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Bioavailability of Lead and Arsenic from Soils: Cherryvale, Kansas

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Acronyms and Abbreviations

ANOVA	analysis of variance
CEN	Comite European de Normalization
CPSC	U.S. Consumer Product Safety Commission
DUP	duplicate sample
ICP/MS	inductively coupled plasma/mass spectrometry
KDHE	Kansas Department of Health and Environment
LEGS	Laboratory for Environmental and Geochemical Studies (University of Colorado, Boulder, Department of Geological Sciences)
RBA	relative bioavailability
RSE	removal site evaluation
SOP	standard operating procedure
SPK	spiked sample
SRM	standard reference material
XRF	x-ray fluorescence

Introduction and Background on Bioaccessibility Testing

This report presents and summarizes the results of *in vitro* extraction testing of lead and arsenic from soil samples collected in Cherryvale, Kansas. The testing was performed to provide data that would substantiate the use of site-specific bioavailability adjustment values for risk-based screenings of the site soils. Samples were collected by staff from Project Navigator and were tested at the University of Colorado, Boulder. All sampling and testing were conducted in accordance with the Removal Site Evaluation Work Plan for Phase I Testing (RSE Work Plan) prepared by Exponent (2013a), and analytical results are included in Attachment A. Deviations from the RSE Work Plan have been documented to the Kansas Department of Health and Environment (KDHE) in a letter to KDHE dated August 22, 2013 (Exponent 2013b, Attachment B).

This introductory section describes the objectives and background of bioaccessibility testing to provide site-specific information for assessment of exposure within a risk assessment or risk-based screening. Subsequent sections describe the *in vitro* extraction testing, conclusions based on the results, and implications for determining bioavailability adjustment factors for use in risk-based evaluations. The results and interpretation of bioavailability from site soils presented in this report are based on the samples tested, and are placed in the context of other studies on the bioavailability or bioaccessibility of lead and arsenic from soils.

It is generally known that metals exhibit reduced bioavailability from soil matrices relative to their soluble forms (Allen and Huang 1994; Dreesen and Williams 1982; Ruby et al. 1999, Roberts et al. 2007, Brattin and Casteel 2013).[1] The importance of bioavailability considerations in evaluating potential exposure to metals from soils is gaining regulatory acceptance, with guidance recently emerging from U.S. EPA (U.S. EPA 2007b, 2007c, 2012). Thus, a particular data need for assessing human health risk from exposure to metals in soil is the bioavailability of the specific metals or metalloids in soil, as compared to the more soluble forms that generally serve as the basis of the toxicity reference values and cancer slope factors. However, the amount of an element in soil that is available for absorption in the human digestive system can vary. (For example, 5% to 90% of total lead in soil may be bioavailable, and 8% to 78% of total arsenic in soil may be bioavailable [U.S. EPA 1997, 2005, 2007b, 2012].). This variability makes it difficult to estimate bioavailability for a particular site without directly testing site-specific environmental media.

Simple *in vitro* extraction tests have been used for 15 to 20 years to assess the degree of metal dissolution in a simulated gastrointestinal-tract environment (Ruby et al. 1993, 1996; Rodriguez et al. 1999; Drexler 2007). Such tests mimic the temperature, pH, and fluid conditions of the digestive system to yield estimates of the amount of a metal in soil that is bioaccessible (i.e., the

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[1] Oral bioavailability is defined herein as the fraction of ingested metal that is absorbed into systemic circulation. Bioaccessibility, on the other hand, refers to the fraction of a chemical that is soluble in a simulated gastrointestinal environment, and would therefore be available for absorption. Bioaccessibility is therefore a precursor to, and provides an estimate of, bioavailability.

fraction that will be soluble and available for absorption). For example, the European Standard for Safety of Toys (CEN 1994) provides for an extraction test (2-hour extraction in pH-1.5 [HCl] fluid) to evaluate the bioaccessibility of eight metals (antimony, arsenic, barium, cadmium, chromium, lead, mercury, and selenium) from children's toys. This method has been used since 1994 by the 18 member countries of the Comite European de Normalization (CEN) to regulate the safety of toys. Similar methods are also recommended by the U.S. Consumer Product Safety Commission (CPSC) for assessing the leachability of metals from vinyl products (U.S. CPSC 1997) or toys (U.S. CPSC 2005) under simulated use or following ingestion.

