA, 2009).