

**ADDENDUM
ASSESSMENT OF BURN DEBRIS - 2007 WILDFIRES
SAN BERNARDINO AND SAN DIEGO COUNTIES, CALIFORNIA**



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engineers | scientists | innovators

5 March 2008

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I certify that this document and all attachments presented in this report are accurate and complete. This report was prepared by the staff of Geosyntec Consultants under my supervision to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who are directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

Veryl Wittig
California Professional Geologist No. 7115

5 March 2008
Date

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- Attachment 1: Tier II Validation – Level II Data deliverables – Select Metals
Attachment 2: Supplemental Statistical Analysis

1. INTRODUCTION

Geosyntec Consultants (Geosyntec) is pleased to submit this addendum to our 27 December 2007 report titled “Assessment of Burn Debris – 2007 Wildfires, San Bernardino and San Diego Counties, California” [Geosyntec, 2007]. The referenced report summarized the results of the assessment of burned residential areas associated with the October 2007 Slide Fire in San Bernardino County and Witch Creek Fire in San Diego County, California. Geosyntec performed the assessment on behalf of the California Environmental Protection Agency (CalEPA), Department of Toxic Substances Control (DTSC) in general accordance with the 27 November 2007 Sampling and Analysis Plan (SAP) [Geosyntec, 2007a].

This addendum was prepared to address comments presented by the United States Environmental Protection Agency Region 9 (USEPA) with regards to data validation and statistical analyses of analytical data. Based on their review of the report, and teleconferences on 19 February and 20 February 2008, it was agreed by the DTSC and the USEPA that an addendum would be prepared to address the following:

- Item 1: Statistically reevaluating arsenic, cadmium, copper and lead as constituents of concern (COCs) due to their prevalence in the burn debris samples collected during this assessment;
- Item 2: Performing focused validation of the laboratory analytical data for the above referenced list of COCs;
- Item 3: Performing a supplemental statistical analysis on the background metals data referenced in the report; and
- Item 4: Using the 95% upper control limit (UCL95) values for comparison to the accepted screening thresholds.

1.1 Constituents of Concern

Laboratory analytical results from the burn debris samples collected in San Bernardino and San Diego Counties indicated the presence of polynuclear aromatic hydrocarbons (PAHs) and metals at concentrations exceeding established screening criteria (California Human Health Screening Levels [CHHSLs] and Preliminary Remediation Goals [PRGs]) for residential properties. However, following additional evaluation of the data and discussions with USEPA it was agreed that the COCs in the residential burned debris with the greatest frequency of exceeding residential CHHSLs and PRGs were arsenic, cadmium, copper, and lead. Therefore, the analytical data for these metals were subjected to a more focused validation process to facilitate a supplemental statistical evaluation as described herein.

1.2 Focused Validation of Laboratory Analytical Data

Based on concerns expressed by the USEPA regarding some matrix spike (MS) and matrix spike duplicate (MSD) quality control analyses performed by the laboratory (Calscience Environmental Laboratories, Inc), Tier II data validation was performed for the primary COCs (arsenic, cadmium, copper, and lead) on each of the eight data sets (Attachment 1).

By nature burn debris is relatively non-homogenous and can contain various residues and fragments resulting in a highly variable and inconsistent matrix. This non-homogenous highly variable matrix collected for laboratory analyses can and does result in interferences that impact laboratory matrix spike analyses. This less than ideal matrix likely resulted in some matrix spike recovery percentages being outside typical quality control ranges for this assessment.

The Calscience laboratory reports indicated that MS/MSD recovery results outside of acceptable MS/MSD recovery ranges were attributed to matrix interference. Upon further review and validation Geosyntec concurs. Since only a portion of the MS/MSD recovery results were outside of acceptable recovery ranges and other laboratory Quality Assurance/Quality Control (QA/QC) data, including laboratory control spike/laboratory control spike duplicate (LCS/LCSD) results, were within acceptable ranges, it can be reasonably concluded that matrix interference was a factor in some of the failed MS/MSD recovery results. Geosyntec has performed a focused validation of the analytical data for the COCs and has flagged results from the samples that were used for MS/MSDs and outside of acceptable recovery ranges with an appropriate qualifier (Attachment 1). Due to the heterogeneity of the sample matrix, only those samples that were used for MS/MSDs were qualified. None of the data were rejected. Following validation of the data as presented in Attachment 1, it was concluded that the data as qualified are usable for meeting the project objectives.

1.3 Supplemental Statistical Evaluation of Background Metals

As requested by USEPA, Geosyntec completed a supplemental statistical evaluation of the concentration of metals in burn debris to background concentrations of these metals in California soils. Data from the Kearney Foundation Special Report “Background Concentrations of Trace and Major Elements in California Soils” [University of California - Riverside, 1996] was used as the comparison dataset. Statistical comparisons were made using the Wilcoxon Rank Sum test [Singh and Singh, 2007]. Results were computed for each metal by county under the null hypothesis that concentrations in the ash samples are elevated compared to background (i.e. $H_0: \text{Mean}_{\text{Site}} - \text{Mean}_{\text{Background}} \geq 0$). The result of the analysis are summarized the following Table.

COC	Background Mean (mg/kg)	San Bernardino County			San Diego County		
		Mean (mg/kg)	Result	WRS P-Value	Mean (mg/kg)	Result	WRS P-Value
Arsenic	3.536	13.97	Ash > Background	>0.99	7.306	Ash > Background	>0.99
Cadmium	0.357	22.99	Ash > Background	0.937	2.640	Ash > Background	0.958
Copper	28.69	3,856	Ash > Background	>0.99	4,383	Ash > Background	>0.99
Lead	23.89	1,493	Ash > Background	>0.99	403.8	Ash > Background	>0.99

WRS: Wilcoxon Rank Sum; refer to Attachment 2 for details

The results demonstrate that concentrations of metals in ash debris samples exceed the corresponding background levels in both San Diego and San Bernardino ash samples. The complete statistical output is supplied in Attachment 2.

1.4 Comparison of Upper Confidence Level (UCL)95 Values to CHHSLs and PRGs

Geosyntec completed a supplemental statistical analysis of the focused COC dataset. As part of this analysis, Geosyntec calculated the 95% UCL of the mean for comparison to human health-based CHHSLs and PRGs [OEHHA, 2003 and USEPA, 2004]. UCLs were calculated using the EPA PROUCL 4.0 software accounting for non-detect values [Singh and Singh, 2007]. The 95% UCL corresponding to the PROUCL selected methodology was selected as the exposure point concentration for comparison to screening values since the maximum concentration for each of the COCs exceeded the 95% UCL. The detailed results of the supplemental statistical evaluation are presented in Attachment 2 and summarized below.

COC	Screening Criteria			San Bernardino County		San Diego County	
	Background Mean (mg/kg)	CHHSL* (mg/kg)	Region 9 PRG* (mg/kg)	Mean (mg/kg)	95% UCL (mg/kg)	Mean (mg/kg)	95% UCL (mg/kg)
Arsenic	3.536	0.07	0.062	13.97	18.51	7.306	8.88
Cadmium	0.357	1.7	37	22.99	93.2	2.640	4.562
Copper	28.69	3,000	3,100	3,856	5,466	4,383	8,208
Lead	23.89	150	150	1,493	6,447	403.8	966.5

* Referenced CHHSLs and PRGs are for residential properties.

