Missouri
Department of
Natural Resources

Site Investigation Findings Report
Tannery Sludge Farm Fields Site
Residential Yard Pilot Study
Buchanan County, MO

Site Information:

ESP LDPR Code:	FEPA8	HWP Staff:	Michael Stroh and Shelly Jackson
Job Code:	NJ10TSFF	Investigation Date:	October 2, 2009

Introduction:
The Missouri Department of Natural Resources (MDNR) Hazardous Waste Program (HWP) conducted sampling related to an ongoing investigation of the Tannery Sludge Farm Fields Site as described in the September 30, 2009 Residential Yard Pilot Study Sampling and Analysis Plan (SAP). This Findings Report is intended as an interim measure to document recent sampling activities. A full project report will be written by the HWP project manager when sample results have been received and evaluated for the overall project.

HWP Environmental Specialists Michael Stroh and Shelly Jackson traveled to the site on October 2, 2009 to collect discrete grab samples of surface soils at a selected residence in Buchanan County. Sampling was conducted in accordance with established standard operating procedures (SOPs) within the MDNR, Environmental Services Program (ESP) and outlined in the September 30, 2009 Sampling and Analysis Plan (SAP).

Observations:
Personnel arrived on-site the mid-morning of October 2, 2009, and began sample collection. Custody of all samples collected was maintained by HWP personnel. Weather conditions were clear and cool and wind was strong from the west. Ten discrete soil samples were collected from within four sampling units established in the yard. No deviations were noted at any sample locations. The name and address of the sampled property's owner is being kept confidential at the owner's request.

Field Methods:
Below is a brief discussion of the sampling activities conducted. A more detailed description of sampling design is outlined in the SAP.

The residential yard was divided into sampling units (SUs) and discrete samples were collected from within each SU at a depth of 0-2 inches. A site sketch of the yard showing the SUs and discrete sample locations was created (Appendix B). All soil samples were brought back to the ESP lab and allowed to air dry for at least three days. All soil samples were then disaggregated and passed through a #60 mesh (0.25mm) sieve.

Samples were analyzed for total chromium by XRF. The total Cr levels in nearly all of the samples were found to be very similar, suggesting the possibility that the concentrations observed represented the naturally-occurring background Cr levels. Since the intent of the XRF analysis was to demonstrate the representativeness of the sample homogenization procedure, these results were not of use, since the values were all similar. The samples were re-analyzed by XRF for total lead, after it was found that there were somewhat elevated levels of lead in the various areas of the yard – most likely due to the past use of lead paint on the residential structures. Lead concentrations were then used as a proxy for chromium for the purposes of demonstrating that the discrete samples and subsequent first and second tier incremental samples were homogenous and representative (Appendix C). Following XRF analysis, the 10 discrete samples, 2 duplicates, 4 first-tier and 1 second-tier incremental samples were submitted to Test America Laboratories (TAL) for hexavalent Cr analysis on October 13, 2009.

Table 1 is a listing of the samples collected.

Table 1: Sample Collection Data

Original DNR Sample Number	TAL* Transfer COC Sample Number	ASC** Transfer COC Sample Number	Date Collected	Time Collected	Location Collected & Description
0931971	AB07939	AB09956	10/02/09	1053	Yard surface soil grab, 0-2". SU1.1.3
0931972	AB07940	AB09957	10/02/09	1054	Yard surface soil grab, 0-2". SU1.2.1
0931973	AB07941	AB09958	10/02/09	1054	Yard surface soil grab, 0-2". SU1.3.1
0931974	AB07942	AB09959	10/02/09	1056	Yard surface soil grab, 0-2". SU2.1.3
0931975	AB07943	AB09960	10/02/09	1058	Yard surface soil grab, 0-2". SU 2.2.3
0931976	AB07944	AB09961	10/02/09	1100	Yard surface soil grab, 0-2". SU3.1.1
0931977	AB07945	AB09962	10/02/09	1100	Yard surface soil grab, 0-2". SU3.1.3 (dupl..)
0931978	AB07946	AB09963	10/02/09	1102	Yard surface soil grab, 0-2". SU3.2.1
0931979	AB07947	AB09964	10/02/09	1102	Yard surface soil grab, 0-2". SU3.2.3 (dupl..)
0931980	AB07948	AB09965	10/02/09	1105	Yard surface soil grab, 0-2". SU3.3.3
0931981	AB07949	AB09966	10/02/09	1107	Yard surface soil grab, 0-2". SU4.1.2
0931982	AB07950	AB09967	10/02/09	1110	Yard surface soil grab, 0-2". SU4.2.3
0931983	AB07951	AB09968	10/02/09	1053	Yard surface soil incremental sample. SU1IS.1
0931984	AB07952	AB09969	10/02/09	1056	Yard surface soil incremental sample. SU2IS.1
0931985	AB07953	AB09970	10/02/09	1102	Yard surface soil incremental sample. SU3IS.1
0931986	AB07954	AB09971	10/02/09	1107	Yard surface soil incremental sample. SU4IS.1
0931987	AB07955	AB09972	10/02/09	1110	Yard surface soil incremental sample. DUIS.3

* Test America Laboratories
** Applied Speciation Consulting, LLC

Prior to submitting yard samples to TAL, the project team had worked with the laboratory to develop a slightly modified approach to EPA Method 7199 for Cr 6+ analysis. Since the Cr 6+ screening level for the residential yards is lower than that developed for the farm fields, a greater level of analytical sensitivity was required. The modification essentially amounted to less dilution of the samples' alkaline digestates prior to analysis. This was done to improve the

method sensitivity and reduce the effect of matrix interferences observed during analysis of the previously-conducted farm fields pilot study in August 2009.

Results were received from TAL on December 1, 2009 (Appendix A). They were immediately provided to the USEPA Office of Superfund Remediation & Technology Innovation (TIO) for analysis. Results of the TIO statistical analysis of the data uncertainty indicated that the analytical method would not be capable of the sensitivity levels needed to demonstrate that residential yard soils were below the screening level (Appendix D).

The planning team identified an alternative laboratory, Applied Speciation and Consulting (ASC) believed capable of the sensitivity needed for the project. ASC employs a modification to EPA Method 7199 by using a mass spectrometer rather than spectrophotometer to quantify the Cr 6+. The mass spectrometer is a more specific and sensitive detection system, and is generally less susceptible to interferences caused by complex sample matrices.

Archived splits of 13 of the yard pilot samples were submitted to ASC for Cr6+ analysis on December 9, 2009. The planning team was aware that the samples had exceeded the holding time limits specified in the SAP by the time they were submitted to ASC. However, the team decided to proceed with analysis due to a number of factors. The results of the analysis would not be used to directly make an environmental decision about the residential yard – the pilot study yard would be re-sampled later along with the other yards as part of the larger investigation once the sampling design was finalized. Secondly, the team felt that additional reduction of Cr6+ to Cr3+ was unlikely to occur over time within a containerized, dried and sieved soil matrix. Thirdly, the intent of the pilot study was primarily to assess Cr6+ variability across the residential yard, and to demonstrate adequate laboratory sensitivity, neither of which were believed to be significantly affected by sample holding times. Finally, the assumptions made based on the results of the residential yard pilot study would be further tested using data obtained during the larger overall sampling event.

Results from ASC were received on January 20, 2010 (Appendix A). They were immediately provided to TIO for analysis. Based on uncertainty evaluation of the analytical results, the ASC method modifications appears to be capable of providing data suitable for making decisions about residential yards (Appendix D). Statistical evaluation of the discrete and incremental samples was conducted by TIO using EPA's Visual Sampling Plan software. The results provided the minimum number of increments (4) that would be required from each yard sampling unit to meet the project objectives (Appendix D). That information was used to finalize the sampling design for the residential yards.

Prepared by: 3-3-10

Michael Stroh (Date)
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Approved by: 3-3-10

Julieann Warren (Date)
Chief, Site Assessment Unit
Hazardous Waste Program

MS:cc

c: Michael Stroh, Environmental Specialist, HWP

APPENDIX A

Chain of Custody/Analytical Results

Tannery Sludge Farm Fields Site
Residential Yard Pilot Study
Buchanan County, MO

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

Job Number: 460-6741-1

Job Description: Missouri DNR Hexavalent Chromium

For:
Missouri Department of Natural Resources
Environmental Services Program
2710 W Main Street
Jefferson City, MO 65109

Attention: Mr. Ron Heckman

Approved for release.
Jannel O Franklin
Project Manager I
12/1/2009 8:53 AM

Jannel O Franklin
Project Manager I
jannel.franklin@testamericainc.com
12/01/2009

cc: Mr. Chris Boldt

The test results in this report meet all NELAP requirements unless specified within the case narrative. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory. All questions regarding this report should be directed to the TestAmerica Edison Project Manager.

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CASE NARRATIVE

Client: Missouri Department of Natural Resources

Project: Missouri DNR Hexavalent Chromium

Report Number: 460-6741-1

This case narrative is in the form of an exception report, where only the anomalies related to this report, method specific performance and/or QA/QC issues are discussed. If there are no issues to report, this narrative will include a statement that documents that there are no relevant data issues.

It should be noted that samples with elevated Reporting Limits (RLs) as a result of a dilution may not be able to satisfy customer reporting limits in some cases. Such increases in the RLs are unavoidable but acceptable consequence of sample dilution that enables quantification of target analytes or interferences which exceed the calibration range of the instrument.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

RECEIPT
The samples were received on 10/14/2009; the samples arrived in good condition, properly preserved and on ice. The temperature of the coolers at receipt was 3.0 C.

Note: All samples which require thermal preservation are considered acceptable if the arrival temperature is within 2C of the required temperature or method specified range. For samples with a specified temperature of 4C, samples with a temperature ranging from just above freezing temperature of water to 6C shall be acceptable. Samples that are hand delivered immediately following collection may not meet these criteria, however they will be deemed acceptable according to NELAC standards, if there is evidence that the chilling process has begun, such as arrival on ice, etc.

HEXAVALENT CHROMIUM
Samples 460-6741-1 through 460-6741-17 were analyzed for hexavalent chromium in accordance with EPA SW-846 Method 7199. The samples were prepared on 10/26/2009 and analyzed on 10/27/2009, 10/28/2009, 10/29/2009 and 11/03/2009.

All of the samples were homogenized following the Japanese two dimensional slab cake method prior to digestion.

Difficulties were encountered during the hex chrome analyses:
The following samples were digested by method 3060a and analyzed by method 7199 at a 2 fold dilution as per client request. The digestates were very dark in color and the 2 fold dilution was insufficient at removing the matrix interference thus causing multiple issues on the analytical run. The digestates were re-analyzed several times at a 5 fold dilution in an attempt to minimize the matrix interference, however, several of the issues persisted. These include: matrix spike soluble/insoluble/post spike recoveries outside of the acceptable range (see pages 112-116), duplicate recoveries outside of the acceptable range (see pages 117-118), laboratory control sample recoveries outside of the acceptable range (see pages 119-122), and continuing calibration verifications outside of the acceptable range (see pages 108-110). The method blank results greater than the MDL (see page 111) are due to carryover from previous samples. In addition, the RPD between duplicate injections for some samples was greater than 20%. The client was notified of these issues and the lab was instructed to stop all analyses and report the data available. Some samples are reported with both a 2 fold and 5 fold dilution and others are reported with only a 5 fold dilution.

Samples 460-6741-1 through 460-6741-17(5X) required dilution prior to analysis. The reporting limits have been adjusted accordingly. Refer to the QC report for details.

PERCENT SOLIDS
Samples 460-6741-1 through 460-6741-17 were analyzed for percent solids in accordance with EPA Method 160.3 Modified. The samples were analyzed on 10/19/2009.

Percent Moisture and Percent Solids exceeded the rpd limit for the duplicate of sample 460-6852-1. Refer to the QC report for details.

No other difficulties were encountered during the % solids analyses.

All other quality control parameters were within the acceptance limits.

SAMPLE SUMMARY

Client: Missouri Department of Natural Resources

Job Number: 460-6741-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
460-6741-1	AB07939	Solid	10/02/2009 1053	10/14/2009 1015
460-6741-1DU	AB07939	Solid	10/02/2009 1053	10/14/2009 1015
460-6741-1MS	AB07939	Solid	10/02/2009 1053	10/14/2009 1015
460-6741-2	AB07940	Solid	10/02/2009 1054	10/14/2009 1015
460-6741-2DU	AB07940	Solid	10/02/2009 1054	10/14/2009 1015
460-6741-3	AB07941	Solid	10/02/2009 1054	10/14/2009 1015
460-6741-4	AB07942	Solid	10/02/2009 1056	10/14/2009 1015
460-6741-5	AB07943	Solid	10/02/2009 1058	10/14/2009 1015
460-6741-5DU	AB07943	Solid	10/02/2009 1058	10/14/2009 1015
460-6741-6	AB07944	Solid	10/02/2009 1100	10/14/2009 1015
460-6741-6DU	AB07944	Solid	10/02/2009 1100	10/14/2009 1015
460-6741-6MS	AB07944	Solid	10/02/2009 1100	10/14/2009 1015
460-6741-7	AB07945	Solid	10/02/2009 1100	10/14/2009 1015
460-6741-8	AB07946	Solid	10/02/2009 1102	10/14/2009 1015
460-6741-8DU	AB07946	Solid	10/02/2009 1102	10/14/2009 1015
460-6741-9	AB07947	Solid	10/02/2009 1102	10/14/2009 1015
460-6741-10	AB07948	Solid	10/02/2009 1105	10/14/2009 1015
460-6741-11	AB07949	Solid	10/02/2009 1107	10/14/2009 1015
460-6741-11DU	AB07949	Solid	10/02/2009 1107	10/14/2009 1015
460-6741-11MS	AB07949	Solid	10/02/2009 1107	10/14/2009 1015
460-6741-12	AB07950	Solid	10/02/2009 1110	10/14/2009 1015
460-6741-13	AB07951	Solid	10/02/2009 1053	10/14/2009 1015
460-6741-14	AB07952	Solid	10/02/2009 1056	10/14/2009 1015
460-6741-14DU	AB07952	Solid	10/02/2009 1056	10/14/2009 1015
460-6741-15	AB07953	Solid	10/02/2009 1102	10/14/2009 1015
460-6741-15DU	AB07953	Solid	10/02/2009 1102	10/14/2009 1015
460-6741-16	AB07954	Solid	10/02/2009 1107	10/14/2009 1015
460-6741-17	AB07955	Solid	10/02/2009 1110	10/14/2009 1015
460-6741-17DU	AB07955	Solid	10/02/2009 1110	10/14/2009 1015

EXECUTIVE SUMMARY - Detections

Client: Missouri Department of Natural Resources

Job Number: 460-6741-1

Lab Sample ID / Analyte	Client Sample ID	Result / Qualifier		Reporting Limit	Units	Method
460-6741-1	**AB07939**					
Chromium (hexavalent)		2.1	B	0.83	mg/Kg	7199
Percent Moisture		3.1		1.0	%	Moisture
Percent Solids		96.9		1.0	%	Moisture
460-6741-2	**AB07940**					
Chromium (hexavalent)		2.2	^ B	0.84	mg/Kg	7199
Percent Moisture		4.7		1.0	%	Moisture
Percent Solids		95.3		1.0	%	Moisture
460-6741-3	**AB07941**					
Chromium (hexavalent)		0.42	J ^ B *	0.82	mg/Kg	7199
Percent Moisture		2.1		1.0	%	Moisture
Percent Solids		97.9		1.0	%	Moisture
460-6741-4	**AB07942**					
Chromium (hexavalent)		0.12	J ^ B	0.83	mg/Kg	7199
Percent Moisture		3.8		1.0	%	Moisture
Percent Solids		96.2		1.0	%	Moisture
460-6741-5	**AB07943**					
Chromium (hexavalent)		0.43	J ^ B *	0.83	mg/Kg	7199
Percent Moisture		3.9		1.0	%	Moisture
Percent Solids		96.1		1.0	%	Moisture
460-6741-6	**AB07944**					
Chromium (hexavalent)		1.1	^ B *	0.84	mg/Kg	7199
Percent Moisture		4.2		1.0	%	Moisture
Percent Solids		95.8		1.0	%	Moisture
460-6741-7	**AB07945**					
Chromium (hexavalent)		0.83	J ^ B *	0.83	mg/Kg	7199
Percent Moisture		3.9		1.0	%	Moisture
Percent Solids		96.1		1.0	%	Moisture