A considerable amount of work has been performed to develop simple, reproducible extraction tests that can predict the oral bioavailability of lead and arsenic that has been observed in animal models (Ruby et al. 1993, 1996; Medlin 1997; Rodriguez et al. 1999; Drexler and Brattin 2007, Brattin et al., 2013). In May 2007, the U.S. Environmental Protection Agency issued *Guidance for Evaluating the Oral Bioavailability of Metals in Soils for Use in Human Health Risk Assessment* (U.S. EPA 2007a). Co-released with this new guidance was technical documentation of methods for *in vivo* and *in vitro* evaluation of the relative oral bioavailability of lead from soils (U.S. EPA 2007b). Although formal validation (i.e., approved by EPA) of *in vitro* bioaccessibility results against data from animal studies has been completed only for lead (Henningson et al. 1999; Drexler 2007; U.S. EPA 2007b), these testing procedures can be used to evaluate the fraction of other metals that would be soluble and available for absorption.

For lead, U.S. EPA (2007b) has recommended a specific approach for implementing *in vitro* methods to predict the relative bioavailability (RBA) of lead from soil on a site-specific basis. This method consists of conducting the *in vitro* extraction using a defined protocol, and then using a regression approach to estimate RBA from the extraction data. This approach is used herein to estimate the RBA of lead in the soils from the site.

For arsenic, while it is well established that the RBA of arsenic in soil varies widely across sites, a specific *in vitro* method has not yet been validated by EPA for use in estimating RBA. Recently, EPA compiled information regarding the bioavailability of arsenic in soil (U.S. EPA 2012a). In their report, EPA lists studies demonstrating that the RBA of arsenic from soil varies considerably based on site-specific characteristics. This database provided the technical basis to substantiate a new default value for the RBA of arsenic from soil of 60% (U.S. EPA 2012b) and to recommend that site-specific data be generated to support additional RBA adjustments. Several studies have also been conducted to identify an *in vitro* method that predicts RBA for arsenic (Rodriguez et al 1999; Makris et al 2008; Ruby et al 1996, Juhasz et al 2007, Wragg et al 2011; Denys et al 2012, Bradham et al 2011; Brattin et al 2012), but to date, EPA has not selected any specific study as acceptable for use in site-specific risk assessments. However, *in vitro* extraction data have been used to establish site-specific RBA adjustments for arsenic as part of a "weight-of-evidence" approach. The arsenic bioaccessibility data from the Cherryvale site will be discussed in light of this developing research.

Bioaccessibility Testing

As described in the RSE Work Plan, soils were collected from various areas around Cherryvale to characterize potentially different sources of metals to soil, and to assess the relative oral bioavailability of the metals from soils across the site. The sample locations are documented in the RSE Work Plan, and were selected specifically to provide data from residential areas that may have received historical aerial deposition from the smelter, areas with apparent smelter slag/waste material placement (including residential areas), Logan Park, ball fields, ditches, and areas adjacent to sidewalks where smelter waste material appears to have been used as underlayment.

A more complete presentation of the rationale for selection of each sample location is presented in the RSE Work Plan. An RSE Phase I Data Report has also been provided to KDHE under separate cover. The Data Report summarizes the sampling effort, including general and overview maps of sample locations. Below is a discussion of sample handling, *in vitro* bioaccessibility extraction testing, and the results of the evaluation.

Although the Work Plan for Phase I Testing at Cherryvale specified for arsenic that soil samples from the site would be characterized for both bioaccessibility and sample mineralogy, this last component was not undertaken for site samples. During planning, the intention in proposing to provide mineralogy data was to further substantiate any differences in arsenic bioaccessibility observed in site samples. The expectation was that soils from different locations, with different sources of arsenic to the soil, might demonstrate "signatures" of different bioaccessibility. The samples for mineralogic evaluation were to be selected based on review of the arsenic bioaccessibility data, with the goal of proving further characterization of the differences among the soils, and thus an understanding of the mineralogic factors controlling arsenic bioaccessibility.