The supplemental statistical analysis for the four metals listed above demonstrates that the burn debris sampled from each of the respective counties contains arsenic, cadmium copper and lead in excess of the referenced screening criteria. Both the mean and the 95% upper confidence limit on the mean exceed at least one of the screening criteria. It is therefore likely that non-sampled residential properties with burn debris and ash may contain concentrations of these metals similar to those analyzed during the assessment.

2. CONCLUSIONS AND RECOMENDATIONS

The 27 December 2007 report supported the determination of an immediate threat to public health and safety made by CalEPA and its boards, departments, and offices according to FEMA Disaster Assistance Policy 9523.13, and that expedited removal of burn debris from these areas was warranted and in the “public interest.” Following a focused validation of the arsenic, cadmium, copper and lead data, and the supplemental statistical analyses performed on the referenced background metals data and the focused data set as requested by USEPA, the information presented in this addendum supports the previous conclusion that arsenic, cadmium, copper, and lead were present in burn debris at concentrations that exceeded residential CHHSLs and PRGs.

The conclusions presented in the 27 December 2007 report and this addendum support CalEPA’s expedited removal of burn debris and ash based on the determination that the burn debris and ash resulting from the 2007 Southern California Wildfires posed an immediate threat to public health and safety. We understand that following their review of this addendum USEPA will submit letters to the FEMA, the State, and the Counties with their recommendations for reimbursement of costs incurred for expedited removal of burn debris following the 2007 wildfires.

3. LIMITATIONS

This assessment of burned residential areas associated with the Slide and Witch Creek fires has been performed in accordance with current practices and the standard of care exercised by scientists and engineers performing similar tasks in this area. The conclusions contained in this report are based solely on the analysis of the conditions observed by Geosyntec personnel and as reported by regulatory agencies and other named sources. We cannot make any assurances concerning the completeness of the data presented to us.

No warranty, expressed or implied, is made regarding the professional opinions expressed in this report. If actual conditions are found to differ from those described in this report, or if new information regarding the site is obtained, Geosyntec should be notified and additional recommendations, if required, will be provided. Geosyntec is not liable for any use of the information contained in this report by persons other than the California Department of Toxic Substances Control, or use of information in this report for any purposes other than referenced in this report without the expressed, written consent of Geosyntec.

4. REFERENCES

- Geosyntec Consultants, 2007. *Assessment of Burned Debris – 2007 Wildfires, San Diego and San Bernardino Counties, California*. 27 December 2007.
- Geosyntec Consultants, 2007a. *Sampling and Analysis Plan, 2007 Wildfires - Burn Debris Assessment, San Diego and San Bernardino Counties, California*. 27 November 2007.
- Office of Environmental Health Hazard Assessment (OEHHA), 2003. *Air Toxics Hot Spots Program Risk Assessment Guidelines – The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*. August 2003.
- Singh, R. and A.K. Singh, 2007. *ProUCL Version 4.0 Technical Guide*. J.M. Nocerino, editor. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/041 (NTIS PB2007-107919), 4/30/2007
- United States Environmental Protection Agency (USEPA), 2004. *Region IX PRGs Table 2002 Update*, 1 October 2004.
- University of California Riverside and CalEPA DTSC, 1996. *Background Concentrations of Trace and Major Elements in California Soils, Kearney Foundation Special Report*, March 1996.

ATTACHMENT 1

Tier II Data Validation

Level II Data Deliverables - Metals

Memorandum

Date: 28 February 2008
To: Veryl Wittig
From: Julia Caprio
CC:
Subject: Tier II Data Validation - Level II Data deliverable – Select Metals by
EPA Method 6010B

SITE: 2007 San Diego and San Bernardino Counties Burn Debris Sampling

Introduction

This report summarizes the findings of the Tier II data validation of ash samples and associated QC samples collected in November 2007 as part of the San Diego County Burn Area sampling event. Calscience Environmental Laboratories, Inc. (CEL), Garden Grove, California analyzed all of the ash samples. For the purposes of this validation report, only the samples analyzed for the following test were validated:

- EPA Method 6010B Arsenic (As), Cadmium (Cd), Copper (Cu), Lead (Pb)

Executive Summary

All samples were handled, prepared, and measured in the same manner under similar prescribed conditions. Overall, based on this Tier II data validation covering the QC parameters listed below, the data as qualified are usable for meeting project objectives.

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2007 Burn Debris Sampling

1.0 CEL Work Order No: 07-11-1933

The following samples were analyzed in the data set:

Client ID	Lab ID
SD-34-11262007	07-11-1933-1-A
SD-31-11262007	07-11-1933-2-A
SD-09-11262007	07-11-1933-3-A
SD-08-11262007	07-11-1933-4-A
SD-40-11262007	07-11-1933-5-A

Five ash samples were analyzed for Title 22 Metals per EPA Method 6010B. The samples were collected on November 26, 2007. The data were reviewed in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review, October 2004, as well as by the pertinent methods referenced by the data package. The data review process provides information on the analytical limitations of data based on specified quality control (QC) criteria.

The following summarizes the results of this review.

The areas of review are listed below. A leading check mark (✓) indicates an area of review in which all data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Times
- ✓ Method Blanks
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Spike

1.1 Overall Assessment

The data reported in this package are considered to be usable for meeting project objectives. All results are considered to be valid; the analytical completeness defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

Note: A review of the chain-of-custody (COC) form did identify a write-over for the relinquish date instead of the proper error correction of a single strike through, correction, initials and date.

1.2 Holding times

All holding times were met for the sample analyses.

1.3 Method Blanks

Blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported with the data (Batch 071128L06). Arsenic was detected in the method blank at an estimated level less than the reporting limit but greater than the minimum detection limit (MDL) at 0.199 mg/kg. However, since the concentrations of Arsenic in the samples was greater than 10X that found in the blank, no qualifications were applied to the data. Cadmium, copper, and lead were not detected in the associated blank above their respective reporting limits.

1.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one pair per batch of 20 samples). Batch QC was used for the MS/MSD (07-11-1892-32) therefore the results from the MS/MSD would not impact the data set. The MS/MSD pairs had recovery and relative percent difference (RPD) results within the laboratory specified criteria for arsenic, cadmium, copper, and lead.

1.5 Laboratory Control Spike (LCS)

An LCS/LCSD pair was analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). The results for the LCS sample (Batch 071128L06) were within the laboratory specified acceptance criteria for recovery.

2.0 CEL Work Order No: 07-11-2008

The following samples were analyzed in the data set:

Client ID	Lab ID
SB-19-112807	07-11-2008-1-A
SB-28-112807	07-11-2008-2-A
SB-28C-112807	07-11-2008-3-A
SB-11-112807	07-11-2008-4-A
SB-29-112807	07-11-2008-5-A
SB-20-112807	07-11-2008-6-A
SB-39-112807	07-11-2008-7-A

Seven ash samples were analyzed for Title 22 Metals per EPA Method 6010B. The samples were collected on November 28, 2007. The data were reviewed in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review, October 2004, as well as by the pertinent methods referenced by the data package. The data review process provides information on the analytical limitations of data based on specified quality control (QC) criteria.

The following summarizes the results of this review.

The areas of review are listed below. A leading check mark (✓) indicates an area of review in which all data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Times
- ✓ Method Blanks
- ⊗ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Spike

2.1 Overall Assessment

The data reported in this package are considered to be usable for meeting project objectives. All results are considered to be valid; the analytical completeness defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

2.2 Holding times

All holding times were met for the sample analyses.