EXECUTIVE SUMMARY - Detections

Client: Missouri Department of Natural Resources

Job Number: 460-6741-1

Lab Sample ID / Analyte	Client Sample ID	Result / Qualifier		Reporting Limit	Units	Method
460-6741-8	**AB07946**					
Chromium (hexavalent)		0.90	^ B *	0.82	mg/Kg	7199
Percent Moisture		2.7		1.0	%	Moisture
Percent Solids		97.3		1.0	%	Moisture
460-6741-9	**AB07947**					
Chromium (hexavalent)		0.20	J ^ B *	0.82	mg/Kg	7199
Percent Moisture		2.7		1.0	%	Moisture
Percent Solids		97.3		1.0	%	Moisture
460-6741-10	**AB07948**					
Chromium (hexavalent)		0.20	J ^ B *	0.83	mg/Kg	7199
Percent Moisture		3.4		1.0	%	Moisture
Percent Solids		96.6		1.0	%	Moisture
460-6741-11	**AB07949**					
Chromium (hexavalent)		0.42	J ^ B *	1.3	mg/Kg	7199
Percent Moisture		37.0		1.0	%	Moisture
Percent Solids		63.0		1.0	%	Moisture
460-6741-12	**AB07950**					
Chromium (hexavalent)		0.29	J ^ B	2.1	mg/Kg	7199
Percent Moisture		3.1		1.0	%	Moisture
Percent Solids		96.9		1.0	%	Moisture
460-6741-13	**AB07951**					
Chromium (hexavalent)		0.31	J ^ B	2.1	mg/Kg	7199
Percent Moisture		3.2		1.0	%	Moisture
Percent Solids		96.8		1.0	%	Moisture
460-6741-14	**AB07952**					
Chromium (hexavalent)		0.63	J ^ *	2.1	mg/Kg	7199
Percent Moisture		3.7		1.0	%	Moisture
Percent Solids		96.3		1.0	%	Moisture

EXECUTIVE SUMMARY - Detections

Client: Missouri Department of Natural Resources

Job Number: 460-6741-1

Lab Sample ID / Analyte	Client Sample ID	Result / Qualifier		Reporting Limit	Units	Method
460-6741-15	**AB07953**					
Chromium (hexavalent)		4.5	H ^	2.1	mg/Kg	7199
Percent Moisture		3.1		1.0	%	Moisture
Percent Solids		96.9		1.0	%	Moisture
460-6741-16	**AB07954**					
Percent Moisture		4.9		1.0	%	Moisture
Percent Solids		95.1		1.0	%	Moisture
460-6741-17	**AB07955**					
Chromium (hexavalent)		3.6	H ^	2.1	mg/Kg	7199
Percent Moisture		3.7		1.0	%	Moisture
Percent Solids		96.3		1.0	%	Moisture

* REMAINDER OF REPORT OMITTED FOR BREVITY. FULL DOCUMENT AVAILABLE UPON REQUEST

APPLIED SPECIATION AND CONSULTING, LLC

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January 20, 2010

Michael Stroh
Missouri Department of Natural Resources
2710 W. Main St.
Jefferson City, MO 65109
(573) 522-9902

Dear Mr. Stroh,

Attached is the report associated with thirteen (13) sediment samples submitted for hexavalent chromium quantitation on December 9, 2009. The samples were received on December 10, 2009 in a sealed cooler at -1.6°C. The submitted samples were extracted using EPA Method 3060A and then analyzed for hexavalent chromium via ion chromatography inductively coupled plasma dynamic reaction cell mass spectrometry (IC-ICP-DRC-MS). Any analytical issues associated with the analysis are addressed in the following report.

If you have any questions, please feel free to contact me at your convenience.

Sincerely,

Ben Wozniak

Ben Wozniak
Project Manager
Applied Speciation and Consulting, LLC

Applied Speciation and Consulting, LLC

Report Prepared for:

Michael Stroh
Missouri Department of Natural Resources
2710 W. Main St.
Jefferson City, MO 65109

January 20, 2010

1. Sample Reception

Thirteen (13) sediment samples were submitted in wide-mouth glass jars (not provided by Applied Speciation and Consulting) for hexavalent chromium quantitation on December 9, 2009. The samples were received in acceptable condition on December 10, 2009 in a sealed cooler at -1.6°C.

All samples were received in a laminar flow clean hood void of trace metals contamination and ultra-violet radiation. Upon reception, all samples were designated discrete sample identifiers and then stored in a secure, monitored refrigerator (maintained at a temperature of $\leq 4^{\circ}C$) until all preparatory and analytical procedures could be performed.

2. Sample Preparation

All sample preparation is performed in laminar flow clean hoods known to be free from trace metals contamination. All applied water for dilutions and sample preservatives are monitored for contamination to account for any biases associated with the sample results.

Hexavalent Chromium Quantification by IC-ICP-DRC-MS Prior to analysis, all samples were extracted using EPA Method 3060A on January 14, 2010. In summary, each sample was first spread into a thin layer onto a clean surface and a known mass of each sample was then weighed into a polypropylene centrifuge tube by taking approximately fifteen random subsamples of the original sample. A buffered alkaline extraction solution, $MgCl_2$, and a phosphate buffer solution were then applied to each sample. All vials were then heated at 90-95°C in a sonicating bath for a minimum of one (1) hour. The resulting extracts were cooled, filtered, and injected directly into sealed autosampler vials prior to analysis for hexavalent chromium.

3. Sample Analysis

All sample analysis is preceded by a minimum of a five-point calibration curve spanning the entire concentration range of interest. Calibration curves are performed

at the beginning of each analytical day. All calibration curves, associated with each species of interest, are standardized by linear regression resulting in a response factor. All sample results are **instrument blank corrected** to account for any operational biases associated with the analytical platform. All sample results have also been **dry-weight corrected** using the percent moisture values provided by the client.

Prior to sample analysis, all calibration curves are verified using second source standards which are identified as initial calibration verification standards (ICV).

Ongoing instrument performance is identified by the analysis of continuing calibration verification standards (CCV) and continuing calibration blanks (CCB) at a minimal interval of every ten analytical runs.

Hexavalent Chromium Quantitation by IC-ICP-DRC-MS All sample extracts for hexavalent chromium quantitation were analyzed via a modified version of EPA Method 7199 employing ion chromatography inductively coupled plasma dynamic reaction cell mass spectrometry (IC-ICP-DRC-MS) on January 15 and January 18, 2010. Aliquots of each sample are injected onto an anion exchange column and mobilized by an alkaline (pH > 7) gradient. The eluting chromium species are then introduced into a radio frequency (RF) plasma where energy-transfer processes cause desolvation, atomization, and ionization. The ions are extracted from the plasma through a differentially-pumped vacuum interface and travel through a pressurized chamber (DRC) containing a specific reactive gas which preferentially reacts with interfering ions of the same target mass to charge (m/z) ratios. A solid-state detector detects ions transmitted through the mass analyzer, on the basis of their mass-to-charge ratio (m/z), and the resulting current is processed by a data handling system.

The retention time for hexavalent chromium is compared to known standards for species identification.

4. Analytical Issues

Although the overall analyses went well, significant issues were encountered during the applied extraction procedure, as described below.

Hexavalent Chromium Quantitation - Laboratory Control Samples Three laboratory control samples were extracted with the submitted samples to identify the extraction efficiency and capacity of the extraction procedure to induce conversion of trivalent chromium to hexavalent chromium. The laboratory control samples spiked with an aqueous hexavalent chromium and a solid $PbCrO_4$ standard produced acceptable recoveries (98.6% and 91.5%, respectively), indicating that the applied method effectively extracts and stabilizes the hexavalent chromium species. The third laboratory control sample spiked with an aqueous trivalent chromium standard solution resulted in a hexavalent chromium recovery of 0.4%. The quantity of hexavalent chromium detected in this LCS is near the level present in the preparation blanks, which is attributed to trace levels of hexavalent chromium in the reagents used for the extraction procedure. This low recovery for the trivalent chromium spike

demonstrates that the extraction procedure, under ideal conditions, induces minimal conversion of trivalent to hexavalent chromium.

Hexavalent Chromium Quantitation – Matrix Spike / Matrix Spike Duplicates (MS/MSDs) Similar to the laboratory control samples, three discrete sets of matrix spikes were extracted to identify the interaction of the sample matrix with trivalent and hexavalent chromium. The performance of the matrix spikes can assist in identifying chemical interferences associated with the sample matrix and the applied extraction procedure.

Hexavalent Chromium Quantitation – Cr(III) MS/MSDs The hexavalent chromium recoveries associated with the aqueous trivalent chromium MS and MSD were less than 5%. For each trivalent chromium MS and MSD performed, the increase in the Cr(VI) concentration above the associated ambient sample concentration was less than ten times the reporting limit (RL) of 0.025mg/kg. These low trivalent chromium matrix spike recoveries confirm that the extraction procedure induces minimal oxidation of trivalent chromium to hexavalent chromium in the spiked sample matrix.

The RPD associated with the MSD performed on the sample identified as AB09966 was above the established control limit of 25% (92.3%), as was that associated with the MSD performed on the sample identified as AB09958 (53.3%). These elevated RPDs are attributable to the fact that a minimal amount of the trivalent chromium spikes were converted to hexavalent chromium during the applied extraction procedure, as expected, resulting in hexavalent chromium concentrations that either were either less than ten times the RL (as in the case of AB09966) or represented an increase in Cr(VI) above the ambient sample concentration that was less than ten times the RL (as in the case of AB09958). Since greater variability is expected as sample concentrations approach the RL, the elevated RPDs are identified as an inherent limitation of any quantitative method and do not impact the validity of the reported results.

Hexavalent Chromium Quantitation – Aqueous Cr(VI) and Solid $PbCrO_4$ MS/MSDs The hexavalent chromium recoveries associated with both the soluble and insoluble hexavalent chromium matrix spikes performed on the samples identified as AB09966, AB09956, and AB09958 were below the established control limit of 75% for all spiked samples except for the $PbCrO_4$ MS performed on AB09956 and the $PbCrO_4$ MSD performed on AB09958 (see attached results). For the samples identified as AB09958 and AB09966, the recoveries of the continuing calibration verification recoveries bracketing the matrix spike sets ranged from 85.9% to 90.6%. When this slight instrument bias is taken into account, the recoveries associated with their associated $PbCrO_4$ matrix spikes are within acceptance limits, but still biased lower than that of the $PbCrO_4$ LCS.

Despite this fact, the matrix spike recoveries indicate that significant interference was encountered during the applied extraction procedure. As previously mentioned, the recoveries associated with both the soluble hexavalent chromium LCS and insoluble

hexavalent chromium LCS were within control, demonstrating that the applied method both extracts and stabilizes hexavalent chromium. Since the biased low recoveries observed for all of the matrix spikes may therefore be attributed to interference from the sample matrices, no further corrective action was deemed necessary. The reported results suggest that these spiked sample matrices favor reduction of hexavalent chromium.

It must be noted that during the analysis of the submitted samples, the instrument sensitivity drifted to approximately seventy percent (70%) of that of the initial calibration, as determined by the CCV recoveries. This instrument drift was noted by the analyst, who analyzed a second calibration curve (on January 18th) after most of the sample batch had already been analyzed (on January 15th). When the second calibration curve was then applied to the sample results immediately preceding this calibration, the recoveries of the CCVs bracketing these samples improved from approximately 70% to 83.8-90.6%. Since these latter recoveries are within Applied Speciation and Consulting's control limits for CCVs and demonstrate acceptable instrument sensitivity at the time these samples were analyzed, all reported sample results from January 15th have been calculated using the second calibration curve.

It should be noted that the estimated method detection limit (eMDL) for hexavalent chromium for solids is generated using the standard deviation of the associated preparation blanks, in accordance with Applied Speciation and Consulting's SOP.

If you have any questions or concerns regarding this report, please feel free to contact me.

Sincerely,

Ben Wozniak

Ben Wozniak
Project Manager
Applied Speciation and Consulting, LLC

Hexavalent Chromium Results for the Missouri Department of Natural Resources
Contact: Michael Stroh

Date: January 20, 2010
Report Generated by: Ben Wozniak
Applied Speciation and Consulting, LLC

Sample Results

Sample ID	Date & Time Analyzed*	Cr(VI)
AB09956	1/18/2010 18:44	0.240
AB09957	1/18/2010 19:46	0.221
AB09958	1/18/2010 19:59	0.348
AB09959	1/15/2010 13:00	0.089
AB09960	1/15/2010 13:59	0.076
AB09962	1/15/2010 14:05	0.059
AB09964	1/15/2010 14:11	1.204
AB09966	1/15/2010 14:17	0.094
AB09967	1/15/2010 16:03	0.068
AB09968	1/15/2010 16:09	0.213
AB09969	1/15/2010 16:28	0.055
AB09971	1/15/2010 16:22	0.049
AB09972	1/15/2010 16:34	0.117

All results are reported in mg/kg (dry wt.)
* Times reported in CST

Missouri Department of Natural Resources
Environmental Services Program

Order ID 091008002 **Program, Contact:** HWP Julieann Warren

Report Date: 01/15/2010 **LDPR/JobCode:** FEPA8 / NJ09TSFA

RECEIVED
JAN 20 2010
Hazardous Waste Program
MO Dept. of Natural Resources

Sample: AB07939
Customer #: 0931971

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH **Affiliation:** HWP **Collect Date:** 10/2/2009 10:53:00AM
Sample Comment: SU 1.1.3
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	2.10	04,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	3.1		%	2,902	Infrared Drying

Sample: AB07940
Customer #: 0931972

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH **Affiliation:** HWP **Collect Date:** 10/2/2009 10:54:00AM
Sample Comment: SU 1.2.1
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	2.20	04,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	4.7		%	2,902	Infrared Drying

Sample: AB07941
Customer #: 0931973

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH **Affiliation:** HWP **Collect Date:** 10/2/2009 10:54:00AM
Sample Comment: SU 1.3.1
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.42	04,05,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	2.1		%	2,902	Infrared Drying

Sample: AB07942

Customer #: 0931974

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 10:56:00AM
Sample Comment: SU 2.1.3
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.12	04,05,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	3.8		%	2,902	Infrared Drying

Sample: AB07943

Customer #: 0931975

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 10:58:00AM
Sample Comment: SU 2.2.3
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.43	04,05,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	3.9		%	2,902	Infrared Drying

Sample: AB07944

Customer #: 0931976

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:00:00AM
Sample Comment: SU 3.1.1
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	1.10	04,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	4.2		%	2,902	Infrared Drying

Sample: AB07945

Customer #: 0931977

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:00:00AM
Sample Comment: SU 3.1.3
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.83	04,05,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	3.9		%	2,902	Infrared Drying

Sample: AB07946
Customer #: 0931978

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:02:00AM
Sample Comment: SU 3.2.1
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.90	04,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	2.7		%	2,902	Infrared Drying

Sample: AB07947
Customer #: 0931979

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:02:00AM
Sample Comment: SU 3.2.3
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.20	04,05,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	2.7		%	2,902	Infrared Drying

Sample: AB07948
Customer #: 0931980

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:05:00AM
Sample Comment: SU 3.3.3
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.20	04,05,06,09,23	mg/Kg	2,892	Contract Lab Dep
Percent Moisture	Percent Moisture	3.4		%	2,902	Infrared Drying

Sample: AB07949
Customer #: 0931981

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:07:00AM
Sample Comment: SU 4.1.2
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.42	04,05,06,09,23	mg/Kg	2,893	Contract Lab Dep
Percent Moisture	Percent Moisture	37		%	2,903	Infrared Drying

Sample: AB07950

Customer #: 0931982

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:10:00AM
Sample Comment: SU 4.2.3
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.29	04,05,06,09,23	mg/Kg	2,893	Contract Lab Dep
Percent Moisture	Percent Moisture	3.1		%	2,903	Infrared Drying

Sample: AB07951

Customer #: 0931983

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 10:53:00AM
Sample Comment: SU1IS.1
Compound was found in the blank and sample.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.31	04,05,06,09,23	mg/Kg	2,893	Contract Lab Dep
Percent Moisture	Percent Moisture	3.2		%	2,903	Infrared Drying

Sample: AB07952

Customer #: 0931984

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 10:56:00AM
Sample Comment: SU2IS.1

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.63	04,05,06,09	mg/Kg	2,893	Contract Lab Dep
Percent Moisture	Percent Moisture	3.7		%	2,903	Infrared Drying

Sample: AB07953

Customer #: 0931985

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:02:00AM
Sample Comment: SU3IS.1

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	4.50	03,04,06,09	mg/Kg	2,893	Contract Lab Dep
Percent Moisture	Percent Moisture	3.1		%	2,903	Infrared Drying

Sample: AB07954

Customer #: 0931986

Facility ID:
County: Buchannan

Site: Tannery Sludge Farm Fields
Sample Reference ID:

Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:07:00AM

Sample Comment: SU4IS.1

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	<2.1	03,04,06,09,ND	mg/Kg	2,893	Contract Lab Dep
Percent Moisture	Percent Moisture	4.9		%	2,903	Infrared Drying

Sample: AB07955

Customer #: 0931987

Facility ID:
County: Buchannan

Site: Tannery Sludge Farm Fields
Sample Reference ID:

Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:10:00AM

Sample Comment: DUIS.3

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	3.60	03,04,06,09	mg/Kg	2,893	Contract Lab Dep
Percent Moisture	Percent Moisture	3.7		%	2,903	Infrared Drying

The analysis of this sample was performed in accordance with procedures approved or recognized by the U.S Environmental Protection Agency.