However, because arsenic bioaccessibility was uniformly low across all samples from the site, with no apparent relation to different geographic areas or anticipated sources, it was determined that conducting mineralogic characterization to distinguish among source materials wasn't warranted. Therefore, instead of using mineralogy to support different assumed bioavailability for arsenic in soils at different parts of the site, the data evaluation was conducted on all samples collectively, and the 95th percentile arsenic bioaccessibility value for the entire set of site samples was selected as the recommended and appropriately conservative, site-specific RBA value for arsenic at the site.

Sample Preparation and Analysis of Metal Content

Sample preparation, bioaccessibility extractions, and analyses for total lead and arsenic concentrations in the sample substrates and extraction fluids were conducted under the direction of Dr. John W. Drexler at the Laboratory for Environmental and Geochemical Studies (LEGS), in the Department of Geological Sciences, University of Colorado at Boulder, Colorado. Twenty-nine soil samples were shipped to Dr. Drexler on August 8, 2013, and were delivered to

his laboratory under chain of custody. Samples were then dried and sieved to <250 μm. The <250-μm soil size fraction is used for bioaccessibility testing, because it is believed to represent the fraction of soil that is more likely to adhere to human hands and be ingested during hand-to-mouth activity (Maddaloni et al. 1998).

Each substrate (approximately 1 gram each) was subjected to the *in vitro* extraction procedure (summarized briefly below and detailed in the SOP; Attachment C), and splits of each soil substrate were generated for analysis of total lead and arsenic concentrations. For analysis of the total metal concentration in the soil samples, the entire mass of each soil split was digested and diluted to a final volume of 50 mL prior to analysis. This mass was then used to calculate soil concentrations from the reported aqueous digestion solution concentration. For two samples, bulk soil analyses and *in vitro* extraction procedures were conducted in duplicate.

Bioaccessibility Testing Procedures

The soil samples (<250-μm size fraction) were subjected to bioaccessibility testing according to EPA's *Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead in Soil* (U.S. EPA 2008). This protocol was attached to the RSE Work Plan, and is included as Attachment C to this report. The evaluation of Site samples included no deviations from the methods outlined in U.S. EPA (2008). Briefly, the bioaccessibility testing entails extracting site soils in a 0.4 molar hydrochloric acid solution buffered with glycine to maintain a pH of 1.5. The sieved soil samples are subjected to an end-over-end rotation for one hour at 37 °C, after which the fluid is separated from the soils and tested for metals concentrations. Bioaccessibility is then calculated as the ratio of the total mass of a metal in solution to the total mass of the metal in the tested soil. For quality assurance, the testing for this site included duplicate extraction and analysis of two soils (samples EX010 and EX020), and extraction and analysis of a fluid blank and an extraction spike. Extraction data for a standard reference material were also reported, to assess reproducibility of the extraction process within the lab.

Analytical Methods

Extraction fluids and solids were analyzed for lead and arsenic by inductively coupled plasma/mass spectrometry (ICP/MS) (EPA Method 200.8). Solids were digested by EPA Method 3050B.

Results and Discussion

Lead and Arsenic Concentrations in Site Soil Samples

Total lead and arsenic concentrations in the sieved soil samples (<250-μm size fraction) are presented in Table 1. The reported concentrations of lead in the soil samples ranged from 64 to 14,344 mg/kg. The sample with lead concentration of 14,344 mg/kg (sample EX005) was underlayment material (i.e., granular slag) collected from under the middle of a sidewalk that

had subsequently been overgrown with grass, and was not from an area where individuals might contact soil during normal daily activities. This concentration is anomalously high relative to the lead concentrations in other samples from the site, as depicted on Figure 1a and Table 1. The range, average, and median lead results for the five sample types are as follows:

- Historical aerial deposition area samples ranged from 151 to 834 mg/kg, with an average of 524 mg/kg and median of 518 mg/kg.
- Parks/fields samples ranged from 66 to 152 mg/kg, with an average of 108 mg/kg and median of 107 mg/kg.
- Sidewalk underlayment samples ranged from 484 to 14,344 mg/kg, with an average of 4,162 mg/kg and median of 911 mg/kg.
- Residential; slag/waste ranged from 286 to 3,831 mg/kg with an average of 1,329 mg/kg and median of 802 mg/kg.
- Ditches ranged from 290 to 676 mg/kg, with an average of 491 mg/kg and median of 506 mg/kg.
- The reported concentrations of arsenic in the soil samples ranged from 8 to 481 mg/kg across all samples collected from the site. As observed for lead, the highest arsenic concentration was also reported in sample EX005, which represented underlayment material collected from under the middle of a sidewalk. Figure 1b depicts the soil concentrations for arsenic in all 29 samples. The range, average, and median arsenic results for the five sample types are as follows: Historical aerial deposition area ranged from 8.4 to 25.2 mg/kg, with an average of 14 mg/kg and median of 12 mg/kg.
- Parks/fields samples ranged from 8 to 31 mg/kg, with an average of 22 mg/kg and median of 24 mg/kg.
- Sidewalk underlayment samples ranged from 16 to 481 mg/kg, with an average of 140 mg/kg and median of 32 mg/kg.
- Residential; slag/waste ranged from 12 to 175 mg/kg, with an average of 50 mg/kg and median of 18 mg/kg.
- Ditches ranged from 22 to 64 mg/kg, with an average of 40 mg/kg and median of 32 mg/kg.

If comparing the data from this effort to prior evaluations for the site, it is important to note that the sample handling and analytical methods used for the bioaccessibility testing are different from those employed in previous soil sampling for the site. Specifically, the protocol for the bioaccessibility testing specifies use of the <250-μm particle size fraction, to focus the evaluation on the fine materials that may adhere to hands, and subsequently could be consumed, inadvertently. This fine fraction is then digested per EPA Method 3050B, and analyses are conducted using ICP/MS. This sampling and analysis is different from earlier soil characterization efforts for the site, wherein samples were focused on characterizing source

materials, were not sieved to remove larger materials, may have been ground (thereby including altered source material in the sample), and were analyzed using methods (i.e., ICP-AES) that have been demonstrated to overestimate arsenic concentrations due to interferences from other elements (Chapnick et al. 2010). Similar to the previous investigations, x-ray fluorescence (XRF) analysis was used to screen bulk samples for lead concentration prior to sieving.

In Vitro Extraction Testing of Lead and Arsenic from Site Soil Samples

Data from the *in vitro* extractions and chemical analyses, as well as the calculation of sample-specific bioaccessibility values for lead and arsenic, are presented in Tables 2 and 3. For lead, Table 2 lists the bioaccessibility data from the extraction testing, as well as the predicted RBA using the regression equation recommended by EPA (U.S. EPA 2007b). Table 3 provides the extraction data and calculated bioaccessibility for arsenic. The data regarding predicted bioavailability or calculated bioaccessibility are also presented graphically in Figures 2 through 7. Summaries of the predicted RBA for lead by type of location and by soil lead concentration are presented in Figures 2 and 3. Similarly, Figures 4 and 5 depict arsenic bioaccessibility, organized by type of location or by soil arsenic concentration.

Across all of the samples evaluated, predicted lead RBA ranges from 48% to a maximum of 71%. The average across all samples is 60.7%. For arsenic, bioaccessibility values ranged from less than 1% to a maximum of 23%, with an average of 11.7%. Figures 6 and 7 provide "box-and-whiskers" plots of the site data, organized by sample type. These figures demonstrate that generally there is no meaningful difference in the predicted lead RBA or arsenic bioaccessibility across the sample types. Statistical comparison between sample types using analysis of variance (ANOVA) detected no relevant differences at the standard 0.05 significance level (i.e., 95% confidence level) with one exception. The single exception is predicted RBA for lead between the combined aerial deposition samples and parks (combining surface and subsurface deposition samples), where aerial deposition samples are slightly higher. This difference[2] was detectable because of the additional aerial deposition samples (surface and subsurface combined), which increased the statistical power to detect a difference. A statistical comparison between the sample types, including aerial deposition surface and subsurface samples separately, indicates no detectable difference between any of the groups at the same 0.05 significance level.

With regard to the relation between lead or arsenic concentration in the sample and the predicted RBA or reported bioaccessibility (Figures 3 and 5), the data overall indicate little relation between soil metal concentration and the fraction that is bioaccessible, with the possible tendency of the few higher bioaccessibility values to occur at lower arsenic concentrations.