2.3 Method Blanks

Blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported with the data (Batch 071129L10). Lead was detected in the method blank at an estimated level less than the reporting limit but greater than the minimum detection limit (MDL) at 0.0934 mg/kg. However, since the concentrations of Lead in the samples was greater than 10X that found in the blank, no qualifications were applied to the data. Cadmium, copper, and arsenic were not detected in the associated blank above their respective reporting limits.

2.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one pair per batch of 20 samples). Sample set specific sample SB-19-112807 was used for the MS/MSD. The recovery for lead was high and outside of the QC criteria (139% and 398% respectively) as was the relative percent difference (RPD) at 44%. Lead was J+ qualified as estimated with a high bias in sample SB-19-112807.

Sample	Compound	Laboratory Result	Qualified Result
SB-19-112807	Lead	79.3	79.3 J+

No other qualifications were applied to the sample based on the MS/MSD results.

Note: Only the sample used for the MS/MSD was qualified. The qualification was not applied to all of the samples in the sample set based on professional judgment that it was not representative of the sample matrix as a whole. The samples consist of randomly-selected 3 to 5-point composites of ash and burned debris (wood, drywall and other non-soil materials) that were placed into a stainless steel bowl and homogenized. Therefore, depending on the materials samples, there could be significant variability between samples.

2.5 Laboratory Control Spike (LCS)

An LCS/LCSD pair was analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). The results for the LCS sample (Batch 071129L10) were within the laboratory specified acceptance criteria for recovery.

3.0 CEL Work Order No: 07-11-2009

The following samples were analyzed in the data set:

Client ID	Lab ID
SB-18-112707	07-11-2009-1-A
SB-32-112707	07-11-2009-2-A
SB-08-112707	07-11-2009-3-A
SB-13A-112707	07-11-2009-4-A
SB-13B-112707	07-11-2009-5-A
SB-13C-112707	07-11-2009-6-A
SB-30A-112707	07-11-2009-7-A
SB-30B-112707	07-11-2009-8-A
SB-14-112707	07-11-2009-9-A
SB-26-112707	07-11-2009-10-A
SB-04-112707	07-11-2009-11-A

Eleven ash samples were analyzed for Title 22 Metals per EPA Method 6010B. The samples were collected on November 27, 2007. The data were reviewed in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review, October 2004, as well as by the pertinent methods referenced by the data package. The data review process provides information on the analytical limitations of data based on specified quality control (QC) criteria.

The following summarizes the results of this review.

The areas of review are listed below. A leading check mark (✓) indicates an area of review in which all data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Times
- ✓ Method Blanks
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Spike

3.1 Overall Assessment

The data reported in this package are considered to be usable for meeting project objectives. All results are considered to be valid; the analytical

completeness defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

3.2 Holding times

All holding times were met for the sample analyses.

3.3 Method Blanks

Blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported with the data (Batch 071129L10). Lead was detected in the method blank at an estimated level less than the reporting limit but greater than the minimum detection limit (MDL) at 0.0934 mg/kg. However, since the concentrations of Lead in the samples was greater than 10X that found in the blank, no qualifications were applied to the data. Cadmium, copper, and arsenic were not detected in the associated blank above their respective reporting limits.

3.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one pair per batch of 20 samples). Batch QC was used for the MS/MSD (07-11-2008-1) therefore the results from the MS/MSD would not impact the data set and no qualifications were applied to the data based on the results.

3.5 Laboratory Control Spike (LCS)

An LCS/LCSD pair was analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). The results for the LCS sample (Batch 071129L10) were within the laboratory specified acceptance criteria for recovery.

4.0 CEL Work Order No: 07-11-2022

The following samples were analyzed in the data set:

Client ID	Lab ID
SD-21-11272007	07-11-2022-1-A
SD-12-11272007	07-11-2022-2-A
SD-16-11272007	07-11-2022-3-A
SD-13-11272007	07-11-2022-4-A
SD-41-11272007	07-11-2022-5-A
SD-19-C-11272007	07-11-2022-6-A
SD-19-11272007	07-11-2022-7-A
SD-38-11272007	07-11-2022-8-A
SD-36-11272007	07-11-2022-9-A
SD-18-11272007	07-11-2022-10-A
SD-18-C-11272007	07-11-2022-11-A
SD-24-11272007	07-11-2022-12-A
SD-22-11272007	07-11-2022-13-A
SD-25-11272007	07-11-2022-14-A
SD-54-11272007	07-11-2022-15-A
SD-46-11272007	07-11-2022-16-A

Sixteen ash samples were analyzed for Title 22 Metals per EPA Method 6010B. The samples were collected on November 27, 2007. The data were reviewed in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review, October 2004, as well as by the pertinent methods referenced by the data package. The data review process provides information on the analytical limitations of data based on specified quality control (QC) criteria.

The following summarizes the results of this review.

The areas of review are listed below. A leading check mark (✓) indicates an area of review in which all data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Times
- ⊗ Method Blanks
- ⊗ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Spike

4.1 Overall Assessment

The data reported in this package are considered to be usable for meeting project objectives. All results are considered to be valid; the analytical completeness defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

4.2 Holding times

All holding times were met for the sample analyses.

4.3 Method Blanks

Blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported with the data (Batch 071129L10). Arsenic was detected in the method blank at an estimated level less than the reporting limit but greater than the minimum detection limit (MDL) at 0.240 mg/kg. The following qualifications were applied to the data based on the blank contamination:

Sample	Laboratory Result	Validation Result
SD-38-11272007	1.78	1.78 J
SD-18-11272007	2.12	2.12 J
SD-22-11272007	1.93	1.93 J
SD-25-11272007	2.23	2.23 J

J=estimated

Cadmium, copper, and lead were not detected in the associated blank above their respective reporting limits.

4.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one pair per batch of 20 samples). Sample set specific sample SB-19-C-11272007 was used for the MS/MSD. The percent recovery for copper was high and outside of the QC criteria (239% and 139% respectively); therefore the following result was J+ qualified as estimated with a high bias:

Sample ID	Compound	Laboratory Result	Validation Result
SB-19-C11272007	Copper	73.1	73.1 J+

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The percent recoveries and RPD results were acceptable for arsenic, cadmium, and lead.

Note: Only the sample used for the MS/MSD was qualified. The qualification was not applied to all of the samples in the sample set based on professional judgment that it was not representative of the sample matrix as a whole. The samples consist of randomly-selected 3 to 5-point composites of ash and burned debris (wood, drywall and other non-soil materials) that were placed into a stainless steel bowl and homogenized. Therefore, depending on the materials samples, there could be significant variability between samples.

4.5 Laboratory Control Spike (LCS)

An LCS/LCSD pair was analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). The results for the LCS sample (Batch 071129L06) were within the laboratory specified acceptance criteria for recovery.

5.0 CEL Work Order No: 07-11-2096

The following samples were analyzed in the data set:

Client ID	Lab ID
SB-31-112807	07-11-2096-1-A
SB-42A-112807	07-11-2096-2-A
SB-42B-112807	07-11-2096-3-A
SB-41-112807	07-11-2096-4-A
SB-25A-112807	07-11-2096-5-A
SB-25B-112807	07-11-2096-6-A
SB-40-112807	07-11-2096-7-A
SB-17-112807	07-11-2096-8-A
SB-35-112907	07-11-2096-9-A
SB-35C-112907	07-11-2096-10-A
SB-24-112907	07-11-2096-11-A
SB-43-112907	07-11-2096-12-A
SB-07-112907	07-11-2096-13-A
SB-21-112907	07-11-2096-14-A
SB-36-112907	07-11-2096-15-A

Fifteen ash samples were analyzed for Title 22 Metals per EPA Method 6010B. The samples were collected on November 28, 2007. The data were reviewed in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review, October 2004, as well as by the pertinent methods referenced by the data package. The data review process provides information on the analytical limitations of data based on specified quality control (QC) criteria.