Chris Boldt

Chris Boldt, Laboratory Manager
Environmental Services Program
Field Services Division

Qualifier Descriptions

01 Improper collection method
02 Improper preservation
03 Exceeded holding time
04 Analyzed by Contract Laboratory
05 Estimated value, detected below PQL
06 Estimated value, QC data outside limits
07 Estimated value, analyte outside calibration range
08 Analyte present in blank at > 1/2 reported value
09 Sample was diluted during analysis
10 Laboratory error
11 Estimated value, matrix interference
12 Insufficient quantity
13 Estimated value, true result is > reported value
14 Estimated value, non-homogeneous sample
15 No Result - Failed Quality Controls Requirements
16 Not analyzed - related analyte not detected
17 Results in dry weight
18 Sample pH is outside the acceptable range
19 Estimated value
20 Not analyzed - Instrument failure
21 No result - spectral interference
22 pH was performed at the Laboratory
ND Not detected at reported value
23 Contract Lab specific qualifier - see sample comments

Missouri Department of Natural Resources
Environmental Services Program

RECEIVED
FEB 23 2010
Hazardous Waste Program
MO Dept. of Natural Resources

Order ID 091119006 **Program, Contact:** HWP Julieann Warren

Report Date: 02/19/2010 **LDPR/JobCode:** FEPA8 / NJ09TSFA

Sample: AB09956
Customer #: 0931971

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH **Affiliation:** HWP **Collect Date:** 10/2/2009 10:53:00AM
Sample Comment: This is an aliquot of AB07939.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.24	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.1		%		Infrared Drying

Sample: AB09957
Customer #: 0931972

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH **Affiliation:** HWP **Collect Date:** 10/2/2009 10:54:00AM
Sample Comment: This is an aliquot of AB07940.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.22	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	4.7		%		Infrared Drying

Sample: AB09958
Customer #: 0931973

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH **Affiliation:** HWP **Collect Date:** 10/2/2009 10:54:00AM
Sample Comment: This is an aliquot of AB07941.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.35	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	2.1		%		Infrared Drying

Sample: AB09959
Customer #: 0931974

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 10:56:00AM
Sample Comment: This is an aliquot of AB07942.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.089	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.8		%		Infrared Drying

Sample: AB09960
Customer #: 0931975

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 10:58:00AM
Sample Comment: This is an aliquot of AB07943.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.076	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.9		%		Infrared Drying

Sample: AB09961
Customer #: 0931976

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:00:00AM
Sample Comment: This is an aliquot of AB07944.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.13	04	mg/Kg	2,894	Contract Lab Dep
Percent Moisture	Percent Moisture	4.2	04	%		Infrared Drying

Sample: AB09962
Customer #: 0931977

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:00:00AM
Sample Comment: This is an aliquot of AB07945.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.059	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.9		%		Infrared Drying

Sample: AB09963

Customer #: 0931978

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:02:00AM
Sample Comment: This is an aliquot of AB07946.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	1.60	04	mg/Kg	2,894	Contract Lab Dep
Percent Moisture	Percent Moisture	2.7	04	%		Infrared Drying

Sample: AB09964

Customer #: 0931979

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:02:00AM
Sample Comment: This is an aliquot of AB07947.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	1.20	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	2.7		%		Infrared Drying

Sample: AB09965

Customer #: 0931980

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:05:00AM
Sample Comment: This is an aliquot of AB07948.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.078	04,11	mg/Kg	2,894	Contract Lab Dep
Percent Moisture	Percent Moisture	3.4	04	%		Infrared Drying

Sample: AB09966

Customer #: 0931981

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:07:00AM
Sample Comment: This is an aliquot of AB07949.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.094	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.7		%		Infrared Drying

Sample: AB09967

Customer #: 0931982

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:10:00AM
Sample Comment: This is an aliquot of AB07950.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.068	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.1		%		Infrared Drying

Sample: AB09968

Customer #: 0931983

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 10:53:00AM
Sample Comment: This is an aliquot of AB07951.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.21	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.2		%		Infrared Drying

Sample: AB09969

Customer #: 0931984

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 10:56:00AM
Sample Comment: This is an aliquot of AB07952.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.055	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.7		%		Infrared Drying

Sample: AB09970

Customer #: 0931985

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:02:00AM
Sample Comment: This is an aliquot of AB07953.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.66	04	mg/Kg	2,894	Contract Lab Dep
Percent Moisture	Percent Moisture	3.1	04	%		Infrared Drying

Sample: AB09971

Customer #: 0931986

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:07:00AM
Sample Comment: This is an aliquot of AB07954.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.049	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	4.9		%		Infrared Drying

Sample: AB09972

Customer #: 0931987

Facility ID:
County: Buchannan
Site: Tannery Sludge Farm Fields
Sample Reference ID:
Collector: MICHAEL STROH
Affiliation: HWP
Collect Date: 10/2/2009 11:10:00AM
Sample Comment: This is an aliquot of AB07955.

Test	Parameter	Result	Qualifier	Units	QC Batch ID	Method
Hexavalent Chromium	Hexavalent Chromium	0.12	04	mg/Kg		Contract Lab Dep
Percent Moisture	Percent Moisture	3.7		%		Infrared Drying

The analysis of this sample was performed in accordance with procedures approved or recognized by the U.S Environmental Protection Agency.

Chris Boldt

Chris Boldt, Laboratory Manager
Environmental Services Program
Field Services Division

Qualifier Descriptions

01 Improper collection method
02 Improper preservation
03 Exceeded holding time
04 Analyzed by Contract Laboratory
05 Estimated value, detected below PQL
06 Estimated value, QC data outside limits
07 Estimated value, analyte outside calibration range
08 Analyte present in blank at > 1/2 reported value
09 Sample was diluted during analysis
10 Laboratory error
11 Estimated value, matrix interference
12 Insufficient quantity
13 Estimated value, true result is >= reported value
14 Estimated value, non-homogeneous sample
15 No Result - Failed Quality Controls Requirements
16 Not analyzed - related analyte not detected
17 Results in dry weight
18 Sample pH is outside the acceptable range
19 Estimated value
20 Not analyzed - Instrument failure
21 No result - spectral interference
22 pH was performed at the Laboratory
ND Not detected at reported value
23 Contract Lab specific qualifier - see sample comments

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

37

LABORATORY ORDER ID: 091008002

Collector's Name: Michael Stroh
(Please Print)

Affiliation: ESP KCRO NERO SERO SLRO SWRO WPP DGLS HWP Other:
(circle one)

Description of Shipment
Shipped-Carrier:
Tape sealed and initialed
Hand Delivered
No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container		Preserved
0931971 (Sample A)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water ✓ Soil Organic Sludge	1L amber Cubitainer ✓ 2 oz glass 8 oz glass	120 mL Nalgene 1L	H_2SO_4 HNO_3 NAOH HCL
For Lab Use Only A607939	Time: 1053	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:	Other:	VOA vial Encore Other:	500mL 250mL	✓ 4° C(None) Disinfected Other
0931972 (Sample B)	Date: 10/02/09	Hexavalent Chromium by EPA SW						X Grab Composite Modified	Water ✓ Soil Organic Sludge	1L amber Cubitainer ✓ 2 oz glass 8 oz glass	120 mL Nalgene 1L	H_2SO_4 HNO_3 NAOH HCL
For Lab Use Only A607940	Time: 1054	D.O	Flow	pH			her:	Other:	Other:	VOA vial Encore Other:	500mL 250mL	✓ 4° C(None) Disinfected Other
0931973 (Sample C)	Date: 10/02/09	Hexavalent Chromium by EPA SW						X Grab Composite Modified	Water ✓ Soil Organic Sludge	1L amber Cubitainer ✓ 2 oz glass 8 oz glass	120 mL Nalgene 1L	H_2SO_4 HNO_3 NAOH HCL
For Lab Use Only A607941	Time: 1054	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:	Other:	VOA vial Encore Other:	500mL 250mL	✓ 4° C(None) Disinfected Other
0931974 (Sample D)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water ✓ Soil Organic Sludge	1L amber Cubitainer ✓ 2 oz glass 8 oz glass	120 mL Nalgene 1L	H_2SO_4 HNO_3 NAOH HCL
For Lab Use Only A607942	Time: 1056	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:	Other:	VOA vial Encore Other:	500mL 250mL	✓ 4° C(None) Disinfected Other

Check Please Email

Relinquished By:	Received By:	Date:	Time:
[signature]	[signature]	10-8-09	1255
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

Sample I.D. Letter	Site Description				
Sample A	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFA → FEPA8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 1.1.3				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	[redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**
Sample B	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFB → FEPA8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 1.2.1				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	[redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**
Sample C	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFC → FEPA8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 1.3.1				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	[redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**
Sample D	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFD → FEPA8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 2.1.3				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	[redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**

REMARKS:

Run Lab Dup~~s~~ on SU 1.2.1

B7

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

LABORATORY ORDER ID: _____

Collector's Name: Michael Stroh
(Please Print)

Affiliation: ESP KCRO NERO SERO SLRO SWRO WPP DGLS (HWP) Other:
(circle one)

Description of Shipment
Shipped-Carrier:
Tape sealed and initialed
Hand Delivered
No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container		Preserved
0931975 (Sample A)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water Soil Organic Sludge Other:	1L amber Cubitainer 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL 4° C(None) Disinfected Other
For Lab Use Only A007943	Time: 1058	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
0931976 (Sample B)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water Soil Organic Sludge Other:	1L amber Cubitainer 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL 4° C(None) Disinfected Other
For Lab Use Only A007944	Time: 1100	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
0931977 (Sample C)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water Soil Organic Sludge Other:	1L amber Cubitainer 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL 4° C(None) Disinfected Other
For Lab Use Only A007945	Time: 1100	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
0931978 (Sample D)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water Soil Organic Sludge Other:	1L amber Cubitainer 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL 4° C(None) Disinfected Other
For Lab Use Only A007946	Time: 1102	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				

Relinquished By:	Received By:	Date:	Time:
Michael Stroh	L. Wilsman	10-8-09	1255

Sample I.D. Letter	Site Description				
Sample A	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFA → FEPA8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 2.2.3				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]		**Accuracy** (check one) EPE (meters) / PDOP	**Sample Reference ID:**	
Sample B	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFB → FEPA8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 3.1.1				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]		**Accuracy** (check one) EPE (meters) / PDOP	**Sample Reference ID:**	
Sample C	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFC → FEPA 8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 3.1.3				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]		**Accuracy** (check one) EPE (meters) / PDOP	**Sample Reference ID:**	
Sample D	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFD → FEPA8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 3.2.1				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]		**Accuracy** (check one) EPE (meters) / PDOP	**Sample Reference ID:**	

REMARKS:

Run Lab Dupson 2.2.3 and SU 3.2.1

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

87

LABORATORY ORDER ID:

Collector's Name: Michael Stroh
(Please Print)

Affiliation: ESP KCRO NERO SERO SLRO SWRO WPP DGLS HWP Other:
(circle one)

Description of Shipment
Shipped-Carrier:
Tape sealed and initialed
Hand Delivered
No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container		Preserved
0931979 (Sample A)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only A607947	Time: 1102	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
0931980 (Sample B)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only A607948	Time: 1105	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
0931981 (Sample C)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only A607949	Time: 1107	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
0931982 (Sample D)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						X Grab Composite Modified	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only A607950	Time: 1110	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				

Relinquished By:	Received By:	Date:	Time:
Michael Stroh	L. Wilemann	10-8-09	1255

Sample I.D. Letter	Site Description				
Sample A	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFA → FEPA 8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 3.2.3				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	[redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**
Sample B	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFB → FEPA 8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 3.3.3				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	[redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**
Sample C	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFC → FEPA 8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 4.1.2				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	[redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**
Sample D	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFD → FEPA 8	**Job Code:** →
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU 4.2.3				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	[redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**

REMARKS:

Run

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

B7

LABORATORY ORDER ID:

Collector's Name: (Please Print) Michael Stroh	**Description of Shipment**
Affiliation: (circle one) ESP KCRO NERO SERO SLRO SWRO WPP DGLS HWP Other:	Shipped-Carrier: ___ Tape sealed and initialed ___ Hand Delivered ___ No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container		Preserved
0931983 (Sample A)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						Grab / X Composite / Modified / Other:	Water / Soil / Organic / Sludge / Other:	1L amber / Cubitainer / 2 oz glass / 8 oz glass / VOA vial / Encore / Other:	120 mL / Nalgene / 1L / 500mL / 250mL	H_2SO_4 / HNO_3 / NAOH / HCL / 4° C(None) / Disinfected / Other
For Lab Use Only AB07951	Time: 1053	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
0931984 (Sample B)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						Grab / X Composite / Modified / Other:	Water / Soil / Organic / Sludge / Other:	1L amber / Cubitainer / 2 oz glass / 8 oz glass / VOA vial / Encore / Other:	120 mL / Nalgene / 1L / 500mL / 250mL	H_2SO_4 / HNO_3 / NAOH / HCL / 4° C(None) / Disinfected / Other
For Lab Use Only AB07952	Time: 1056	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
0931985 (Sample C)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						Grab / X Composite / Modified / Other:	Water / Soil / Organic / Sludge / Other:	1L amber / Cubitainer / 2 oz glass / 8 oz glass / VOA vial / Encore / Other:	120 mL / Nalgene / 1L / 500mL / 250mL	H_2SO_4 / HNO_3 / NAOH / HCL / 4° C(None) / Disinfected / Other
For Lab Use Only AB07953	Time: 1102	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
0931986 (Sample D)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						Grab / X Composite / Modified / Other:	Water / Soil / Organic / Sludge / Other:	1L amber / Cubitainer / 2 oz glass / 8 oz glass / VOA vial / Encore / Other:	120 mL / Nalgene / 1L / 500mL / 250mL	H_2SO_4 / HNO_3 / NAOH / HCL / 4° C(None) / Disinfected / Other
For Lab Use Only AB07954	Time: 1107	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					