There is also no evidence from the existing data set that sample depth influences measured bioaccessibility. For five residential locations, paired samples were collected from two depths. In Tables 1–3, samples demarked "A" were collected from the surface soil horizon, while those demarked "B" were collected from a lower depth. The lower samples were collected because

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[2] Average lead RBA for parks was 54.2% as compared to 64.3% for the combined aerial deposition samples.

surface soils contained lead concentrations, as measured in the field by XRF, below the screening criterion of 400 ppm. Comparison of the A and B samples indicates no clear pattern for estimated lead RBA or arsenic bioaccessibility (Figures 6 and 7) Statistical comparisons between depths (based on the paired differences) of lead RBA and arsenic bioaccessibility identified no significant difference between the depths using the standard 0.05 significance level.

Data Quality Assurance Review

This quality assurance review discusses the results from the analyses for total concentrations of lead and arsenic in soil samples and *in vitro* extracts by LEGS. The quality control samples submitted for analysis consisted of two soil samples (EX010 and EX020) that were evaluated in duplicate for both *in vitro* bioaccessibility and total lead or arsenic concentrations. Additional quality control samples included a bottle blank, an extraction matrix spike, and soil matrix spikes. Additionally, to assess the accuracy of the results, Exponent reviewed *in vitro* extraction results for a standard reference soil (SRM; NIST 2711), which was analyzed by LEGS as a blind sample.

This quality assurance review was conducted to assess the quality of the analytical results and evaluate whether the data are of acceptable quality for their intended use. The laboratory data were reviewed, and the associated quality control results were assessed to determine the quality of the reported data.

Tables 4a and 4b present a summary of the results from the quality assurance data generated during this study. Generally, the replicates of lead and arsenic in soil, and the concentration of lead and arsenic in the bioaccessibility extraction fluid for the two soils tested in replicate, demonstrated consistent lead and arsenic concentrations. Variability for the soil data was within control limits, indicating good consistency across replicates for soil sample analysis.

All other QC sample results were within control limits, with the exception of the replicate extraction concentration for one of the extraction duplicates. This is likely associated with the very low concentration of arsenic in the extraction fluid, which resulted because the soil has a low arsenic concentration (8.4 mg/kg), together with a low bioaccessibility (20%). The low soil concentration of arsenic and the low bioaccessibility in this sample result in arsenic concentrations in the extraction fluid that are near the analytical detection limit. When arsenic concentrations are low like this, the relative percent difference on duplicate samples would be expected to climb. Thus, this exceedance of control limits does not indicate a broader problem with the project data. The "bottle blank" indicated very low concentrations of lead or arsenic, and recovery of the matrix spike fell within control limits (control limits specify recovery of 85%–115% of the spike mass). Results of extraction testing of the SRM NIST 2711 were within control limits, indicating good accuracy of extraction results.

Specifically, our analysis indicates lead and arsenic concentrations in the NIST 2711 sample of 1117 mg/kg for lead and 105 mg/kg for arsenic. These values are in good agreement with the certified concentrations for this soil of 1162 mg/kg for lead and 105 mg/kg for arsenic. Duplicate analyses of lead and arsenic in soils and in the extraction of replicate samples demonstrate low variability, suggesting consistent extraction with good reproducibility.

Consequently, it is reasonable to conclude that the soil concentrations of metals and the bioaccessibility values reported herein are reasonable estimates, and that the data quality measures ensure that the evaluation was conducted in a manner that demonstrates good accuracy and precision of the resulting data.

Site-Specific Estimates of RBA for Cherryvale

As discussed above, all data developed by LEGS at the University of Colorado appear to be of good technical quality. This includes the lead and arsenic concentrations in the soil samples collected, and the results of the *in vitro* bioaccessibility testing. These data provide a technical basis for estimating the RBA of lead and arsenic in site soils.

For lead, the method to estimate RBA is straightforward and specified by EPA guidance (U.S. EPA 2009). Specifically, the bioaccessibility values developed using the methods employed in this investigation are used to predict the RBA for a given soil by applying a regression equation that was derived from a validation of this bioaccessibility method against bioavailability data from animal studies using young swine. The predicted lead RBA values are presented in Table 2, together with data for each soil regarding the lead concentration in the test soil and the *in vitro* bioaccessibility results. Taken together, the results indicate that predicted RBA varies across the soils tested, from 48% to 71%. Across all site soils tested, the average predicted RBA is 60.7%. For soils from specific areas, the average lead RBA values range from 54% (observed for the soils from the ballfield and Logan Park) to 65% (for the residential area with historical aerial deposition).