The following summarizes the results of this review.

The areas of review are listed below. A leading check mark (✓) indicates an area of review in which all data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Times
- ✓ Method Blanks
- ⊗ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Spike

5.1 Overall Assessment

The data reported in this package are considered to be usable for meeting project objectives. All results are considered to be valid; the analytical completeness defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

5.2 Holding times

All holding times were met for the sample analyses.

5.3 Method Blanks

Blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported with the data (Batch 071130L04). Lead and copper were detected in the method blank at estimated levels less than the reporting limit but greater than the minimum detection limit (MDL) at 0.179 and .496 mg/kg. However, since the concentrations of lead and copper in the samples was greater than 10X that found in the blank, no qualifications were applied to the data. Cadmium and arsenic were not detected in the associated blank above their respective reporting limits.

5.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one pair per batch of 20 samples). Sample set specific sample SB-17-1128207 was used for the MS/MSD. The MSD result for arsenic was high and outside of the QC acceptance limit at 151%. The following arsenic result is J+ qualified as estimated with a high bias, based on this result:

Sample	Compound	Laboratory Result	Validation Result
SB-17-112807	Arsenic	52.0	52.0 J+

The percent recovery could not be quantified for lead and copper since the concentrations were greater than 4X the spike amount. The percent recoveries and RPD results were acceptable for cadmium.

Note: Only the sample used for the MS/MSD was qualified. The qualification was not applied to all of the samples in the sample set based on professional judgment that it was not representative of the sample matrix as a whole. The samples consist of randomly-selected 3 to 5-point composites of ash and

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burned debris (wood, drywall and other non-soil materials) that were placed into a stainless steel bowl and homogenized. Therefore, depending on the materials samples, there could be significant variability between samples.

5.5 Laboratory Control Spike (LCS)

An LCS/LCSD pair was analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). The results for the LCS sample (Batch 071130L04) were within the laboratory specified acceptance criteria for recovery.

6.0 CEL Work Order No: 07-11-2129

The following samples were analyzed in the data set:

Client ID	Lab ID
SD-26-11282007	07-11-2129-1-A
SD-02-11282007	07-11-2129-2-A
SD-44-11282007	07-11-2129-3-A
SD-20-11282007	07-11-2129-4-A
SD-11-11282007	07-11-2129-5-A
SD-53-11282007	07-11-2129-6-A
SD-47-11282007	07-11-2129-7-A
SD-50-11282007	07-11-2129-8-A
SD-50C-11282007	07-11-2129-9-A
SD-55-11282007	07-11-2129-10-A
SD-51-11282007	07-11-2129-11-A
SD-62-11282007	07-11-2129-12-A
SD-58-11282007	07-11-2129-13-A
SD-56-11282007	07-11-2129-14-A

Fourteen ash samples were analyzed for Title 22 Metals per EPA Method 6010B. The samples were collected on November 28, 2007. The data were reviewed in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review, October 2004, as well as by the pertinent methods referenced by the data package. The data review process provides information on the analytical limitations of data based on specified quality control (QC) criteria.

The following summarizes the results of this review.

The areas of review are listed below. A leading check mark (✓) indicates an area of review in which all data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Times
- ✓ Method Blanks
- ⊗ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Spike

6.1 Overall Assessment

The data reported in this package are considered to be usable for meeting project objectives. All results are considered to be valid; the analytical completeness defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

6.2 Holding times

All holding times were met for the sample analyses.

6.3 Method Blanks

Blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported with the data (Batch 071203L08). Lead, cadmium, copper, and arsenic were not detected in the associated blank above their respective reporting limits.

6.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD) MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one pair per batch of 20 samples). Sample set specific sample SD-20-11282007 was used for the MS/MSD. The MSD result for arsenic was high and outside of the QC acceptance limit at 127%. The following arsenic result is J+ qualified as estimated with a high bias:

Sample	Compound	Laboratory Result	Validation Result
SD-20-1128007	Arsenic	11.3	11.3 J+

The percent recovery could not be quantified for lead and copper since the concentrations of lead and copper were greater than 4X the spike amount. The percent recovery and RPD result were acceptable for cadmium.

Note: Only the sample used for the MS/MSD was qualified. The qualification was not applied to all of the samples in the sample set based on professional judgment that it was not representative of the sample matrix as a whole. The samples consist of randomly-selected 3 to 5-point composites of ash and burned debris (wood, drywall and other non-soil materials) that were placed into a stainless steel bowl and homogenized. Therefore, depending on the materials samples, there could be significant variability between samples.

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6.5 Laboratory Control Spike (LCS)

An LCS/LCSD pair was analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). The results for the LCS sample (Batch 071203L08) were within the laboratory specified acceptance criteria for recovery

7.0 CEL Work Order No: 07-11-2130

The following samples were analyzed in the data set:

Client ID	Lab ID
SD-63-11292007	07-11-2130-1-A
SD-67-11292007	07-11-2130-2-A
SD-72-11292007	07-11-2130-3-A
SD-72-C-11292007	07-11-2130-4-A

Four ash samples were analyzed for Title 22 Metals per EPA Method 6010B. The samples were collected on November 29, 2007. The data were reviewed in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review, October 2004, as well as by the pertinent methods referenced by the data package. The data review process provides information on the analytical limitations of data based on specified quality control (QC) criteria.

The following summarizes the results of this review.

The areas of review are listed below. A leading check mark (✓) indicates an area of review in which all data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Times
- ✓ Method Blanks
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Spike

7.1 Overall Assessment

The data reported in this package are considered to be usable for meeting project objectives. All results are considered to be valid; the analytical completeness defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total number of analytical results requested on samples submitted for analysis, for the project is 100%.

7.2 Holding times

All holding times were met for the sample analyses.

7.3 Method Blanks

Blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported with the data (Batch 071130L04). Lead was detected in the method blank at an estimated level less than the reporting limit but greater than the minimum detection limit (MDL) at 0.179 mg/kg. However, since the concentrations of Lead in the samples was greater than 10X that found in the blank, no qualifications were applied to the data. Cadmium, copper, and arsenic were not detected in the associated blank above their respective reporting limits.

7.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one pair per batch of 20 samples). Batch QC was used for the MS/MSD (07-11-2096-8) therefore the results from the MS/MSD would not impact the data set and no qualifications were applied to the data based on the results.

7.5 Laboratory Control Spike (LCS)

An LCS/LCSD pair was analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). The results for the LCS sample (Batch 071130L04) were within the laboratory specified acceptance criteria for recovery

8.0 CEL Work Order No: 07-12-0014

The following samples were analyzed in the data set:

Client ID	Lab ID
SB-45-112907	07-12-0014-1-A
SB-48-112907	07-12-0014-2-A
SB-46-112907	07-12-0014-3-A
SB-05-112907	07-12-0014-4-A
SB-47-112907	07-12-0014-5-A
SB-51-113007	07-12-0014-6-A
SB-44-113007	07-12-0014-7-A
SB-44C-113007	07-12-0014-8-A
SB-38-113007	07-12-0014-9-A
SB-50-113007	07-12-0014-10-A

Ten ash samples were analyzed for Title 22 Metals per EPA Method 6010B. The samples were collected on November 29, 2007. The data were reviewed in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Methods Data Review, October 2004, as well as by the pertinent methods referenced by the data package. The data review process provides information on the analytical limitations of data based on specified quality control (QC) criteria.