Relinquished By:	Received By:	Date:	Time:
[signature]	L. Nuhmann	10-8-09	1255

Sample I.D. Letter	Site Description				
Sample A	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFA → FEPA8	**Job Code:**
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU1IS.1				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only):		**Accuracy** (check one)	**Sample Reference ID:**	
	[redacted]	[redacted]	EPE (meters)		
			PDOP		
Sample B	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFB → FEPA8	**Job Code:**
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU2IS.~~2~~1 MS				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only):		**Accuracy** (check one)	**Sample Reference ID:**	
	[redacted]	[redacted]	EPE (meters)		
			PDOP		
Sample C	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFC → FEPA8	**Job Code:**
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU3IS.~~3~~ MS 1				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only):		**Accuracy** (check one)	**Sample Reference ID:**	
	[redacted]	[redacted]	EPE (meters)		
			PDOP		
Sample D	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFD → FEPA8	**Job Code:**
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): SU4IS.1				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only):		**Accuracy** (check one)	**Sample Reference ID:**	
	[redacted]	[redacted]	EPE (meters)		
			PDOP		

REMARKS: Run Lab Dups on SU2IS.1 and SU3IS.1

B7

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

LABORATORY ORDER ID:

Collector's Name: Michael Stroh
(Please Print)

Affiliation: ESP KCRO NERO SERO SLRO SWRO WPP DGLS HWP Other:
(circle one)

Description of Shipment
Shipped-Carrier:
Tape sealed and initialed
Hand Delivered
No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container	Preserved
0931987 (Sample A)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						Grab / X Composite / Modified / Other:	Water / 1 Soil / Organic / Sludge / Other:	1L amber / Cubitainer / 1 2 oz glass / 8 oz glass / VOA vial / Encore / Other: / 120 mL / Nalgene / 1L / 500mL / 250mL	H_2SO_4 / HNO_3 / NAOH / HCL / 1 4° C(None) / Disinfected / Other
For Lab Use Only A007955	Time: 1110	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
(Sample B)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						Grab / Composite / Modified / Other:	Water / Soil / Organic / Sludge / Other:	1L amber / Cubitainer / 2 oz glass / 8 oz glass / VOA vial / Encore / Other: / 120 mL / Nalgene / 1L / 500mL / 250mL	H_2SO_4 / HNO_3 / NAOH / HCL / 4° C(None) / Disinfected / Other
For Lab Use Only	Time:	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
(Sample C)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						Grab / Composite / Modified / Other:	Water / Soil / Organic / Sludge / Other:	1L amber / Cubitainer / 2 oz glass / 8 oz glass / VOA vial / Encore / Other: / 120 mL / Nalgene / 1L / 500mL / 250mL	H_2SO_4 / HNO_3 / NAOH / HCL / 4° C(None) / Disinfected / Other
For Lab Use Only	Time:	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
(Sample D)	Date: 10/02/09	Hexavalent Chromium by EPA SW-846 Method 7199						Grab / Composite / Modified / Other:	Water / Soil / Organic / Sludge / Other:	1L amber / Cubitainer / 2 oz glass / 8 oz glass / VOA vial / Encore / Other: / 120 mL / Nalgene / 1L / 500mL / 250mL	H_2SO_4 / HNO_3 / NAOH / HCL / 4° C(None) / Disinfected / Other
For Lab Use Only	Time:	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				

Relinquished By:	Received By:	Date:	Time:
[signature]	L. Ulbmann	10-8-09	1255

Sample I.D. Letter	Site Description				
Sample A	**Facility ID:**	**Site/Study Name:** Tannery Sludge Farm Fields	**County:** Buchannan	**LDPR Code:** NJ09TSFA → FEPA8	**Job Code:**
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.): DUIS.3				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**	
Sample B	**Facility ID:**	**Site/Study Name:** ~~Tannery Sludge Farm Fields~~	**County:** ~~Buchannan~~	**LDPR Code:** ~~NJ09TSFB~~ ~~FEPA8~~	**Job Code:**
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.):				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**	
Sample C	**Facility ID:**	**Site/Study Name:** ~~Tannery Sludge Farm Fields~~	**County:** ~~Buchannan~~	**LDPR Code:** ~~NJ09TSFC~~ ~~FEPA8~~	**Job Code:**
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.):				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**	
Sample D	**Facility ID:**	**Site/Study Name:** ~~Tannery Sludge Farm Fields~~	**County:** ~~Buchannan~~	**LDPR Code:** ~~NJ09TSFD~~ ~~FEPA~~	**Job Code:**
	Sample Comment (briefly describe where and how the sample was collected, station number, sample type, etc.):				
	GPS Coordinates (Record Coordinates in UTM Zone 15 NAD 83 Only): [redacted]	**Accuracy**	(check one) EPE (meters) / PDOP	**Sample Reference ID:**	

REMARKS:

Run Lab Dup on DUIS.3

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

LABORATORY ORDER ID: _____

Collector's Name: (Please Print) Transfer Chain of Custody-Applied Speciation &Consulting, LLC

Affiliation: (circle one) ESP KCRO NERO SERO SLRO SWRO WPP DGLS HWP Other:

Description of Shipment
- x Shipped-Carrier: UPS next day air
- x Tape sealed and initialed
- Hand Delivered

No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container	Preserved
AB09956 (Sample A)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						X Grab; Composite; Modified; Other:	Water; / Soil; Organic; Sludge; Other:	1L amber; 120 mL; Cubitainer; / 2 oz glass; Nalgene; 8 oz glass; 1L; VOA vial; 500mL; Encore; 250mL; Other:	H_2SO_4; HNO_3; NAOH; HCL; / 4° C(None); Disinfected; Other
For Lab Use Only 7939	Time: 10:53	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
AB09957 (Sample B)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab; Composite; Modified; Other:	Water; / Soil; Organic; Sludge; Other:	1L amber; 120 mL; Cubitainer; / 2 oz glass; Nalgene; 8 oz glass; 1L; VOA vial; 500mL; Encore; 250mL; Other:	H_2SO_4; HNO_3; NAOH; HCL; / 4° C(None); Disinfected; Other
For Lab Use Only 7940	Time: 1054	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
AB09958 (Sample C)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab; Composite; Modified; Other:	Water; / Soil; Organic; Sludge; Other:	1L amber; 120 mL; Cubitainer; / 2 oz glass; Nalgene; 8 oz glass; 1L; VOA vial; 500mL; Encore; 250mL; Other:	H_2SO_4; HNO_3; NAOH; HCL; / 4° C(None); Disinfected; Other
For Lab Use Only 7941	Time: 10:54	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
AB09959 (Sample D)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab; Composite; Modified; Other:	Water; / Soil; Organic; Sludge; Other:	1L amber; 120 mL; Cubitainer; / 2 oz glass; Nalgene; 8 oz glass; 1L; VOA vial; 500mL; Encore; 250mL; Other:	H_2SO_4; HNO_3; NAOH; HCL; / 4° C(None); Disinfected; Other
For Lab Use Only 7942	Time: 10:56	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				

Relinquished By:	Received By:	Date:	Time:
[illegible] 12/9/09			
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

LABORATORY ORDER ID: _____

Collector's Name: Transfer Chain of Custody-Applied Speciation &Consulting, LLC
(Please Print)

Affiliation: ESP KCRO NERO SERO SLRO SWRO WPP
(circle one) DGLS HWP Other:

Description of Shipment
x Shipped-Carrier: UPS next day air
x Tape sealed and initialed
Hand Delivered
No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container		Preserved
AB09960 (Sample A)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						X Grab Composite Modified	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only 7943	Time: 10:58	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
AB09961 (Sample B)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab Composite Modified	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only 7944	Time: 11:00	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
AB09962 (Sample C)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab Composite Modified	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only 7945	Time: 11:00	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				
AB09963 (Sample D)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab Composite Modified	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only 7946	Time: 11:02	D.O	Flow	pH	Spec. Cond.	Temp.	Other:	Other:				

Relinquished By:	Received By:	Date:	Time:
Jon Dunmire 12/9/09			
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

LABORATORY ORDER ID: _____

Collector's Name: Transfer Chain of Custody-Applied Speciation &Consulting, LLC
(Please Print)

Affiliation: ESP KCRO NERO SERO SLRO SWRO WPP DGLS HWP Other:
(circle one)

Description of Shipment
x Shipped-Carrier: UPS next day air
x Tape sealed and initialed
Hand Delivered
No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container		Preserved
AB09964 (Sample A)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						X Grab Composite Modified Other:	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only 47	Time: 11:02	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
AB09965 (Sample B)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab Composite Modified Other:	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only 48	Time: 11:05	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
AB09966 (Sample C)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab Composite Modified Other:	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only 49	Time: 11:07	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
AB09967 (Sample D)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						x Grab Composite Modified Other:	Water / Soil Organic Sludge Other:	1L amber Cubitainer / 2 oz glass 8 oz glass VOA vial Encore Other:	120 mL Nalgene 1L 500mL 250mL	H_2SO_4 HNO_3 NAOH HCL / 4° C(None) Disinfected Other
For Lab Use Only 50	Time: 11:10	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					

Relinquished By:	Received By:	Date:	Time:
Jeri Dunmire 12/9/09			
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

LABORATORY ORDER ID: _____

Collector's Name: (Please Print) Transfer Chain of Custody-Applied Speciation &Consulting, LLC

Affiliation: (circle one) ESP KCRO NERO SERO SLRO SWRO WPP DGLS HWP Other:

Description of Shipment
x Shipped-Carrier: UPS next day air
x Tape sealed and initialed
Hand Delivered
No. Of Containers: 4

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container	Preserved
AB09968 (Sample A)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						X Grab; Composite; Modified; Other:	Water; / Soil; ✓ LD 12/9/09 Organic; Sludge; Other:	1L amber; Cubitainer; / 2 oz glass; 8 oz glass; VOA vial; Encore; Other:	120 mL; Nalgene; 1L; 500mL; 250mL	H_2SO_4; HNO_3; NAOH; HCL; / 4° C(None); Disinfected; Other
For Lab Use Only 51	Time: 10:53	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
AB09969 (Sample B)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						LD 12/9/09 ✓ Grab; X Composite; Modified; Other:	Water; / Soil; Organic; Sludge; Other:	1L amber; Cubitainer; / 2 oz glass; 8 oz glass; VOA vial; Encore; Other:	120 mL; Nalgene; 1L; 500mL; 250mL	H_2SO_4; HNO_3; NAOH; HCL; / 4° C(None); Disinfected; Other
For Lab Use Only 52	Time: 14:56 LD 12/9/09	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
AB09970 (Sample C)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						LD 12/9/09 ✓ Grab; X Composite; Modified; Other:	Water; / Soil; Organic; Sludge; Other:	1L amber; Cubitainer; / 2 oz glass; 8 oz glass; VOA vial; Encore; Other:	120 mL; Nalgene; 1L; 500mL; 250mL	H_2SO_4; HNO_3; NAOH; HCL; / 4° C(None); Disinfected; Other
For Lab Use Only 53	Time: 11:02	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				
AB09971 (Sample D)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						LD 12/9/09 ✓ Grab; X Composite; Modified; Other:	Water; / Soil; Organic; Sludge; Other:	1L amber; Cubitainer; / 2 oz glass; 8 oz glass; VOA vial; Encore; Other:	120 mL; Nalgene; 1L; 500mL; 250mL	H_2SO_4; HNO_3; NAOH; HCL; / 4° C(None); Disinfected; Other
For Lab Use Only 54	Time: 11:07	D.O	Flow	pH	Spec. Cond.	Temp.	Other:				

Relinquished By:	Received By:	Date:	Time:
Lori Dunmire 12/9/09			
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

MISSOURI DEPARTMENT OF NATURAL RESOURCES

FIELD SHEET AND CHAIN-OF-CUSTODY RECORD

LABORATORY ORDER ID: _____

Collector's Name: (Please Print) Transfer Chain of Custody-Applied Speciation &Consulting, LLC

Affiliation: (circle one) ESP KCRO NERO SERO SLRO SWRO WPP DGLS HWP Other:

Description of Shipment
- x Shipped-Carrier: UPS next day air
- x Tape sealed and initialed
- Hand Delivered

No. Of Containers: 1

Sample Number	Sample Collected	Analyses						Sample Type	For Lab Use Only: Matrix	Container		Preserved
AB09972 (Sample A)	Date: 10/02/09	HEXAVALENT CHROMIUM/PERCENT MOISTURE						ID 12/9/09 ~~X~~ Grab; X Composite; Modified; Other:	Water; / Soil; Organic; Sludge; Other:	1L amber; Cubitainer; / 2 oz glass; 8 oz glass; VOA vial; Encore; Other:	120 mL; Nalgene; 1L; 500mL; 250mL	H_2SO_4; HNO_3; NAOH; HCL; / 4°C(None); Disinfected; Other
For Lab Use Only 55	Time: 11:10	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
(Sample B)	Date:							x Grab; Composite; Modified; Other:	Water; Soil; Organic; Sludge; Other:	1L amber; Cubitainer; 2 oz glass; 8 oz glass; VOA vial; Encore; Other:	120 mL; Nalgene; 1L; 500mL; 250mL	H_2SO_4; HNO_3; NAOH; HCL; 4°C(None); Disinfected; Other
For Lab Use Only	Time:	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
(Sample C)	Date:							x Grab; Composite; Modified; Other:	Water; Soil; Organic; Sludge; Other:	1L amber; Cubitainer; 2 oz glass; 8 oz glass; VOA vial; Encore; Other:	120 mL; Nalgene; 1L; 500mL; 250mL	H_2SO_4; HNO_3; NAOH; HCL; 4°C(None); Disinfected; Other
For Lab Use Only	Time:	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					
(Sample D)	Date:							x Grab; Composite; Modified; Other:	Water; Soil; Organic; Sludge; Other:	1L amber; Cubitainer; 2 oz glass; 8 oz glass; VOA vial; Encore; Other:	120 mL; Nalgene; 1L; 500mL; 250mL	H_2SO_4; HNO_3; NAOH; HCL; 4°C(None); Disinfected; Other
For Lab Use Only	Time:	D.O	Flow	pH	Spec. Cond.	Temp.	Other:					

Relinquished By:	Received By:	Date:	Time:
Lori Dunmire 12/9/09			
Relinquished By:	Received By:	Date:	Time:
Relinquished By:	Received By:	Date:	Time:

APPENDIX C

XRF Data

Tannery Sludge Farm Fields Site
Residential Yard Pilot Study
Buchanan County, MO

Project: Missouri Tannery Sludge Farm Fields Residential Yard Pilot Study

This spreadsheet records 4 results per bag; calculates the mean & SD & 2-sided confidence limits on the bag