Closer inspection of the data, however, suggests that the variability within each grouping of soils precludes firm conclusions with regard to different lead RBA values for different potential source materials. As discussed above, a statistical evaluation of the predicted lead RBA indicated no statistically-relevant differences between the values for soil samples from the different source areas except in the comparison between aerial deposition and park samples (Figure 6). As depicted in Figure 6, there is similarity in the ranges of the predicted lead RBA values measured for the different source materials, consistent with the findings of the statistical evaluation.

Given the lack of statistical difference between most of the source areas, the most reasonable conclusion from the available data from the site is that the RBA for lead is approximately 60.7%. This is nearly exactly equivalent to the default value (60%) included in the calculation of the risk-based soil screening standard for lead specified by KDHE (2010).

For arsenic, the bioaccessibility values reported for Cherryvale soils are uniformly low relative to the default assumption for arsenic RBA used by KDHE. More specifically, the current risk-based standards for Kansas assume a default of 60% RBA in the derivation of the standard for arsenic in soil, whereas the data for all soil samples from Cherryvale average 12% bioaccessibility, with a range from <1% to 23%, and a 95th percentile value of 21%. The 60% value was "selected as the default value and is supported by the analysis of soil arsenic RBA estimates which showed that less than 5% of the RBA estimates exceed 60%" (U.S. EPA 2012b), leading EPA to determine that, for arsenic in soil, RBA estimates exceeding 60% would be uncommon, effectively considering the 60% default value to be a reasonable upper-bound estimate. This same guidance from EPA encourages the use of site-specific assessment of arsenic bioavailability where "deemed feasible," indicating that default values "should not be used when site-specific assessments are performed."

As with lead, a similar statistical evaluation (using ANOVA at an overall 0.05 significance level) of the arsenic bioaccessibility data from the site indicated that there are no statistically relevant differences between the bioaccessibility measured for soil samples from the different source areas (Figure 7). As depicted in Figure 7, there is significant similarity in the ranges of bioaccessibility values measured for the different source materials, consistent with the findings of the statistical evaluation.

The bioaccessibility data for arsenic collected for soil samples from Cherryvale provide site-specific information that is relevant to understanding the RBA of arsenic from site soils. However, because EPA has not provided guidance on the interpretation of bioaccessibility data, there is some uncertainty regarding application of bioaccessibility data on a site-specific basis. Several research efforts have been undertaken to evaluate the relation between *in vitro* arsenic bioaccessibility data and animal RBA data for arsenic. A summary of these models is provided in Brattin et al. (2013), and based on this summary, Table 5 provides a calculation of what arsenic RBA value each of those models would predict based on either the average or the 95th percentile site arsenic bioaccessibility values of 12% and 21%, respectively. Based on the average site bioaccessibility, the predicted arsenic RBA ranges from 9% to 27% across the various models. For the 95th percentile bioaccessibility value, the predicted arsenic RBA ranges from 16% to 35%.

The *in vitro* extraction data for Cherryvale consistently indicate that the solubility of arsenic from these soils is low. Although there is no clear guidance regarding the application of these data on a site-specific basis, EPA now encourages the use of site-specific information to determine arsenic RBA, and *in vitro* data have been used to establish site-specific RBA adjustments for arsenic as part of a "weight-of-evidence" approach (Exponent 2008).

Based on the data for this site, we recommend the use of an arsenic RBA adjustment of 21%. This value was selected because:

- It represents the 95th percentile value (a reasonable "upper bound") for the *in vitro* extraction data for the site.
- It is reasonable to assume that an RBA of 21% for arsenic is higher than the model predictions for the majority of the models available in the peer-reviewed literature, whether those predicted values are based on the average or 95th percentile site bioaccessibility data.
- For the models that predict RBA values higher than 21%, the underlying data have some significant limitations:
  - The model recommended by Brattin et al. (2013) results in predicted RBA values of 27% and 33% for the average and 95th percentile site bioaccessibility data, respectively. However, this model has significant limitations, specifically with regard to the ability to predict low RBA values. The animal data set upon which the model equation was derived includes no samples with low RBA values. This results in a model with a high intercept and associated inability of the model to predict low RBA from *in vitro* data. The inability of this model to

predict low RBA values is inconsistent with the broad database from other studies (see U.S. EPA 2012) that includes soils for which the RBA is lower than 20% (the intercept value in this model, and hence the lowest possible predicted RBA). The authors discuss this feature as a significant limitation of their model.