The following summarizes the results of this review.

The areas of review are listed below. A leading check mark (✓) indicates an area of review in which all data were acceptable. A preceding crossed circle (⊗) signifies areas where issues were raised during the course of the validation review and should be considered to determine any impact on data quality and usability.

- ✓ Overall Assessment
- ✓ Holding Times
- ✓ Method Blanks
- ✓ Matrix Spike/Matrix Spike Duplicate
- ✓ Laboratory Control Spike

8.1 Overall Assessment

The data reported in this package are considered to be usable for meeting project objectives. All results are considered to be valid; the analytical completeness defined as the ratio of the number of valid analytical results (valid analytical results include values qualified as estimated) to the total

number of analytical results requested on samples submitted for analysis, for the project is 100%.

Note: A review of the COC indicated that a relinquished time was not indicated for the samples.

8.2 Holding times

All holding times were met for the sample analyses.

8.3 Method Blanks

Blanks were analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). One method blank was reported with the data (Batch 071203L13). Lead, cadmium, copper, and arsenic were not detected in the associated blank above their respective reporting limits.

8.4 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD pairs were analyzed at the proper frequency for the number and types of samples analyzed (one pair per batch of 20 samples). Batch QC was used for the MS/MSD (07-11-2200-3) therefore the results from the MS/MSD would not impact the data set and no qualifications were applied to the data based on the results.

8.5 Laboratory Control Spike (LCS)

An LCS/LCSD pair was analyzed at the proper frequency for the number and types of samples analyzed (one per batch of 20 samples). The results for the LCS sample (Batch 071203L04) were within the laboratory specified acceptance criteria for recovery

ATTACHMENT 2

Supplemental Statistical Analysis

Attachment 2

Supplemental Statistical Analysis 2007 Wildfires – Burned Debris Assessment San Diego and San Bernardino Counties, California

This Attachment includes the statistical output for the supplemental statistical analysis requested by EPA for the burn debris sampling data collected from the San Diego and San Bernardino County fires in November 2007.

Statistical evaluations were performed independently for each County dataset. Four compounds arsenic (As), cadmium (Cd), copper (Cu), and lead (Pb) were selected for inclusion in this analysis. Based on the detected concentrations and toxicity considerations these compounds were determined to be representative compounds of concern for ash. Data were evaluated for suitability for inclusion in the analysis based on MS/MSD recovery. Proxy values equivalent to ½ the Method Detection Limit (MDL) were included for samples where the concentration was reported as non-detect.

Mean and 95% UCLs on the mean were calculated using the EPA PROUCL ver 4.0 software accounting for non-detects in the data [Singh and Singh, 2007]. The 95% UCL corresponding to the PROUCL selected methodology was selected as the exposure point concentration for comparison to screening values and is the smaller of the 95%UCL and the maximum detected concentration. Detailed statistical output for the 95% UCL calculations is provided below.

Background comparisons were made using the Wilcoxon Rank Sum test (Singh and Singh, 2007). Data for each County and compound were compared to the California background dataset [UC Riverside and DTSC, 1996] under the null hypothesis that concentrations in the ash samples are elevated compared to background (i.e. $H_0: \text{Mean}_{\text{Site}} - \text{Mean}_{\text{Background}} \geq 0$). Statistical output from these tests is provided below.

Key:

SD = San Diego

SB = San Bernardino

PROUCL 4.0 Output

SD_arsenic

General Statistics

Number of Valid Samples	39	Number of Unique Samples	37
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Raw Statistics

Minimum	1.26	Log-transformed Statistics	
Maximum	34.3	Minimum of Log Data	0.231
Mean	7.306	Maximum of Log Data	3.535
Median	6.62	Mean of log Data	1.743
SD	5.937	SD of log Data	0.711
Coefficient of Variation	0.813		
Skewness	2.784		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.752	Shapiro Wilk Test Statistic	0.976
Shapiro Wilk Critical Value	0.939	Shapiro Wilk Critical Value	0.939
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

95% Student's-t UCL	8.909	Assuming Lognormal Distribution	
95% UCLs (Adjusted for Skewness)		95% H-UCL	9.354
95% Adjusted-CLT UCL	9.323	95% Chebyshev (MVUE) UCL	11.25
95% Modified-t UCL	8.98	97.5% Chebyshev (MVUE) UCL	12.96
		99% Chebyshev (MVUE) UCL	16.32

Gamma Distribution Test

k star (bias corrected)	2.036	Nonparametric Test	
Theta Star	3.589	Data appear Gamma Distributed at 5% Significance Level	
nu star	158.8		

Approximate Chi Square Value (.05)

Adjusted Level of Significance	0.0437	Nonparametric Statistics	
Adjusted Chi Square Value	129.6	95% CLT UCL	8.87
		95% Jackknife UCL	8.909
		95% Standard Bootstrap UCL	8.885

Anderson-Darling Test Statistic

Anderson-Darling Test Statistic	0.427	95% Bootstrap-t UCL	9.559
Anderson-Darling 5% Critical Value	0.758	95% Hall's Bootstrap UCL	15.11
Kolmogorov-Smirnov Test Statistic	0.0838	95% Percentile Bootstrap UCL	8.92
Kolmogorov-Smirnov 5% Critical Value	0.143	95% BCA Bootstrap UCL	9.519
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	11.45
		97.5% Chebyshev(Mean, Sd) UCL	13.24
		99% Chebyshev(Mean, Sd) UCL	16.77

Assuming Gamma Distribution

95% Approximate Gamma UCL	8.88		
95% Adjusted Gamma UCL	8.948		

Potential UCL to Use

	Use 95% Approximate Gamma UCL	8.88
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SD_cadmium

General Statistics

Number of Valid Samples	39	Number of Detected Data	24
Number of Unique Samples	23	Number of Non-Detect Data	15
		Percent Non-Detects	38.46%

Raw Statistics

Minimum Detected	0.736	Log-transformed Statistics	
Maximum Detected	31.4	Minimum Detected	-0.307
Mean of Detected	4.287	Maximum Detected	3.447
SD of Detected	6.461	Mean of Detected	0.959
Minimum Non-Detect	0.0049	SD of Detected	0.89
Maximum Non-Detect	0.0049	Minimum Non-Detect	-5.31
		Maximum Non-Detect	-5.31

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.513	Shapiro Wilk Test Statistic	0.932
5% Shapiro Wilk Critical Value	0.916	5% Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

DL/2 Substitution Method		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.639	Mean	-1.719
SD	5.452	SD	3.501
95% DL/2 (t) UCL	4.111	95% H-Stat (DL/2) UCL	692.9
Maximum Likelihood Estimate(MLE) Method		Robust ROS Method	
Mean	0.38	Mean in Log Scale	0.088
SD	7.532	SD in Log Scale	1.379
95% MLE (t) UCL	2.414	Mean in Original Scale	2.765
95% MLE (Tiku) UCL	2.635	SD in Original Scale	5.393