Property ID: yard pilot

Using Total Pb

Date: Samples Collected 10/2/09, XRF analyses 10/7 & 10/8, 2009

LEAD 45sec Runs

Sample ID & Bagged Replicate Readings	Time	Reading No	Run Time (sec)	Instrmnt Result (ppm Pb)	Instrmnt Error (as 1SD)	Flag?
Information: SU1.1						
Bag reading 1	10/7/2009			38		
2	10/7/2009			32		
3	10/7/2009			31		
4	10/7/2009			33		
			Mean	33.5		
			SD	3.1		
			%RSD	9.3	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	29		
			Section 95%UCL =	38		
Information: SU1.1.1						
Bag reading 1	10/7/2009			37		
2	10/7/2009			36		
3	10/7/2009			37		
4	10/7/2009			42		
			Mean	38.0		
			SD	2.7		
			%RSD	7.1	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	34		
			Section 95%UCL =	42		
Information: SU1.1.2						
Bag reading 1	10/7/2009			35	4	
2	10/7/2009			35	4	
3	10/7/2009			33	4	
4	10/7/2009			34	4	
			Mean	34.3		
			SD	1.0		
			%RSD	2.8		
			n =	4		
2-sided CIs			Section 95%LCL =	33		
			Section 95%UCL =	36		
Information: SU1.1.3						
Bag reading 1	10/7/2009			34		
2	10/7/2009			27		
3	10/7/2009			25		
4	10/7/2009			42		
			Mean	32.0		
			SD	7.7		**
			%RSD	24.1	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	20		
			Section 95%UCL =	44		
Information: SU1.2						
Bag reading 1	10/7/2009			30		
2	10/7/2009			29		
3	10/7/2009			28		
4	10/7/2009			27		
			Mean	28.5		
			SD	1.3		
			%RSD	4.5	0.0	
			n =	4	0	
2-sided CIs			Section 95%LCL =	26		
			Section 95%UCL =	31		
Information: SU1.2.1						
Bag reading 1	10/7/2009			31		
2	10/7/2009			39		
3	10/7/2009			33		
4	10/7/2009			27		
			Mean	32.5		**
			SD	5.0		**
			%RSD	15.4		
			n =	4		
2-sided CIs			Section 95%LCL =	25		
			Section 95%UCL =	40		
Information: SU1.2.2						
Bag reading 1	10/7/2009			25		
2	10/7/2009			33		
3	10/7/2009			31		
4	10/7/2009			27		
			Mean	29.0		
			SD	3.7		**
			%RSD	12.6	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	23		
			Section 95%UCL =	35		
Information: SU1.2.3						
Bag reading 1	10/7/2009			33	4	
2	10/7/2009			25	4	
3	10/7/2009			34	4	
4	10/7/2009			32	4	
			Mean	31.0		
			SD	4.1		**
			%RSD	13.2	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	25		
			Section 95%UCL =	37		
Information: SU1.3						
Bag reading 1	10/7/2009			24		
2	10/7/2009			24		
3	10/7/2009			22		
4	10/7/2009			25		
			Mean	23.8		
			SD	1.3		
			%RSD	5.3		
			n =	4		
2-sided CIs			Section 95%LCL =	22		
			Section 95%UCL =	25.8		
Information: SU1.3.1						
Bag reading 1	10/7/2009			24		
2	10/7/2009			29		
3	10/7/2009			29		
4	10/7/2009			25		
			Mean	26.8		
			SD	2.6		**
			%RSD	9.8	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	23		
			Section 95%UCL =	31		
Information: SU1.3.2						
Bag reading 1	10/7/2009			29	4	
2	10/7/2009			26	4	
3	10/7/2009			24	4	
4	10/7/2009			27	4	
			Mean	26.5		
			SD	2.1		**
			%RSD	7.9	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	23		
			Section 95%UCL =	30		
Information: SU1.3.3						
Bag reading 1	10/7/2009			30		
2	10/7/2009			24		
3	10/7/2009			18		
4	10/7/2009			24		
			Mean	24.0		
			SD	4.9		**
			%RSD	20.4		
			n =	4		
2-sided CIs			Section 95%LCL =	16		
			Section 95%UCL =	32		
Information: SU1IS (1.1.2, 1.2.2, & 1.3.2)						
Bag reading 1	10/8/2009			25		
2	10/8/2009			36		
3	10/8/2009			26		
4	10/8/2009			30		
5	10/8/2009			30		
6	10/8/2009			29		
			Mean	29.3		
			SD	3.9		
			%RSD	13.2	0.0	
			n =	6		
2-sided CIs			Section 95%LCL =	25		
			Section 95%UCL =	33		
Information: SU1IS.1						
Bag reading 1	10/8/2009			31		
2	10/8/2009			25		
3	10/8/2009			33		
4	10/8/2009			32		
			Mean	30.3		
			SD	3.6		
			%RSD	11.9	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#NUM!		
			Section 95%UCL =	#NUM!		
Information: SU1IS.2						
Bag reading 1	10/8/2009			34		
2	10/8/2009			30		
3	10/8/2009			26		
4	10/8/2009			31		
			Mean	30.3		
			SD	3.3		
			%RSD	10.9		
			n =	4		
2-sided CIs			Section 95%LCL =	25		
			Section 95%UCL =	36		
Information: SU1IS.3						
Bag reading 1	10/8/2009			31		
2	10/8/2009			30		
3	10/8/2009			34		
4	10/8/2009			29		
			Mean	31.0		
			SD	2.2		
			%RSD	7.0	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	28		
			Section 95%UCL =	34		
Information:						
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		
Information:						
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!		
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		
Information: SU2.1						
Bag reading 1	10/7/2009			128		
2	10/7/2009			146		
3	10/7/2009			149		
4	10/7/2009			163		
			Mean	146.5		
			SD	14.4		
			%RSD	9.8	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	124		
			Section 95%UCL =	169		
Information: SU2.1.1						
Bag reading 1	10/7/2009			134	7	
2	10/7/2009			131	6	
3	10/7/2009			147	7	
4	10/7/2009			139	6	
			Mean	137.8		
			SD	7.0		
			%RSD	5.1	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	127	130	
			Section 95%UCL =	149	146	
Information: SU2.1.2						Flag?
Bag reading 1	10/7/2009			133		
2	10/7/2009			153		
3	10/7/2009			131		
4	10/7/2009			128		
			Mean	136.3		
			SD	11.4		
			%RSD	8.3		0.0
			n =	4		
2-sided CIs			Section 95%LCL =	118		
			Section 95%UCL =	154		

Project: Missouri Tannery Sludge Farm Fields Residential Yard Pilot Study

This spreadsheet records 4 results per bag; calculates the mean & SD & 2-sided confidence limits on the bag

Property ID: yard pilot

Using Total Pb

Date: Samples Collected 10/2/09, XRF analyses 10/7 & 10/8, 2009

LEAD 45sec Runs

Information: SU2.1.3

Bag reading 1	10/7/2009	150	
2	10/7/2009	136	
3	10/7/2009	134	
4	10/7/2009	136	
	Mean	139.0	
	SD	7.4	
	%RSD	5.3	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	127	
	Section 95%UCL =	151	

Information: SU2.2

Bag reading 1	10/7/2009	163	
2	10/7/2009	160	
3	10/7/2009	165	
4	10/7/2009	151	
	Mean	159.8	
	SD	6.2	
	%RSD	3.9	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	150	152
	Section 95%UCL =	170	167

Information: Flag?

Bag reading 1	10/7/2009		
2	10/7/2009		
3	10/7/2009		
4	10/7/2009		
	Mean	#DIV/0!	
	SD	#DIV/0!	
	%RSD	#DIV/0!	0.0
	n =	0	
2-sided CIs	Section 95%LCL =	#DIV/0!	
	Section 95%UCL =	#DIV/0!	

Information: SU2.2.1

Bag reading 1	10/7/2009	161	7
2	10/7/2009	157	7
3	10/7/2009	150	7
4	10/7/2009	173	7
	Mean	160.3	
	SD	9.6	
	%RSD	6.0	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	145	149
	Section 95%UCL =	176	172

Information: SU2.2.2 Flag?

Bag reading 1	10/7/2009	164	7
2	10/7/2009	158	7
3	10/7/2009	158	7
4	10/7/2009	172	7
	Mean	163.0	
	SD	6.6	
	%RSD	4.1	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	152	
	Section 95%UCL =	174	

Information: SU2.2.3

Bag reading 1	10/7/2009	144	7
2	10/7/2009	156	7
3	10/7/2009	167	7
4	10/7/2009	167	7
	Mean	158.5	
	SD	11.0	
	%RSD	6.9	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	141	
	Section 95%UCL =	176	

Information: SU2IS (2.1.2 an

Bag reading 1	10/8/090	143	
2	10/8/090	142	
3	10/8/090	140	
4	10/8/090	152	
	Mean	145.5	
	SD	5.5	
	%RSD	3.8	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	137	139
	Section 95%UCL =	154	152

Information: SU2IS.1 Flag?

Bag reading 1	10/8/090	145	
2	10/8/090	141	
3	10/8/090	157	
4	10/8/090	155	
	Mean	149.5	
	SD	7.7	
	%RSD	5.2	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	137	
	Section 95%UCL =	162	

Information: SU2IS.2

Bag reading 1	10/8/090	139	
2	10/8/090	154	
3	10/8/090	153	
4	10/8/090	151	
	Mean	149.3	
	SD	6.9	
	%RSD	4.7	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	138	
	Section 95%UCL =	160	

Information: SU2IS.3

Bag reading 1	10/8/090	154	
2	10/8/090	151	
3	10/8/090	150	
4	10/8/090	154	
	Mean	152.3	
	SD	2.1	
	%RSD	1.4	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	149	150
	Section 95%UCL =	156	155

Information: Flag?

Bag reading 1			
2			
3			
4			
	Mean	#DIV/0!	
	SD	#DIV/0!	
	%RSD	#DIV/0!	0.0
	n =	0	
2-sided CIs	Section 95%LCL =	#DIV/0!	
	Section 95%UCL =	#DIV/0!	

Information:

Bag reading 1			
2			
3			
4			
	Mean	#DIV/0!	
	SD	#DIV/0!	
	%RSD	#DIV/0!	0.0
	n =	0	
2-sided CIs	Section 95%LCL =	#DIV/0!	
	Section 95%UCL =	#DIV/0!	

Information: SU3.1

Bag reading 1	10/7/2009	455	
2	10/7/2009	460	
3	10/7/2009	441	
4	10/7/2009	464	
	Mean	455.0	
	SD	10.0	
	%RSD	2.2	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	439	
	Section 95%UCL =	471	

Information: SU3.1.1

Bag reading 1	10/7/2009	462	
2	10/7/2009	443	
3	10/7/2009	457	
4	10/7/2009	462	
	Mean	456.0	
	SD	9.0	
	%RSD	2.0	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	442	
	Section 95%UCL =	470	

Information: SU3.1.2

Bag reading 1	10/7/2009	450	
2	10/7/2009	437	
3	10/7/2009	459	
4	10/7/2009	472	
	Mean	454.5	
	SD	14.8	
	%RSD	3.2	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	431	
	Section 95%UCL =	478	

Information: SU3.1.3

Bag reading 1	10/7/2009	478	12
2	10/7/2009	451	11
3	10/7/2009	466	12
4	10/7/2009	456	12
	Mean	462.8	
	SD	11.9	
	%RSD	2.6	0.0
	n =	0	
2-sided CIs	Section 95%LCL =	#NUM!	
	Section 95%UCL =	#NUM!	

Information: SU3.2

	10/7/2009	118	
	10/7/2009	114	
	10/7/2009	115	
	10/7/2009	118	
	Mean	116.3	
	SD	2.1	
	%RSD	1.8	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	113	
	Section 95%UCL =	120	

Information: SU3.2.1

Bag reading 1	10/7/2009	114	
2	10/7/2009	113	
3	10/7/2009	119	
4	10/7/2009	113	
	Mean	114.8	
	SD	2.9	
	%RSD	2.5	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	110	
	Section 95%UCL =	119	

Information: SU3.2.2

Bag reading 1	10/7/2009	102	
2	10/7/2009	113	
3	10/7/2009	110	
4	10/7/2009	120	
	Mean	111.3	
	SD	7.5	**
	%RSD	6.7	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	99	
	Section 95%UCL =	123	

Information: SU3.2.3

Bag reading 1	10/7/2009	115	
2	10/7/2009	108	
3	10/7/2009	108	
4	10/7/2009	116	
	Mean	111.8	
	SD	4.3	
	%RSD	3.9	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	105	
	Section 95%UCL =	119	

Information: SU3.3

Bag reading 1	10/7/2009	39	
2	10/7/2009	41	
3	10/7/2009	35	
4	10/7/2009	31	
	Mean	36.5	
	SD	4.4	
	%RSD	12.1	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	29	
	Section 95%UCL =	44	

Information: SU3.3.1

Bag reading 1	10/7/2009	33	
2	10/7/2009	35	
3	10/7/2009	30	
4	10/7/2009	29	
	Mean	31.8	
	SD	2.8	
	%RSD	8.7	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	27	
	Section 95%UCL =	36	

Information: SU3.3.2

Bag reading 1	10/7/2009	28	
2	10/7/2009	32	
3	10/7/2009	33	
4	10/7/2009	38	
	Mean	32.8	
	SD	4.1	
	%RSD	12.6	0.0
	n =	0	
2-sided CIs	Section 95%LCL =	#NUM!	
	Section 95%UCL =	#NUM!	

Information: SU3.3.3

Bag reading 1	10/7/2009	27	
2	10/7/2009	32	
3	10/7/2009	31	
4	10/7/2009	30	
	Mean	30.0	
	SD	2.2	
	%RSD	7.2	
	n =	4	
2-sided CIs	Section 95%LCL =	27	
	Section 95%UCL =	33	

Project: Missouri Tannery Sludge Farm Fields Residential Yard Pilot Study

This spreadsheet records 4 results per bag; calculates the mean & SD & 2-sided confidence limits on the bag

Property ID: yard pilot

Using Total Pb

Date: Samples Collected 10/2/09, XRF analyses 10/7 & 10/8, 2009

LEAD 45sec Runs

Information: SU3IS (3.1.2, 3.2.2, & 3.3.2)

Bag reading 1	10/8/2009	198
2	10/8/2009	206
3	10/8/2009	202
4	10/8/2009	185
Mean		197.8
SD		9.1
%RSD		4.6
		0.0
n =		4
2-sided CIs	Section 95%LCL =	183
	Section 95%UCL =	212

Information: SU3IS.1

Bag reading 1		190
2		219
3		198
4		225
5		204
Mean		207.2
SD		14.5
%RSD		7.0
		0.0
n =		5
2-sided CIs	Section 95%LCL =	189
	Section 95%UCL =	225

Information: SU3IS.2

Bag reading 1		210
2		193
3		203
4		203
Mean		202.3
SD		7.0
%RSD		3.5
n =		4
2-sided CIs	Section 95%LCL =	191
	Section 95%UCL =	213

Information: SU3IS.3

Bag reading 1		222
2		202
3		219
4		199
Mean		210.5
SD		11.7
%RSD		5.5
		0.0
n =		4
2-sided CIs	Section 95%LCL =	192
	Section 95%UCL =	229

Information:

Bag reading 1		
2		
3		
4		
Mean		#DIV/0!
SD		#DIV/0!
%RSD		#DIV/0!
		0.0
n =		0
2-sided CIs	Section 95%LCL =	#DIV/0!
	Section 95%UCL =	#DIV/0!

Information:

Bag reading 1		
2		
3		
4		
Mean		#DIV/0!
SD		#DIV/0!
%RSD		#DIV/0!
n =		0
2-sided CIs	Section 95%LCL =	#DIV/0!
	Section 95%UCL =	#DIV/0!

Information: SU4.1

Bag reading 1	10/7/2009	51
2	10/7/2009	54
3	10/7/2009	55
4	10/7/2009	41
Mean		50.3
SD		6.4
%RSD		12.7
		0.0
n =		4
2-sided CIs	Section 95%LCL =	40
	Section 95%UCL =	60

Information: SU4.1.1

Bag reading 1	10/7/2009	51
2	10/7/2009	51
3	10/7/2009	38
4	10/7/2009	48
Mean		47.0
SD		6.2
%RSD		13.1
		0.0
n =		4
2-sided CIs	Section 95%LCL =	37
	Section 95%UCL =	57

Information: SU4.1.2

Bag reading 1	10/7/2009	47
2	10/7/2009	42
3	10/7/2009	47
4	10/7/2009	46
Mean		45.5
SD		2.4
%RSD		5.2
		0.0
n =		4
2-sided CIs	Section 95%LCL =	42
	Section 95%UCL =	49

Information: SU4.1.3

Bag reading 1	10/7/2009	53
2	10/7/2009	47
3	10/7/2009	41
4	10/7/2009	46
Mean		46.8
SD		4.9
%RSD		10.5
		0.0
n =		4
2-sided CIs	Section 95%LCL =	39
	Section 95%UCL =	55

Information: SU4.2

Bag reading 1	10/7/2009	70
2	10/7/2009	96
3	10/7/2009	68
4	10/7/2009	64
Mean		74.5
SD		14.5
%RSD		19.5
		0.0
n =		4
2-sided CIs	Section 95%LCL =	51
	Section 95%UCL =	98

Information: SU4.2.1

Bag reading 1	10/7/2009	62
2	10/7/2009	72
3	10/7/2009	65
4	10/7/2009	65
Mean		66.0
SD		4.2
%RSD		6.4
		0.0
n =		4
2-sided CIs	Section 95%LCL =	59
	Section 95%UCL =	73

Information: SU4.2.2

Bag reading 1	10/7/2009	69
2	10/7/2009	69
3	10/7/2009	67
4	10/7/2009	65
Mean		67.5
SD		1.9
%RSD		2.8
		0.0
n =		4
2-sided CIs	Section 95%LCL =	64
	Section 95%UCL =	71

Information: SU4.2.3

Bag reading 1	10/7/2009	63
2	10/7/2009	62
3	10/7/2009	59
4	10/7/2009	78
Mean		65.5
SD		8.5
%RSD		13.0
		0.0
n =		4
2-sided CIs	Section 95%LCL =	52
	Section 95%UCL =	79

Information:

Bag reading 1		
2		
3		
4		
Mean		#DIV/0!
SD		#DIV/0!
%RSD		#DIV/0!
		0.0
n =		0
2-sided CIs	Section 95%LCL =	#DIV/0!
	Section 95%UCL =	#DIV/0!