- In Wragg et al. (2011), the regression model recommended for predicting RBA from *in vitro* data produces predicted RBA values for Cherryvale of 24% and 35% for the average and 95th percentile bioaccessibility data, respectively. On inspecting the data underlying the model proposed by Wragg et al. (2011), it appears that the high predicted RBA is due to one sample in the data set used by these researchers for which RBA was spuriously higher than the *in vitro* data for the sample. Absent this sample, for all samples from Wragg et al. (2011) with *in vitro* bioaccessibility lower than 20%, the associated RBA values were either close to or well below 20%.

- The literature on the RBA of arsenic from soil is replete with samples for which RBA values are very low, including several of mining or smelting provenance, where the reported RBA was 21% or lower. The compilation of arsenic RBA data put together by EPA (U.S. EPA 2012a) reports that, across the various studies reviewed, 63 samples are designated as mining/smelting "type" soils. Of these, 25 soils yielded RBA values in animal studies of 21% or lower (this constitutes 44% of the mining/smelting samples). This observation indicates that, while Cherryvale soils have not been dosed to animals to determine RBA, an assumption of 21% RBA is well within the range of RBA values observed for arsenic at other mining/smelting sites.

Summary and Conclusions

Soil characterization data for 29 soil samples collected from different areas of Cherryvale, Kansas, were evaluated for *in vitro* bioaccessibility testing of lead and arsenic. Criteria used in selecting the specific sampling locations are documented in the RSE Work Plan for the site. We evaluated bioaccessibility by determining the amount of lead and arsenic that becomes soluble in a simulated gastrointestinal extraction (the *in vitro* extraction test). Results from this testing are presented in Tables 1 through 3, and Figures 1a through 5. QA sample results are presented in Tables 4a and 4b. The results of this study indicate that:

- All samples evaluated produced lead and arsenic bioaccessibility values well below 100%, suggesting that the nature of the soils at this site limits the solubility of the lead and arsenic under physiological conditions.
- Across all of the samples evaluated, lead concentration in the <250-μm particle size fraction ranged from 66 mg/kg to over 14,000 mg/kg, the latter being associated with one sample collected from granular slag beneath a brick sidewalk. As discussed above and depicted in Figure 1a, this was an anomalous value—lead results for the other samples across the site were much lower.
- The predicted RBA for lead, based on bioaccessibility data, ranges from 48% to 71%, with an average across the site of 60.7%. As summarized in Figure 6, there was little variability among samples of a similar type or across the site as a whole. The soil sample with the highest lead concentration (discussed in the previous bullet) demonstrated predicted lead RBA (59%) that was consistent with other samples from the site.
- Because the site average value of 60.7% is nearly identical to the default value (60%) used in the derivation of the risk-based standards for Kansas, no site-specific adjustment of the soil lead screening value of 400 mg/kg is recommended for the site.
- Across all the samples evaluated, arsenic concentrations in the <250-μm particle size fraction ranged from 8 mg/kg to 481 mg/kg, the latter being associated with a sample of granular slag collected from beneath a brick sidewalk (same sample that had the anomalous lead result). Arsenic concentrations in all other samples were much lower. As observed for lead, the arsenic bioaccessibility from this sample with the highest arsenic concentration was within the range of bioaccessibility (19%) observed for other samples from the site.
- The bioaccessibility for arsenic ranges from <1% to 23%, with an average of 12%. The 95th percentile value for arsenic bioaccessibility is 21% across all samples tested. This 95th percentile value is recommended as an appropriately conservative site-specific RBA for the site. Adjusting the risk-

based standard for arsenic to include this RBA results in an arsenic screening value for the soil exposure pathway of 53.6 mg/kg (i.e., using Equation 3 of the RSK Manual[3] and incorporating the site-specific RBA of 0.21).