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.029	Nonparametric Test with Detected Values Only	
Theta Star	4.166	Data appear Lognormal at 5% Significance Level	
nu star	49.4		
A-D Test Statistic	1.461	Nonparametric Statistics	
5% A-D Critical Value	0.769	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.769	Mean	2.921
5% K-S Critical Value	0.182	SD	5.254
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.859

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data		95% KM (t) UCL	4.37
Minimum	0	95% KM (z) UCL	4.335
Maximum	31.4	95% KM (jackknife) UCL	4.355
Mean	2.638	95% KM (bootstrap t) UCL	7.059
Median	1.3	95% KM (BCA) UCL	4.562
SD	5.453	95% KM (percentile) UCL	4.512
k star	0.107	95% KM (Chebyshev) UCL	6.667
Theta star	24.62	97.5% KM (Chebyshev) UCL	8.288
Nu star	8.357	99% KM (Chebyshev) UCL	11.47
AppChi2	2.944	Potential UCLs to Use	
95% Gamma Approximate UCL	7.49	95% KM (BCA) UCL	4.562
95% Adjusted Gamma UCL	7.825		

SD_copper

General Statistics

Number of Valid Samples 39 Number of Unique Samples 39

Raw Statistics

	Log-transformed Statistics	
Minimum	69.7 Minimum of Log Data	4.244
Maximum	46000 Maximum of Log Data	10.74
Mean	4383 Mean of log Data	7.074
Median	937 SD of log Data	1.507
SD	10457	
Coefficient of Variation	2.386	
Skewness	3.567	

Relevant UCL Statistics

	Lognormal Distribution Test	
Normal Distribution Test		
Shapiro Wilk Test Statistic	0.419 Shapiro Wilk Test Statistic	0.958
Shapiro Wilk Critical Value	0.939 Shapiro Wilk Critical Value	0.939
Data not Normal at 5% Significance Level	Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

	Assuming Lognormal Distribution	
95% Student's-t UCL	7206 95% H-UCL	7664
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL	8208
95% Adjusted-CLT UCL	8159 97.5% Chebyshev (MVUE) UCL	10259
95% Modified-t UCL	7366 99% Chebyshev (MVUE) UCL	14289

Gamma Distribution Test

	Nonparametric Test	
k star (bias corrected)	0.466 Data appear Lognormal at 5% Significance Level	
Theta Star	9407	
nu star	36.34	
Approximate Chi Square Value (.05)	23.55 Nonparametric Statistics	
Adjusted Level of Significance	0.0437 95% CLT UCL	7137
Adjusted Chi Square Value	23.14 95% Jackknife UCL	7206

Anderson-Darling Test Statistic

	95% Standard Bootstrap UCL	
Anderson-Darling Test Statistic	2.906 95% Bootstrap-t UCL	12134
Anderson-Darling 5% Critical Value	0.816 95% Hall's Bootstrap UCL	8970
Kolmogorov-Smirnov Test Statistic	0.263 95% Percentile Bootstrap UCL	7408
Kolmogorov-Smirnov 5% Critical Value	0.15 95% BCA Bootstrap UCL	8154
Data not Gamma Distributed at 5% Significance Level	95% Chebyshev(Mean, Sd) UCL	11682

Assuming Gamma Distribution

	97.5% Chebyshev(Mean, Sd) UCL	
	99% Chebyshev(Mean, Sd) UCL	
95% Approximate Gamma UCL	6765	14841
95% Adjusted Gamma UCL	6885	21044

Potential UCL to Use

Use 95% Chebyshev (MVUE) UCL 8208

SD_lead

General Statistics

Number of Valid Samples 39 Number of Unique Samples 39

Raw Statistics

	Log-transformed Statistics	
Minimum	20.3 Minimum of Log Data	3.011
Maximum	3350 Maximum of Log Data	8.117
Mean	403.8 Mean of log Data	4.743
Median	80.8 SD of log Data	1.457
SD	806.1	
Coefficient of Variation	1.996	
Skewness	2.665	

Relevant UCL Statistics

	Lognormal Distribution Test	
Normal Distribution Test		
Shapiro Wilk Test Statistic	0.524 Shapiro Wilk Test Statistic	0.884
Shapiro Wilk Critical Value	0.939 Shapiro Wilk Critical Value	0.939
Data not Normal at 5% Significance Level	Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution

	Assuming Lognormal Distribution	
95% Student's-t UCL	621.5 95% H-UCL	664.9
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL	727
95% Adjusted-CLT UCL	675 97.5% Chebyshev (MVUE) UCL	905.3
95% Modified-t UCL	630.7 99% Chebyshev (MVUE) UCL	1256

Gamma Distribution Test

	Nonparametric Test	
k star (bias corrected)	0.483 Data do not follow a Discernable Distribution (0.05)	
Theta Star	836.8	
nu star	37.64	

Approximate Chi Square Value (.05)

	Nonparametric Statistics	
Adjusted Level of Significance	0.0437 95% CLT UCL	616.2
Adjusted Chi Square Value	24.18 95% Jackknife UCL	621.5
	95% Standard Bootstrap UCL	612.5

Anderson-Darling Test Statistic

	95% Bootstrap-t UCL	
Anderson-Darling 5% Critical Value	3.527 95% Hall's Bootstrap UCL	753.3
Kolmogorov-Smirnov Test Statistic	0.813 95% Percentile Bootstrap UCL	625
Kolmogorov-Smirnov 5% Critical Value	0.243 95% BCA Bootstrap UCL	635.9
	0.149 95% BCA Bootstrap UCL	673.6

Data not Gamma Distributed at 5% Significance Level

	95% Chebyshev(Mean, Sd) UCL	
	95% Chebyshev(Mean, Sd) UCL	966.5
	97.5% Chebyshev(Mean, Sd) UCL	1210
	99% Chebyshev(Mean, Sd) UCL	1688

Assuming Gamma Distribution

95% Approximate Gamma UCL	618.1	
95% Adjusted Gamma UCL	628.8	

Potential UCL to Use

	Use 99% Chebyshev (Mean, Sd) UCL	
		1688

SB_arsenic

General Statistics

Number of Valid Samples 43 Number of Unique Samples 41

Raw Statistics

	Log-transformed Statistics	
Minimum	0.807 Minimum of Log Data	-0.214
Maximum	73.5 Maximum of Log Data	4.297
Mean	13.97 Mean of log Data	2.046
Median	7.21 SD of log Data	1.121
SD	16.89	
Coefficient of Variation	1.209	
Skewness	2.203	

Relevant UCL Statistics

Normal Distribution Test

	Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.714 Shapiro Wilk Test Statistic	0.98
Shapiro Wilk Critical Value	0.943 Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level	Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

	Assuming Lognormal Distribution	
95% Student's-t UCL	18.3 95% H-UCL	22.33
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL	26.91
95% Adjusted-CLT UCL	19.13 97.5% Chebyshev (MVUE) UCL	32.42
95% Modified-t UCL	18.44 99% Chebyshev (MVUE) UCL	43.24