Information: SU4IS (4.1.2 & 4.2.2)

Bag reading 1	10/8/2009	57
2	10/8/2009	56
3	10/8/2009	67
4	10/8/2009	56
Mean		59.0
SD		5.4
%RSD		9.1
		0.0
n =		4
2-sided CIs	Section 95%LCL =	50
	Section 95%UCL =	68

Information: SU4IS.1

Bag reading 1	10/8/2009	55
2	10/8/2009	52
3	10/8/2009	64
4	10/8/2009	50
Mean		55.3
SD		6.2
%RSD		11.2
		0.0
n =		4
2-sided CIs	Section 95%LCL =	45
	Section 95%UCL =	65

Information: SU4IS.2

Bag reading 1	10/8/2009	57
2	10/8/2009	58
3	10/8/2009	57
4	10/8/2009	51
Mean		55.8
SD		3.2
%RSD		5.7
		0.0
n =		4
2-sided CIs	Section 95%LCL =	51
	Section 95%UCL =	61

Information: SU4IS.3

Bag reading 1	10/8/2009	57
2	10/8/2009	61
3	10/8/2009	59
4	10/8/2009	53
Mean		57.5
SD		3.4
%RSD		5.9
		0.0
n =		4
2-sided CIs	Section 95%LCL =	52
	Section 95%UCL =	63

Information:

Bag reading 1		
2		
3		
4		
Mean		#DIV/0!
SD		#DIV/0!
%RSD		#DIV/0!
		0.0
n =		0
2-sided CIs	Section 95%LCL =	#DIV/0!
	Section 95%UCL =	#DIV/0!

Information:

Bag reading 1		
2		
3		
4		
Mean		#DIV/0!
SD		#DIV/0!
%RSD		#DIV/0!
		0.0
n =		0
2-sided CIs	Section 95%LCL =	#DIV/0!
	Section 95%UCL =	#DIV/0!

Information: DUIS

Bag reading 1	10/8/2009	109
2	10/8/2009	103
3	10/8/2009	98
4	10/8/2009	114
Mean		106.0
SD		7.0
%RSD		6.6
		0.0
n =		4
2-sided CIs	Section 95%LCL =	95
	Section 95%UCL =	117

Information: DUIS.1

Bag reading 1	10/8/2009	104
2	10/8/2009	112
3	10/8/2009	97
4	10/8/2009	109
Mean		105.5
SD		6.6
%RSD		6.2
		0.0
n =		4
2-sided CIs	Section 95%LCL =	95
	Section 95%UCL =	116

Information: DUIS.2

Bag reading 1	10/8/2009	110
2	10/8/2009	111
3	10/8/2009	107
4	10/8/2009	101
Mean		107.3
SD		4.5
%RSD		4.2
		0.0
n =		4
2-sided CIs	Section 95%LCL =	100
	Section 95%UCL =	114

Information: DUIS.3

Project: Missouri Tannery Sludge Farm Fields Residential Yard Pilot Study

This spreadsheet requires 4 readings per bag, calculates the mean & SD & 2-sided confidence limits on the bag

Property ID: Yard Pilot

Using Total Cr

Date: Samples Collected 10/2/09, XRF analyses 10/5 thru 10/6, 2009

Information: SU1.1.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			32	6	
2	10/5/2009			31	6	
3	10/5/2009			28	5	
4	10/5/2009			35	6	
			Mean	31.5	5.8	
			SD	2.9	0.5	
			%RSD	9.2	1.0	
			n =	4	4	
2-sided CIs			Section 95%LCL =	27	5	
			Section 95%UCL =	36.1	7	

Information: SU1.1.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1				43	6	
2				32	6	
3				36	6	
4				37	6	
			Mean	36.3		
			SD	3.3		
			%RSD	9.1	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	31		
			Section 95%UCL =	42		

Information: SU1.1.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1				35		
2				48		
3				34		
4				33		
			Mean	34.8		
			SD	7.8		
			%RSD	21.2	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	24		
			Section 95%UCL =	49		

Information: SU1.1.4

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1				39		
2				29		
3				41		
4				40		
			Mean	37.0		
			SD	5.4		
			%RSD	14.5	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	29		
			Section 95%UCL =	46		

Information: SU1.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			28	6	
2	10/5/2009			34	6	
3	10/5/2009			26	5	
4	10/5/2009			37	6	
			Mean	31.3	5.8	
			SD	5.1	0.5	
			%RSD	16.4	1.0	
			n =	4	4	
2-sided CIs			Section 95%LCL =	23	5	
			Section 95%UCL =	39	7	

Information: SU1.2.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			29		
2	10/5/2009			24		
3	10/5/2009			37		
4	10/5/2009			29		
			Mean	29.5		
			SD	5.3		
			%RSD	21.6	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	19		
			Section 95%UCL =	38		

Information: SU1.2.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			38		
2	10/5/2009			34		
3	10/5/2009			41		
4	10/5/2009			34		
			Mean	36.8		
			SD	3.4		
			%RSD	9.3	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	31		
			Section 95%UCL =	42		

Information: SU1.2.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			23		
2	10/5/2009			44		
3	10/5/2009			32		
4	10/5/2009			38		
			Mean	34.3		
			SD	8.7		
			%RSD	25.2	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	20		
			Section 95%UCL =	49		

Information: SU1.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			47	6	
2	10/5/2009			27	6	
3	10/5/2009			38	6	
4	10/5/2009			25	6	
			Mean	34.3	6.0	
			SD	10.2	0.0	
			%RSD	29.8	0.0	
			n =	4	4	
2-sided CIs			Section 95%LCL =	18	6	
			Section 95%UCL =	51	6	

Information: SU1.3.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			46		
2	10/5/2009			30		
3	10/5/2009			30		
4	10/5/2009			41		
			Mean	36.8		
			SD	8.1		
			%RSD	21.9	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	24		
			Section 95%UCL =	50		

Information: SU1.3.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			26.6		
2	10/5/2009			32		
3	10/5/2009			22		
4	10/5/2009			31		
			Mean	27.9		
			SD	4.6		
			%RSD	16.4	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	21		
			Section 95%UCL =	35		

Information: SU1.3.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading	10/5/2009			41		
2	10/5/2009			34		
3	10/5/2009			35		
4	10/5/2009			30		
			Mean	35.0		
			SD	4.5		
			%RSD	13.0	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	29		
			Section 95%UCL =	42		

Information: SU2.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			30	6	
2	10/5/2009			31	5	
3	10/5/2009			25	5	
4	10/5/2009			34	5	
			Mean	30.0		
			SD	3.7		
			%RSD	12.5	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	24		
			Section 95%UCL =	36		

Information: SU2.1.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			28		
2	10/5/2009			29		
3	10/5/2009			32		
4	10/5/2009			22		
			Mean	27.8		
			SD	4.2		
			%RSD	15.1		
			n =	4		
2-sided CIs			Section 95%LCL =	21		
			Section 95%UCL =	34		

Information: SU2.1.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU2.1.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU2.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			30	6	
2	10/5/2009			26	6	
3	10/5/2009			24	6	
4	10/5/2009			26	6	
			Mean	26.5		
			SD	2.5		
			%RSD	9.5	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	22		
			Section 95%UCL =	31		

Information: SU2.2.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU2.2.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU2.2.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU3.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			19	6	
2	10/5/2009			35	6	
3	10/5/2009			25	6	
4	10/5/2009			22	5	
			Mean	25.3		
			SD	6.9		
			%RSD	27.6	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	14		
			Section 95%UCL =	36		

Information: SU3.1.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU3.1.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU3.1.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU3.2

*This sample next to soybean field

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			121	7	
2	10/5/2009			120	7	
3	10/5/2009			106	7	
4	10/5/2009			105	7	
			Mean	113.0		
			SD	8.7		
			%RSD	7.7	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	99		
			Section 95%UCL =	127		

Information: SU3.2.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU3.2.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU3.2.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1						
2						
3						
4						
			Mean	#DIV/0!		
			SD	#DIV/0!		
			%RSD	#DIV/0!	0.0	
			n =	0		
2-sided CIs			Section 95%LCL =	#DIV/0!		
			Section 95%UCL =	#DIV/0!		

Information: SU3.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			30		
2	10/5/2009			37		
3	10/5/2009			18		
4	10/5/2009			26		
			Mean	27.8		
			SD	7.8		
			%RSD	28.6	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	15		
			Section 95%UCL =	40		

Information: SU3.3.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			33		
2	10/5/2009			32		
3	10/5/2009			24		
4	10/5/2009			25		
			Mean	28.8		
			SD	4.4		
			%RSD	15.4	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	22		
			Section 95%UCL =	36		

Information: SU3.3.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			21		
2	10/5/2009			33		
3	10/5/2009			24		
4	10/5/2009			20		
			Mean	24.5		
			SD	5.9		
			%RSD	24.1		
			n =	4		
2-sided CIs			Section 95%LCL =	15		
			Section 95%UCL =	34		

Information: SU3.3.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading	10/5/2009			17		
2	10/5/2009			17		
3	10/5/2009			27		
4	10/5/2009			6		
			Mean	16.8		
			SD	8.6		
			%RSD	51.2	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	3		
			Section 95%UCL =	30		

Information: SU4.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			16		
2	10/5/2009			35		
3	10/5/2009			15		
4	10/5/2009			31		
			Mean	24.3		
			SD	10.2		
			%RSD	42.2	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	6		
			Section 95%UCL =	41		

Information: SU4.1.1

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			23		
2	10/5/2009			27		
3	10/5/2009			21		
4	10/5/2009			44		
			Mean	29.8		
			SD	10.5		
			%RSD	36.4	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	12		
			Section 95%UCL =	48		

Information: SU4.1.2

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading 1	10/5/2009			24		
2	10/5/2009			11		
3	10/5/2009			23		
4	10/5/2009			20		
			Mean	19.5		
			SD	5.9		
			%RSD	30.3	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	10		
			Section 95%UCL =	29		

Information: SU4.1.3

Sample ID & Bagged Replicate Readings	Time	Reading No.	Run Time (sec)	Instrmt Result (ppm Cr)	Instrmt Error (as 1SD)	Flag?
Bag reading	10/5/2009			20		
2	10/5/2009			28		
3	10/5/2009			15		
4	10/5/2009			27		
			Mean	22.8		
			SD	5.7		
			%RSD	25.2	0.0	
			n =	4		
2-sided CIs			Section 95%LCL =	14		
			Section 95%UCL =	32		

Project: Missouri Tannery Sludge Farm Fields Residential Yard Pilot Study

This spreadsheet is for 4 results per bag; calculates the mean & SD & 2-sided confidence limits on the bag

Property ID: Yard Pilot — Using Total Cr

Date: Samples Collected 10/2/09, XRF analyses 10/5 thru 10/8, 2009

Information: SU4.2

Bag reading 1	10/5/2009	12	
2	10/5/2009	34	
3	10/5/2009	25	
4	10/5/2009	33	
	Mean	26.3	
	SD	10.1	
	%RSD	38.6	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	10	
	Section 95%UCL =	42	

Information: SU4.2.1

Bag reading 1	10/5/2009	30	
2	10/5/2009	21	
3	10/5/2009	24	
4	10/5/2009	15	
	Mean	22.5	
	SD	6.2	
	%RSD	27.8	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	13	
	Section 95%UCL =	32	

Information: SU4.2.2

Bag reading 1	10/5/2009	25	
2	10/5/2009	29	
3	10/5/2009	24	
4	10/5/2009	35	
	Mean	28.5	
	SD	4.8	
	%RSD	16.8	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	21	
	Section 95%UCL =	36	

Information: SU4.2.3

Bag reading	10/5/2009	19	
2	10/5/2009	29	
3	10/5/2009	23	
4	10/5/2009	20	
	Mean	22.8	
	SD	4.5	
	%RSD	19.8	0.0
	n =	4	
2-sided CIs	Section 95%LCL =	16	
	Section 95%UCL =	30	

Information: SU 3.2 Precision Check

Bag reading 1	10/5/2009	112	7
2	10/5/2009	100	6
3	10/5/2009	99	6
4	10/5/2009	105	6
5	10/5/2009	105	6
6	10/5/2009	109	6
7	10/5/2009	120	7
	Mean	107.3	
	SD	7.3	
	%RSD	6.8	0.0
	n =	7	
2-sided CIs	Section 95%LCL =	101	
	Section 95%UCL =	114	

Information: su2.1.1 Precisi

Bag reading 1	28	5
2	29	5
3	32	5
4	22	5
5	18	5
Mean	27.8	
SD	4.2	
%RSD	15.1	0.0
n =	5	
2-sided CIs Section 95%LCL =	21	
Section 95%UCL =	34	

Information:

Bag reading 1		
2		
3		
4		
Mean	#DIV/0!	
SD	#DIV/0!	
%RSD	#DIV/0!	0.0
n =	0	
2-sided CIs Section 95%LCL =	#DIV/0!	
Section 95%UCL =	#DIV/0!	

APPENDIX D

Data Analysis Documentation

Tannery Sludge Farm Fields Site
Residential Yard Pilot Study
Buchanan County, MO

TETRA TECH

FINAL MEMORANDUM, REVISION 1

Date: March 9, 2010

To: Deana Crumbling, Work Assignment Manager
US EPA Office of Superfund Remediation & Technology Innovation (OSRTI)
Technical Innovation & Integration Branch (TIIB)

From: Rob Tisdale, Technical Task Manager, Tetra Tech EMI

Subject: Multisample Ingersoll Uncertainty Calculator for
Missouri Farms Yard Pilot Study Test Samples

EPA Contract # EP-W-07-078
Work Assignment WA-46

1.0 Introduction

The purpose of this memorandum is to describe a Microsoft Excel workbook based on the Ingersoll Uncertainty Calculator, to describe a quality review of data from a residential yard pilot study conducted in October 2009 at the Tannery Sludge Farm Fields Site (Site), and to present the uncertainty calculations performed on the test sample results by Tetra Tech EMI (TTEMI).

This quality review was conducted on data from a re-analysis of the soil samples conducted in December, 2009. The yard pilot soil samples were originally analyzed for hexavalent chromium (Cr(VI)) within their specified holding times by Test America Laboratories. However, it was subsequently determined that the laboratory method used was not capable of meeting the sensitivity requirements for the project. The samples were, therefore, submitted to Applied Speciation Consulting for re-analysis using a more sensitive analytical method. It was understood by the planning team that the second analysis would be conducted beyond the sample holding times. This was considered acceptable, however, since the results would not be used to make an environmental decision at the pilot study yard; only to demonstrate the suitability of the analytical method and to aid in preparation of a sampling design.

Section 2.0 provides background information on the Ingersoll Uncertainty Calculator. Section 3.0 discusses modifications made to the calculator. Section 4.0 presents the results from the test sample pilot study for the Site.