Gamma Distribution Test

	Nonparametric Test	
k star (bias corrected)	0.927 Data appear Gamma Distributed at 5% Significance Level	
Theta Star	15.06	
nu star	79.75	
Approximate Chi Square Value (.05)	60.17 Nonparametric Statistics	
Adjusted Level of Significance	0.0444 95% CLT UCL	18.2
Adjusted Chi Square Value	59.58 95% Jackknife UCL	18.3
	95% Standard Bootstrap UCL	18.14
Anderson-Darling Test Statistic	0.723 95% Bootstrap-t UCL	20.02
Anderson-Darling 5% Critical Value	0.779 95% Hall's Bootstrap UCL	19.21
Kolmogorov-Smirnov Test Statistic	0.105 95% Percentile Bootstrap UCL	18.23
Kolmogorov-Smirnov 5% Critical Value	0.139 95% BCA Bootstrap UCL	19.22
Data appear Gamma Distributed at 5% Significance Level	95% Chebyshev(Mean, Sd) UCL	25.2
	97.5% Chebyshev(Mean, Sd) UCL	30.05
Assuming Gamma Distribution	99% Chebyshev(Mean, Sd) UCL	39.6
95% Approximate Gamma UCL	18.51	
95% Adjusted Gamma UCL	18.69	

Potential UCL to Use Use 95% Approximate Gamma UCL 18.51

SB_cadmium

General Statistics

Number of Valid Samples	43	Number of Detected Data	26
Number of Unique Samples	25	Number of Non-Detect Data	17
		Percent Non-Detects	39.53%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.598	Minimum Detected	-0.514
Maximum Detected	683	Maximum Detected	6.526
Mean of Detected	38.02	Mean of Detected	1.527
SD of Detected	133.2	SD of Detected	1.772
Minimum Non-Detect	0.0049	Minimum Non-Detect	-5.31
Maximum Non-Detect	0.0049	Maximum Non-Detect	-5.31
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.297	Shapiro Wilk Test Statistic	0.877
5% Shapiro Wilk Critical Value	0.92	5% Shapiro Wilk Critical Value	0.92
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	22.99	Mean	-1.45
SD	104.5	SD	3.968
95% DL/2 (t) UCL	49.79	95% H-Stat (DL/2) UCL	3890
Maximum Likelihood Estimate(MLE) Method		Robust ROS Method	
Mean	-24.76	Mean in Log Scale	-0.259
SD	139.5	SD in Log Scale	2.761
95% MLE (t) UCL	11.02	Mean in Original Scale	23.03
95% MLE (Tiku) UCL	15.86	SD in Original Scale	104.5
		95% Percentile Bootstrap UCL	53.34
Gamma Distribution Test with Detected Values Only		Nonparametric Test with Detected Values Only	
k star (bias corrected)	0.311	Data do not follow a Discernable Distribution (0.05)	
Theta Star	122.2		
nu star	16.18		
A-D Test Statistic	3.188	Nonparametric Statistics	
5% A-D Critical Value	0.847	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.847	Mean	23.23
5% K-S Critical Value	0.185	SD	103.2
Data not Gamma Distributed at 5% Significance Level		SE of Mean	16.05
		95% KM (t) UCL	50.23
Assuming Gamma Distribution		95% KM (z) UCL	49.63
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	49.99
Minimum	0	95% KM (bootstrap t) UCL	183.4
Maximum	683	95% KM (BCA) UCL	56.2
Mean	22.99	95% KM (percentile) UCL	54.65
Median	1.23	95% KM (Chebyshev) UCL	93.2
SD	104.5	97.5% KM (Chebyshev) UCL	123.5
k star	0.0901	99% KM (Chebyshev) UCL	182.9
Theta star	255.3		
Nu star	7.746	Potential UCLs to Use	
AppChi2	2.589	97.5% KM (Chebyshev) UCL	123.5
95% Gamma Approximate UCL	68.79		
95% Adjusted Gamma UCL	71.63		

SB_copper

General Statistics

Number of Valid Samples 43 Number of Unique Samples 43

Raw Statistics

	Log-transformed Statistics	
Minimum	129 Minimum of Log Data	4.86
Maximum	20800 Maximum of Log Data	9.943
Mean	3856 Mean of log Data	7.329
Median	1380 SD of log Data	1.492
SD	5036	
Coefficient of Variation	1.306	
Skewness	1.717	

Relevant UCL Statistics

	Lognormal Distribution Test	
Normal Distribution Test		
Shapiro Wilk Test Statistic	0.745 Shapiro Wilk Test Statistic	0.948
Shapiro Wilk Critical Value	0.943 Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level	Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

	Assuming Lognormal Distribution	
95% Student's-t UCL	5148 95% H-UCL	9142
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL	10120
95% Adjusted-CLT UCL	5334 97.5% Chebyshev (MVUE) UCL	12593
95% Modified-t UCL	5182 99% Chebyshev (MVUE) UCL	17450

Gamma Distribution Test

	Nonparametric Test	
k star (bias corrected)	0.626 Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	6156	
nu star	53.87	

Approximate Chi Square Value (.05)

	Nonparametric Statistics	
Adjusted Level of Significance	0.0444 95% CLT UCL	5120
Adjusted Chi Square Value	37.55 95% Jackknife UCL	5148
	95% Standard Bootstrap UCL	5098

Anderson-Darling Test Statistic

	95% Bootstrap-t UCL	
Anderson-Darling Test Statistic	0.929 95% Bootstrap-t UCL	5488
Anderson-Darling 5% Critical Value	0.798 95% Hall's Bootstrap UCL	5397
Kolmogorov-Smirnov Test Statistic	0.137 95% Percentile Bootstrap UCL	5111
Kolmogorov-Smirnov 5% Critical Value	0.141 95% BCA Bootstrap UCL	5289

Data follow Appr. Gamma Distribution at 5% Significance Level

	95% Chebyshev(Mean, Sd) UCL	
	95% Chebyshev(Mean, Sd) UCL	7204
	97.5% Chebyshev(Mean, Sd) UCL	
	97.5% Chebyshev(Mean, Sd) UCL	8652
	99% Chebyshev(Mean, Sd) UCL	
	99% Chebyshev(Mean, Sd) UCL	11498
Assuming Gamma Distribution		
95% Approximate Gamma UCL	5466	
95% Adjusted Gamma UCL	5533	

Potential UCL to Use

Use 95% Approximate Gamma UCL 5466

SB_Lead

General Statistics

Number of Valid Samples 43 Number of Unique Samples 43

Raw Statistics

	Log-transformed Statistics	
Minimum	13.6 Minimum of Log Data	2.61
Maximum	49100 Maximum of Log Data	10.8
Mean	1493 Mean of log Data	5.201
Median	135 SD of log Data	1.534
SD	7454	
Coefficient of Variation	4.993	
Skewness	6.501	

Relevant UCL Statistics

Normal Distribution Test

	Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.196 Shapiro Wilk Test Statistic	0.937
Shapiro Wilk Critical Value	0.943 Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level	Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution

	Assuming Lognormal Distribution	
95% Student's-t UCL	3405 95% H-UCL	1200
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL	1307
95% Adjusted-CLT UCL	4567 97.5% Chebyshev (MVUE) UCL	1631
95% Modified-t UCL	3592 99% Chebyshev (MVUE) UCL	2269

Gamma Distribution Test

	Nonparametric Test	
k star (bias corrected)	0.316 Data do not follow a Discernable Distribution (0.05)	
Theta Star	4721	
nu star	27.2	
Approximate Chi Square Value (.05)	16.3 Nonparametric Statistics	
Adjusted Level of Significance	0.0444 95% CLT UCL	3362
Adjusted Chi Square Value	16.01 95% Jackknife UCL	3405
	95% Standard Bootstrap UCL	3275
Anderson-Darling Test Statistic	6.109 95% Bootstrap-t UCL	24384
Anderson-Darling 5% Critical Value	0.855 95% Hall's Bootstrap UCL	14914
Kolmogorov-Smirnov Test Statistic	0.302 95% Percentile Bootstrap UCL	3709
Kolmogorov-Smirnov 5% Critical Value	0.146 95% BCA Bootstrap UCL	5001
Data not Gamma Distributed at 5% Significance Level	95% Chebyshev(Mean, Sd) UCL	6447
	97.5% Chebyshev(Mean, Sd) UCL	8591
Assuming Gamma Distribution	99% Chebyshev(Mean, Sd) UCL	12803
95% Approximate Gamma UCL	2490	
95% Adjusted Gamma UCL	2536	

Potential UCL to Use Use 99% Chebyshev (Mean, Sd) UCL 12803

Background Statistical Comparison Test Outputs

Area of Concern Data: [SD_arsenic](#)

Background Data: Kearney CA As

Raw Statistics

	Site	Background
Number of Valid Samples	39	50
Number of Distinct Samples	37	33
Minimum	1.26	0.6
Maximum	34.3	11
Mean	7.306	3.536
Median	6.62	2.7
SD	5.937	2.497
SE of Mean	0.951	0.353

Mann-Whitney (Wilcoxon Rank Sum) Test

H0: Mu of Site - Mu of Background <= 0

Rank Sum W-Stat = 2269

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	z (0.95)		
4.25	1.645	0	Reject H0, Conclude Site > Background

H0: Mu of Site - Mu of Background >= 0

Rank Sum W-Stat = 2269

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	- z (0.95)		
4.25	-1.645	1	Do Not Reject H0, Conclude Site >= Background

Area of Concern Data: [SD_cadmium](#)

Background Data:Kearney CA Cd

Raw Statistics

	Site	Background
Number of Valid Samples	39	50
Number of Distinct Samples	24	33
Minimum	0.00494	0.05
Maximum	31.4	1.7
Mean	2.64	0.357
Median	1.3	0.275
SD	5.452	0.315
SE of Mean	0.873	0.0445

Mann-Whitney (Wilcoxon Rank Sum) Test

H0: Mu of Site - Mu of Background \leq 0

Rank Sum W-Stat = 1964

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	z (0.95)		
1.728	1.645	0.042	Reject H0, Conclude Site > Background

H0: Mu of Site - Mu of Background \geq 0

Rank Sum W-Stat = 1964

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	- z (0.95)		
1.728	-1.645	0.958	Do Not Reject H0, Conclude Site \geq Background

Area of Concern Data: [SD_copper](#)

Background Data: Kearney CA Cu

Raw Statistics

	Site	Background
Number of Valid Samples	39	50
Number of Distinct Samples	39	47
Minimum	69.7	9.1
Maximum	46000	96.4
Mean	4383	28.69
Median	937	21.75
SD	10457	19.31
SE of Mean	1675	2.731

Mann-Whitney (Wilcoxon Rank Sum) Test

H0: Mu of Site - Mu of Background \leq 0

Rank Sum W-Stat = 2726

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	z (0.95)		
8.029	1.645	0	Reject H0, Conclude Site > Background

H0: Mu of Site - Mu of Background \geq 0

Rank Sum W-Stat = 2726

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	- z (0.95)		
8.029	-1.645	1	Do Not Reject H0, Conclude Site \geq Background

Area of Concern Data: [SD_lead](#)
 Background Data: Kearney CA Pb

Raw Statistics

	Site	Background
Number of Valid Samples	39	50
Number of Distinct Samples	39	44
Minimum	20.3	12.4
Maximum	3350	97.1
Mean	403.8	23.89
Median	80.8	20.95
SD	806.1	13.81
SE of Mean	129.1	1.954

Mann-Whitney (Wilcoxon Rank Sum) Test

H0: Mu of Site - Mu of Background <= 0

Rank Sum W-Stat = 2574

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	z (0.95)		
6.772	1.645	0	Reject H0, Conclude Site > Background

H0: Mu of Site - Mu of Background >= 0

Rank Sum W-Stat = 2574

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	- z (0.95)		
6.772	-1.645	1	Do Not Reject H0, Conclude Site >= Background

Area of Concern Data: [SB_arsenic](#)

Background Data: Kearney CA As

Raw Statistics

	Site	Background	
Number of Valid Samples	43		50
Number of Distinct Samples	41	33	
Minimum	0.807	0.6	
Maximum	73.5	11	
Mean	13.97	3.536	
Median	7.21	2.7	
SD	16.89	2.497	
SE of Mean	2.576	0.353	

Mann-Whitney (Wilcoxon Rank Sum) Test

H0: Mu of Site - Mu of Background <= 0

Rank Sum W-Stat = 2608

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	z (0.95)		
4.523	1.645	0	Reject H0, Conclude Site > Background

H0: Mu of Site - Mu of Background >= 0

Rank Sum W-Stat = 2608

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	- z (0.95)		
4.523	-1.645	1	Do Not Reject H0, Conclude Site >= Background

Area of Concern Data: [SB_cadmium](#)

Background Data: Kearney CA Cd

Raw Statistics

	Site	Background
Number of Valid Samples	43	50
Number of Distinct Samples	26	33
Minimum	0.00494	0.05
Maximum	683	1.7
Mean	22.99	0.357
Median	1.23	0.275
SD	104.5	0.315
SE of Mean	15.93	0.0445

Mann-Whitney (Wilcoxon Rank Sum) Test

H0: Mu of Site - Mu of Background \leq 0

Rank Sum W-Stat = 2220

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	z (0.95)		
1.533	1.645	0.063	Do Not Reject H0, Conclude Site \leq Background

H0: Mu of Site - Mu of Background \geq 0

Rank Sum W-Stat = 2220

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	- z (0.95)		
1.533	-1.645	0.937	Do Not Reject H0, Conclude Site \geq Background

Area of Concern Data: [SB_copper](#)

Background Data: Kearney CA Cu

Raw Statistics

	Site	Background
Number of Valid Samples	43	50
Number of Distinct Samples	43	47
Minimum	129	9.1
Maximum	20800	96.4
Mean	3856	28.69
Median	1380	21.75
SD	5036	19.31
SE of Mean	768	2.731

Mann-Whitney (Wilcoxon Rank Sum) Test

H0: Mu of Site - Mu of Background \leq 0

Rank Sum W-Stat = 3096

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	z (0.95)		
8.284	1.645	0	Reject H0, Conclude Site > Background

H0: Mu of Site - Mu of Background \geq 0

Rank Sum W-Stat = 3096

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	- z (0.95)		
8.284	-1.645	1	Do Not Reject H0, Conclude Site \geq Background

Area of Concern Data: [SB_lead](#)
 Background Data: Kearney CA Pb

Raw Statistics

	Site	Background
Number of Valid Samples	43	50
Number of Distinct Samples	43	44
Minimum	13.6	12.4
Maximum	49100	97.1
Mean	1493	23.89
Median	135	20.95
SD	7454	13.81
SE of Mean	1137	1.954

Mann-Whitney (Wilcoxon Rank Sum) Test

H0: Mu of Site - Mu of Background <= 0

Rank Sum W-Stat = 2964

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	z (0.95)		
7.266	1.645	0	Reject H0, Conclude Site > Background

H0: Mu of Site - Mu of Background >= 0

Rank Sum W-Stat = 2964

Test	Critical	P Value	Conclusion with Alpha = 0.05
MW z	- z (0.95)		
7.266	-1.645	1	Do Not Reject H0, Conclude Site >= Background