2.0 Background

The Ingersoll Uncertainty Calculator is a Microsoft Excel based workbook developed in 2002 by William Ingersoll of the US Navy. The workbook uses quality assurance/quality control (QA/QC) data from a chemical laboratory to estimate the uncertainty associated with each step in the sample collection and sample analysis process, as well as an overall uncertainty associated with a single sample result. The calculator is comprised of a single worksheet entitled ***Cal***, which contains QA/QC input fields as well as output fields for the uncertainty intervals associated with a single sample result. These uncertainty evaluations were performed to comply with the requirements for "definitive data" as spelled out in EPA Superfund guidance, one of which is that "either analytical or total measurement error [i.e., uncertainty] must be determined." (Ref: Data Quality Objectives Process for Superfund: Interim Final Guidance, Sept. 1993, p. 42).

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TTEMI modified the workbook to allow uncertainty to be calculated simultaneously for a group of sample results. The workbook was also modified to include calculations of uncertainty intervals based on laboratory duplicate precision. The modified workbook will hereafter be referred to as the "Multisample Ingersoll Uncertainty Calculator."

3.0 Modifications to Ingersoll Uncertainty Calculator

The template version of the Multisample Ingersoll Uncertainty Calculator is attached for active review. The filename is "QC-based Multisample Uncertainty Calculator – Template Final.xlsx".

A total of three worksheets were added to the workbook, as follows:

- ***Input worksheet***. This worksheet is used to enter raw data from the data package. Raw results are entered, and relative deviations are automatically calculated based on the raw results. These relative deviations are linked to the ***Cal*** worksheet that calculates uncertainties.

- ***Actual Output worksheet.*** This worksheet is used to enter sample analytical results data. An uncertainty interval is calculated for each result based on the output of the calculator's existing ***Cal*** worksheet.

- ***Explore Uncertainty Effects worksheet.*** This worksheet generates uncertainty intervals for a customizable list of 20 analytical results, and shows the effects of the uncertainty intervals on the application of decision limits to these results. This worksheet also shows the analytical value that will result in an upper uncertainty limit (that is, an upper confidence limit [(UCL]) equal to a specified decision limit.

Both the ***Actual Output*** and ***Explore Uncertainty Effects*** worksheets include three calculations of the uncertainty interval, as follows:

- The first uncertainty interval is based only on analytical uncertainty (which can also be described as analytical precision or analytical variability); calculated based on the formulas in the original uncertainty calculator.

- The second uncertainty interval is based on analytical uncertainty and analytical bias; based on the formulas in the original uncertainty calculator.

- The third uncertainty interval is new to this version of the uncertainty calculator; based on analytical uncertainty, analytical bias, and sampling uncertainty (which can also be described as sampling precision or sampling variability).

Thus, results in the ***Actual Output*** and ***Explore Uncertainty Effects*** worksheets are compared to three different uncertainty intervals. The ***Cal*** worksheet was modified to include (in cell U33) a calculation of the sampling uncertainty from field and laboratory duplicate data.

Other than data input fields, most cells in the original workbook are locked. The password to unlock the worksheets is currently blank so that the worksheets can be locked and unlocked without a password. If there are 50 or fewer analytical results, it is possible to enter all needed data into all worksheets without unlocking the worksheets, because the spreadsheet design includes 50 data input rows. If more data input rows are needed, the user can unlock the

worksheet, insert additional rows as needed, copy the formulas down, and reprotect the worksheet. Worksheets must be unlocked and locked individually.

The following bullet list summarizes each worksheet (original and modified) and the inputs needed to use the calculator:

- ***Cal*** worksheet
  - Analyte, matrix, and technology – enter this information in cell E2. This field is informational only, and is optional.
  - Confidence Level – enter one of the specified percentages in cell W24. If no confidence level is entered, then no uncertainty intervals will be calculated.
- ***Input*** worksheet
  - Instrument calibration standards (ICS) spike amounts and results– enter in cells A5:B24. If a minimum of two ICS results are not entered, then no uncertainty intervals will be calculated.
  - Second source calibration verification standard (ICV) spike amounts and results– enter in cells F5:F24. If a minimum of two ICV results are not entered, then no uncertainty intervals will be calculated.
  - Laboratory control sample (LCS) spike amounts and results– enter in cells K5:K24. If a minimum of two LCS results are not entered, then no uncertainty limits will be calculated.
  - Matrix interference spike (MIS) amounts and results – enter in cells P5:R24. If a minimum of two MIS results are not entered, then no uncertainty limits will be calculated.
  - Laboratory duplicate sample (LDS) original and duplicate results – enter in cells V5:W24. If a minimum of two LDS results are not entered, then an uncertainty interval for bias- and duplicate-variability-corrected measurements will not be calculated.
  - Field-split duplicate sample (FDS) original and duplicate results – enter in cells AA5:AB24. If a minimum of two FDS results are not entered, then an uncertainty interval for bias- and duplicate-variability-corrected measurements will not be calculated.
  - Co-located duplicate sample (CLS) original and duplicate results – enter in cells AF5:AG24. If a minimum of two CLS results are not entered, then an uncertainty interval for bias- and duplicate-variability-corrected measurements will not be calculated
- ***Actual Output*** worksheet
  - Decision limit – enter the decision limit to which the upper uncertainty interval will be compared in cell G12.
  - Decision limit units (optional) – enter the units for the decision limit in cell H12.
  - Sample ID – enter the sample IDs in cells A16:A65.
  - Sample measurements – enter the sample results in cells B16:B65. The autofilter function can be used to hide blank cells if desired.

- Qualifier – enter qualifiers in cells C16:C65.
- Comment – enter comments in cells D16:D65.
- Conditional formatting (output cell color) is used to indicate how many of the UCLs (all three, two, one, or none) are below the decision limit.

- ***Explore Uncertainty Effects*** worksheet
  - Maximum concentration – enter the maximum concentration to be evaluated in the table. The values for 20 equally-spaced theoretical concentrations will be calculated from this concentration.
  - Conditional formatting is used to indicate how many of the UCLs (all three, two, one, or none) are below the decision limit.

The following bulletized list summarizes the outputs shown on each worksheet:

- ***Cal*** worksheet – most outputs here are the same as they were in the original Ingersoll Uncertainty Calculator, therefore, they are not discussed here. However, the analytical measurement result and units on Page 3 of the ***Cal*** worksheet are now linked to the input cells in the new ***Explore Uncertainty Effects*** worksheet. There are also several new output fields:
  - The relative deviations for laboratory duplicate samples are transferred from the Input worksheet to cells F13:F32.
  - The standard deviation associated with laboratory duplicate samples is calculated in cell F33.
  - The component percent standard uncertainty resulting from laboratory subsample collection effects is calculated in cell L18.
  - The percent relative uncertainty associated with sampling measurement error for routine field samples is calculated in cell U33. This was not calculated in the original version of the Ingersoll Uncertainty Calculator. The measurement uncertainty for laboratory subsample collection effects (LSE), sample collection effects (SCE) and sample location effects (SLE) are included in this uncertainty estimate. The estimated uncertainty from LSE, SCE, and SLE is used to estimate the uncertainty interval based on analytical bias, analytical uncertainty, and sampling uncertainty. The t-value (a measure of expected variability based on sample size and statistical confidence) in cell N25 is used for this calculation in the same way as the other percent relative uncertainty calculations.
  - A third calculation of the uncertainty interval based on analytical uncertainty, analytical bias, and sampling uncertainty is performed in cells AA33:AM35. In addition, the LSE is included in the "Partitioning of Uncertainty" graph along with the other uncertainty effects.
- ***Input*** worksheet – there are no outputs on this worksheet – all calculated values are intermediate results that are transferred to the ***Cal*** worksheet.

- ***Actual Output*** worksheet
  - Uncertainty interval without considering bias – these intervals are shown in cells E16:G65.
  - Bias-corrected measurement – these values are shown in cells H16:H65.
  - Uncertainty interval at the selected confidence level for bias-corrected measurements– these intervals are shown in cells I16:K65.
  - Uncertainty interval at the selected confidence level for bias- and duplicate-variability-corrected measurements – these intervals are shown in cells L16:N65.
- ***Explore Uncertainty Effects*** worksheet
  - Uncertainty interval without considering bias – these intervals are shown in cells C17:E65.
  - Bias-corrected measurement – these values are shown in cells F17:F65.
  - Uncertainty interval at the selected confidence level for bias-corrected measurements– these intervals are shown in cells G17:I65.
  - Uncertainty interval at the selected confidence level for bias- and duplicate-variability-corrected measurements – these intervals are shown in cells J17:L65.
  - Sample results where the UCL is equal to the decision limit – these values are shown in cells B43:B45 for each of the three uncertainty interval types listed above.

4.0 Missouri Farms Pilot Study Test Sample Data Results

4.1 Data Quality Review

Soil analytical data generated by the Missouri Farms Pilot Study were obtained from Applied Speciation and Consulting via Michael Stroh of the Missouri Department of Natural Resources (MDNR).

Data included results for 17 soil samples prepared by EPA Method 3060A and analyzed for Cr(VI) by modified EPA Method 7199. The data deliverable included:

- A case narrative describing sample reception, sample preparation, sample analysis, and analytical issues;
- Analytical results;
- A summary of QA/QC data associated with the analytical batch; and
- Historical QA/QC data for use in the uncertainty calculator.

A review of the data deliverable conducted by TTEMI indicates the following:

- Seven of the eight Cr(VI) matrix spike/matrix spike duplicate (MS/MSD) results were below the control limit of 75%.
- Four of the eight $PbCrO_4$ MS/MSD results were below the control limit of 75%.

- The samples were analyzed beyond the holding time of 30 days specified in the yard pilot study sampling and analysis plan (SAP).

Based on acceptable LCS results, the low recoveries for these MS are associated with sample matrix, and did not require any corrective action by the laboratory. The bias introduced by low MS recoveries was quantified in the Multisample Ingersoll Uncertainty Calculator, and taken into account in developing the 95% confidence intervals for sample results.

As noted above, since these sample results are from analyses conducted beyond the sample holding times, they should not be used to make final decisions regarding whether Cr(VI) concentrations in soils in the pilot study residential yard are above or below screening levels. However, the results are still valid for assessing whether the screening level of 2 mg/kg is achievable for this method.

4.2 Uncertainty Interval Calculations

As shown in the attached workbook titled "QC-based Multisample Uncertainty Calculator – Pilot Study Lab 2 Full Final.xls", the QA/QC data from the data deliverables were entered into the Multisample Ingersoll Uncertainty Calculator as follows:

Data type	Location in December 17, 2009 Data Deliverable	Location in January 20, 2010 Data Deliverable
Sample results	Page 1	Page 6
ICS*	Page 3 – used three results for 5 µg/L standards, two results for 25 µg/L standards, and one result for a 50 µg/L standard *	Page 9 – used all three results for 5 µg/L standards, one result for a 25 µg/L standard, and two results for 50 µg/L standards *
ICV*	Page 5 – used first 16 results*	Page 11 – used four ICVs with true values below 10 mg/kg*
LCS	Page 2 – used the Cr(VI) LCS result only	Page 7 – used the Cr(VI) LCS result only
MIS**	Page 2 – used the two Cr(VI) MS/MSD results only**	Page 8 – used the six Cr(VI) MS/MSD results only**
LDS	Page 2 – used the MSD result	Page 8 – used the five MSD results
FDS	Page 1 – used the sample results for samples AB09961 and AB09963, which were field duplicates of AB09962 and AB09964	Page 6– used the sample results for samples AB09962 and AB09964, which were field duplicates of AB09961 and AB09963
CLS	No co-located duplicate samples were collected. FDS results were used as a proxy since CLS uncertainty is expected to be the same or greater than FDS uncertainty.	

Notes:

* The ICS and ICV results used were all historical values. The data package provided did not include a summary of ICS and ICV results specifically from the analytical runs used for sample quantification. The preparation method uses 0.5 g of sample diluted to a 10.1 mL final volume; therefore, a sample concentration of 1 mg/kg corresponds to approximately 50 µg/L on the calibration curve. The calibration standards used to assess uncertainty from instrumental measurement effects, therefore, correspond to a range of approximately 0.1 to 1 mg/kg, which is the range of interest for the project.

** Although historical MS/MSD results were also provided, these were not used in the uncertainty analysis since the soil matrices for those samples were not representative of soil matrix from the project samples.

The Multisample Ingersoll Uncertainty Calculator shows that there is a negative bias in the method due to sample matrix. The major contribution to the width of the uncertainty interval is the sampling uncertainty, which had more than three times the relative uncertainty of the other uncertainty components (see the Partitioning of Uncertainty chart on page 3 of the ***Cal*** worksheet).

Based on the effects of analytical measurement uncertainty, matrix bias, and sample measurement uncertainty, the results of the Multisample Ingersoll Uncertainty Calculator indicate that samples with results below 0.72 milligram per kilogram (mg/kg) have a 95% UCL of 2 mg/kg or lower (see cell B43 on the ***Explore Uncertainty Effects*** worksheet). Since the laboratory has estimated a reporting limit of 0.025 mg/kg, the method appears suitable for making decisions at the Site.

Other confidence levels were investigated to provide an estimate of the statistical confidence in a decision that the results for samples AB09963 and AB09964 would be below 2 mg/kg if the samples had been analyzed within the 30-day holding time. The 80% UCL is not below 2 mg/kg for either sample AB09963 or AB09964.

cc: Michael Stroh, Environmental Specialist, MDNR
Jody Edwards, PG; Work Assignment Manager, TTEMI

QC-based Nested Approach for Estimating Analytical Measurement Uncertainty

What are the analyte, matrix, and technology? Chromium VI in soil by Modified Method 7199

Enter 20 replicate results for the following quality control samples as relative deviation (%):

ICS - Instrument calibration standard
ICV - Second source calibration verification standard
LCS - Laboratory control sample
MIS - Matrix interference sample (matrix spike, organic surrogate, radiochemical tracer)
LDS - Laboratory duplicate sample
FDS - Field-split duplicate sample
CLS - Co-located duplicate sample

	ICS	ICV	LCS	MIS	LDS	FDS	CLS
	0.4	-1.3	2.1	-34.4	0.1	-77.1	-77.1
	1.2	-7.3	-1.4	-29.7	0.1	-28.2	-28.2
	2.3	2.8		-52.9	0.2		
	2.0	1.8		-34.8	0.3		
	-0.3	3.8		-27.6	0.2		
	0.6	11.2		-31.7	0.3		
	0.0	-0.8		-56.7			
	0.0	-8.3		-36.2			
	-0.2	-5.6					
	0.0	1.5					
	-0.1	-3.7					
	-0.1	0.5					
		3.1					
		5.8					
		6.6					
		-4.7					
		-1.4					
		-5.1					
		2.1					
		9.9					
Std. Dev.	0.90	5.41	2.5	10.8	0.1	34.5	34.5
Bias	0.5	0.5	0.4	-38.0			
Recovery	100.5	100.5	100.4	62.0			

Components of Analytical Uncertainty
IME - Intrinsic instrumental measurement effects
SPE - Spike preparation effects
PME - Preparation method effects
MIE - Matrix interference effects

Components of Sampling Uncertainty
LSE - Laboratory subsample collection effects
SCE- Sample collection effects
SLE - Sample location effects

Component	Percent Standard Uncertainty	
IME	~ 0.9	% relative standard deviation
SPE	~ 5.3	% relative standard deviation
PME	~ 0.0	% relative standard deviation
MIE	~ 9.3	% relative standard deviation
LSE	~ 0.0	% relative standard deviation
SCE	~ 33.2	% relative standard deviation
SLE	~ 0.0	% relative standard deviation

Component	Percent Recovery	Component	Systematic Error	
IME	~ 100	IME	~ 0	percent
SPE	~ 100	SPE	~ 0	percent
PME	~ 100	PME	~ 0	percent
MIE	~ 62	MIE	~ -38	percent

2.093
2.093
2.093
WRONG CL

WRONG CL

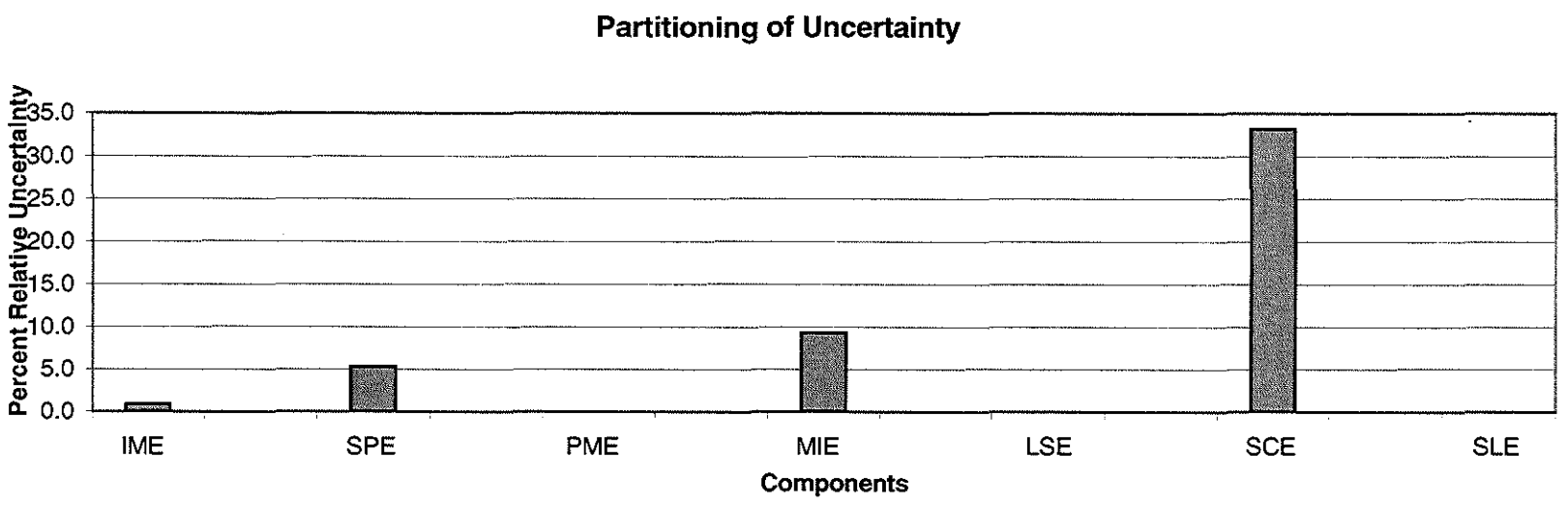
What is the Confidence Level (CL)? Enter ONLY one of these percentages: 80, 90, 95, 99 95 %

Your specified t-value is 2.093 for a Two-Tailed Normal Distribution Confidence Interval

Relative Analytical Measurement Uncertainty for routine field samples 19.6 % relative uncertainty
(Only the IME, PME, and MIE are combined for the analytical measurement uncertainty)

Relative Systematic Error associated with the measurement of routine field samples -38.0 % relative systematic error
(Only the IME, PME, and MIE biases are combined for the analytical measurement systematic error)

Relative Sampling Measurement Uncertainty for routine field samples 69.6 % relative uncertainty
(Only the LDS, SCE and SLE are combined for the sampling measurement uncertainty)



What is the analytical measurement result? 2

What are the analytical measurement units? mg/kg

If the sample measurement is 2 mg/kg , then the uncertainty interval based only on analytical uncertainty is 1.6 - 2.4 mg/kg at the 95 % Confidence Level (Expanded Uncertainty)

For the above result, if the systematic measurement error (bias) is corrected, and the corrected measurement is 3.2 mg/kg , then the uncertainty interval based only on analytical uncertainty is 2.6 - 3.9 mg/kg at the 95 % Confidence Level (Expanded Uncertainty)

For the above result, if the systematic measurement error (bias) is corrected, and the corrected measurement is 3.2 mg/kg , then the uncertainty interval based on analytical and sampling uncertainty is 0.9 - 5.6 mg/kg at the 95 % Confidence Level (Expanded Uncertainty)

Relative Deviation Calculations

LDS			
Original	Duplicate	Mean	Relative Deviation
0.078	0.075	0.08	-3.92
0.094	0.108	0.10	13.86
0.24	0.208	0.22	-14.29
0.348	0.335	0.34	-3.81
0.221	0.248	0.23	11.51
0.348	0.335	0.34	-3.81

FDS			
Original	Duplicate	Mean	Relative Deviation
0.133	0.059	0.10	-77.08
1.6	1.204	1.40	-28.25

Relative Deviation Calculations

CLS			
Original	Duplicate	Mean	Relative Deviation
0.133	0.059	0.10	-77.08
1.6	1.204	1.40	-28.25

Relative Deviation Calculations

ICS			
Spike Amount	Result	Recovery	Relative Deviation
5	5.02	100%	0.40
5	5.062	101%	1.24
5	5.117	102%	2.34
5	5.101	102%	2.02
5	4.985	100%	-0.30
5	5.031	101%	0.62
50	49.99	100%	-0.02
50	49.98	100%	-0.04
25	24.96	100%	-0.16
50	49.99	100%	-0.02
25	24.98	100%	-0.08
25	24.979	100%	-0.08

ICV			
Spike Amount	Result	Recovery	Relative Deviation
10	9.875	99%	-1.25
10	9.266	93%	-7.34
10	10.28	103%	2.80
10	10.18	102%	1.80
10	10.38	104%	3.80
10	11.12	111%	11.20
10	9.916	99%	-0.84
10	9.171	92%	-8.29
10	9.44	94%	-5.60
10	10.15	102%	1.50
10	9.63	96%	-3.70
10	10.05	101%	0.50
10	10.31	103%	3.10
10	10.58	106%	5.80
10	10.66	107%	6.60
10	9.531	95%	-4.69
5	4.932	99%	-1.36
4	3.795	95%	-5.13
5	5.107	102%	2.14
5	5.495	110%	9.90

Relative Deviation Calculations

LCS			
Spike Amount	Result	Recovery	Relative Deviation
5	5.107	102%	2.14
5	4.932	99%	-1.36

MIS				
Native Amount	Spike Amount	Result	Recovery	Relative Deviation
0.078	4.976	3.343	66.1%	-34.39
0.094	5.052	3.646	70.9%	-29.69
0.24	4.91	2.551	49.5%	-52.93
0.348	4.885	3.534	67.5%	-34.78
0.078	5.124	3.79	72.9%	-27.56
0.094	4.694	3.3	68.9%	-31.70
0.24	4.893	2.361	46.0%	-56.65
0.348	4.82	3.424	66.3%	-36.18

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM **March 4, 2010**

SUBJECT: Determination of the numbers of incremental samples and increments in the incremental sampling designs for yards

FROM: Deana Crumbling, M.S.
Technology Integration and Information Branch
Office of Superfund Remediation and Technology Innovation
USEPA

Deana M. Crumbling

TO: Michael Stroh
Missouri Department of Natural Resources

To use an incremental sampling design, the number of incremental samples (ISs) and the number of increments per IS must be determined. Whenever possible, a statistical approach is useful, especially when the data will be analyzed statistically after it is collected.

A free software package called "Visual Sample Plan" (VSP) was used to perform the statistical calculations. To obtain inputs to the VSP programs, data from the yard pilot study was analyzed and used to determine statistical properties likely to represent other yards.

The overall concentration of Cr(VI) in the pilot yard was 0.3 ppm (which is well below the screening level of 2 ppm). This value would be used to determine the "gray region" in the VSP input screen. The lower the yard average, the fewer the samples recommended by VSP for collection. In order to be conservative, a 1 ppm, rather than 0.3 ppm, was used to determine the gray region input. Being "conservative" in this context means that more ISs would be collected and more increments would be collected for each IS.

The worst case value for standard deviation (SD) from the pilot study results (0.4 ppm) was used as that VSP input. This selection was worst case because the data set from which the SD of 0.4 was calculated included a sample taken from outside the yard proper, and next to a crop field. Although not exceeding the screening level of 2 ppm, this sample's average concentration (1.4

ppm) was several times higher than samples from the yard proper [which ranged from 0.08 to 0.27 ppm Cr(VI)]. However, inclusion of this non-representative sample served to create a conservative estimate of the variability across the yard (SD = 0.4 ppm vs SD = 0.1 when that sample is not included).

With these input values, VSP recommended 3 samples (as ISs) per yard. This would represent a minimum of sampling units per yard. However, more sampling units (i.e., more ISs) might be defined for any particular yard based on the conceptual site model for that yard. This could raise the number of ISs above the minimum of 3 for some yards.

Next, the number of increments per IS needed to be selected. Again, VSP provided a statistical basis for this selection. A "multi-increment" module of VSP was used. One of the inputs to this module is the variability seen in subsampling replicates. There were two sets of suitable data. For one set, the variability was SD equal to 0.05 ppm. For the other, the SD equaled 0.28 ppm. Even though the 0.28 was from the non-representative sample, it represents a worst case scenario, and so 0.28 was selected for input to the multi-increment VSP module.

This VSP module assumes that the number of increments is known, and the goal is to calculate the number of ISs. However, the module can also be used to find the number of increments. Since we know that we want to have a minimum number of 3 ISs per yard, various numbers can be entered into the "Increments per MI sample" input box until the number of the number of calculated IS samples is 3. When this is done, 4 is the recommended number of increments.

Cr6 increment numbers calculations for Yards from pilot yard data

Yard section 1

grab sample 1 (SU1.1.3)	0.24	
grab sample 2 (SU1.2.1)	0.221	
grab sample 3 (SU1.3.1)	0.348	
Yard section 1 Mean =	0.270	
Std Dev =	0.069	
n	3	grab samples
2-sided 95%LCL	0.10	
2-sided 95%UCL	0.44	0.39 for 1-sided 95%
1-sided interval	0.2	
CV =	0.25	

Yard section 2

grab sample 1 (SU2.1.3)	0.089	
grab sample 2 (SU2.2.3)	0.076	
Yard section 2 Mean =	0.083	
Std Dev =	0.009	
n	2	
2-sided 95%LCL	0.0	
2-sided 95%UCL	0.17	0.12 for 1-sided 95%
1-sided interval	0.1	
CV =	0.11	

Yard section 3–has 2 sets of duplicate subsamples

Duplicate 1 (SU3.1	0.133	
Duplicate 2 (SU3.1	0.059	
Duplicates Mean (for SU = 3.1)	0.096	
Std Dev =	0.052	
n	2	
2-sided 95%LCL	-0.4	
2-sided 95%UCL	0.57	0.33 for 1-sided 95%
1-sided interval	0.5	
CV =	0.55	
Duplicate 1 (SU3.2	1.6	
Duplicate 2 (SU3.2	1.204	
Duplicates Mean (for SU = 3.2)	1.40	
Std Dev =	0.28	use this for worst case subsampling SD
n	2	
2-sided 95%LCL	-1.1	
2-sided 95%UCL	3.92	2.65 for 1-sided 95%
1-sided interval	2.5	
CV =	0.20	

Yard section 3 mean–INcluding sample influenced by wind deposition

Duplicates Mean (for SU = 3.1)	0.096	
Duplicates Mean (for SU = 3.2)	1.402	
grab sample 3 (SU3.3.3)	0.078	
Yard section 3 Mean =	0.53	includes "non-representative" sample
Std Dev =	0.76	
n	3	
2-sided 95%LCL	-1.4	
2-sided 95%UCL	2.41	1.81 for 1-sided 95%
1-sided interval	1.9	
CV =	1.45	

Yard section 3 mean–EXcluding sample influenced by wind deposition

Duplicates Mean (for SU = 3.1)	0.096	
grab sample 3 (SU3.3.3)	0.078	
Yard section 3 Mean =	0.087	excluding "non-representative" sample
Std Dev =	0.013	
n	2	
2-sided 95%LCL	0.0	
2-sided 95%UCL	0.20	0.14 for 1-sided 95%
1-sided interval	0.1	
CV =	0.15	

Yard section 4

grab sample 1 (SU4.1.2)	0.24	
grab sample 2 (SU4.2.3)	0.22	
Yard section 4 Mean =	0.230	
Std Dev =	0.014	0.29 for 1-sided 95%
n	2	
2-sided 95%LCL	0.1	
2-sided 95%UCL	0.36	
1-sided interval	0.1	
CV =	0.06	

Yard statistics (as compilation of the means for the 4 SUs)

Yard section 1	0.27	
Yard section 2	0.083	
Yard section 3	0.53	includes "non-representative" sample
Yard section 4	0.23	
Yard section 1 Mean =	0.278	
Std Dev =	0.186	
n	4	
2-sided 95%LCL	0.0	
2-sided 95%UCL	0.57	**0.50 for 1-sided 95% UCL**
1-sided interval	0.3	
CV =	0.67	

Yard statistics (as compilation of the means for the 4 SUs)

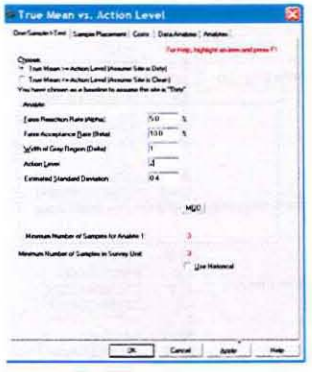
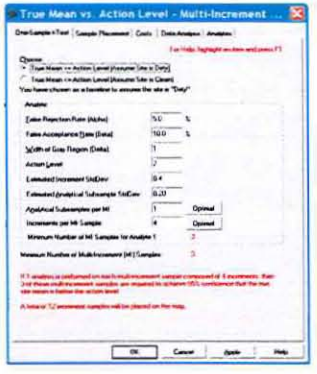
Yard section 1	0.27	
Yard section 2	0.083	
Yard section 3	0.087	excludes "non-representative" sample
Yard section 4	0.23	
Yard section 1 Mean =	0.168	
Std Dev =	0.097	
n	4	
2-sided 95%LCL	0.0	
2-sided 95%UCL	0.32	**0.28 for 1-sided 95% UCL**
1-sided interval	0.2	
CV =	0.58	

Yard statistics (as compilation of individual grab samples)

grab sample 1 (SU1.1.3)	0.24	
grab sample 2 (SU1.2.1)	0.221	
grab sample 3 (SU1.3.1)	0.348	
grab sample 1 (SU2.1.3)	0.089	
grab sample 2 (SU2.2.3)	0.076	
Duplicates Mean (for SU = 3.1)	0.096	
Duplicates Mean (for SU = 3.2)	1.402	includes
grab sample 3 (SU3.3.3)	0.078	"non-representative" sample
grab sample 1 (SU4.1.2)	0.24	
grab sample 2 (SU4.2.3)	0.22	
Total Yard Mean =	**0.30**	
Std Dev =	**0.40**	
n	10	
2-sided 95%LCL	0.0	
2-sided 95%UCL	0.59	**0.53 for 1-sided 95% UCL**
1-sided interval	0.3	
CV =	1.32	

Yard statistics (as compilation of individual grab samples)

grab sample 1 (SU1.1.3)	0.24	
grab sample 2 (SU1.2.1)	0.221	
grab sample 3 (SU1.3.1)	0.348	
grab sample 1 (SU2.1.3)	0.089	
grab sample 2 (SU2.2.3)	0.076	
Duplicates Mean (for SU = 3.1)	0.096	excludes the "non-representative" sample
grab sample 3 (SU3.3.3)	0.078	
grab sample 1 (SU4.1.2)	0.24	
grab sample 2 (SU4.2.3)	0.22	
Yard section 1 Mean =	**0.18**	
Std Dev =	**0.10**	
n	9	
2-sided 95%LCL	0.1	
2-sided 95%UCL	0.25	**0.24 for 1-sided 95% UCL**
1-sided interval	0.1	
CV =	0.54	

USE WORST CASE SD (FROM INCLUSION OF THE NON-REPRESENTATIVE SAMPLE) TO CREATE CUSHION IN CASE Cr6 LOSS OVER TIME

REDUCED VARIABILITY (SD)