- The results suggest little relation between either lead or arsenic concentration in the soil samples and measured bioaccessibility or predicted RBA.
- The results suggest little relation between either lead or arsenic bioaccessibility and the type of sample, in terms of whether the samples were collected from residential areas with aerial disposition, or residential areas with slag/smelter waste. A statistical evaluation generally indicated no significant difference in bioaccessibility between different types of samples.[4]
- Data from quality control samples indicate that the data are of good quality with regard to accuracy and precision.

Overall, the data support the use of an assumed RBA for soils in Cherryvale of the default of 60% for lead, and a site-specific value of 21% for arsenic.

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[3] Risk-based Standards for Kansas (KDHE 2010; http://www.kdheks.gov/remedial/download/RSK_Manual_10.pdf)

[4] The only difference identified in the statistical comparisons between sample types was in predicted RBA for lead between aerial deposition areas (64.3%) and parks (54.2%).

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Figures

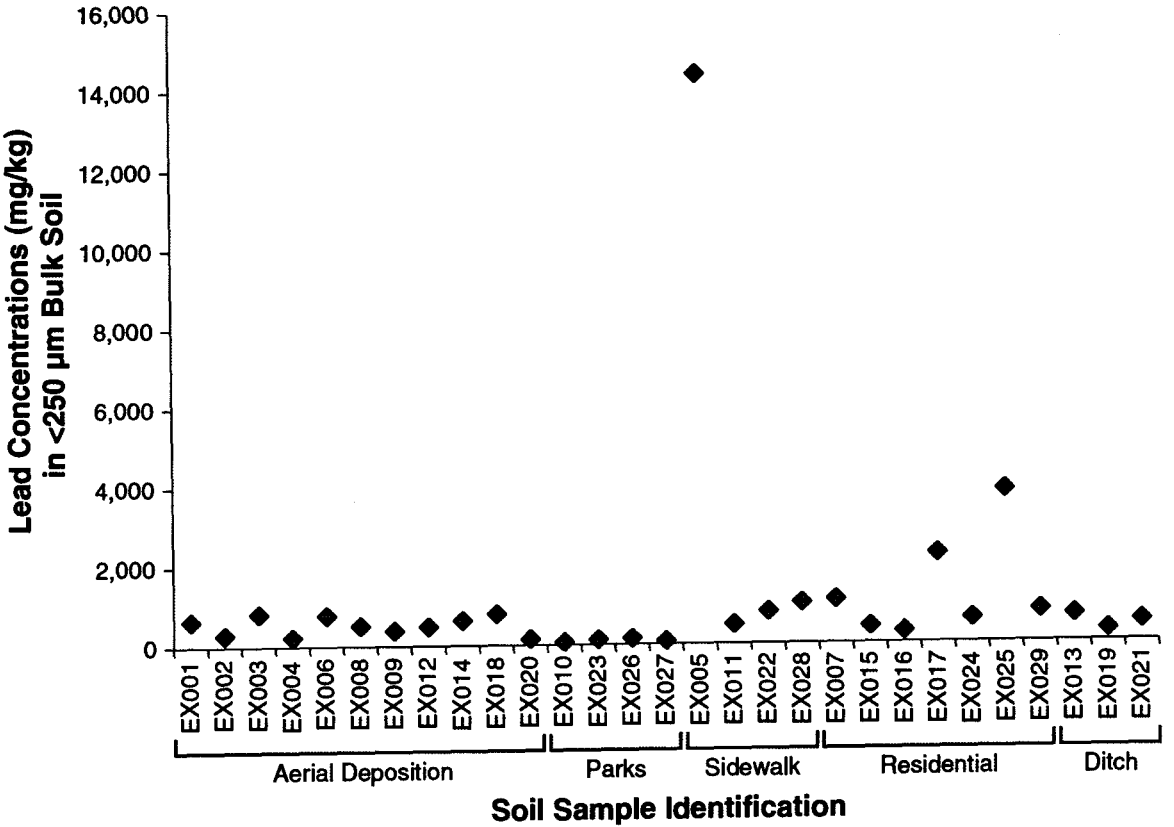


Figure 1a. Soil lead concentrations from Cherryvale, Kansas, organized by sample type

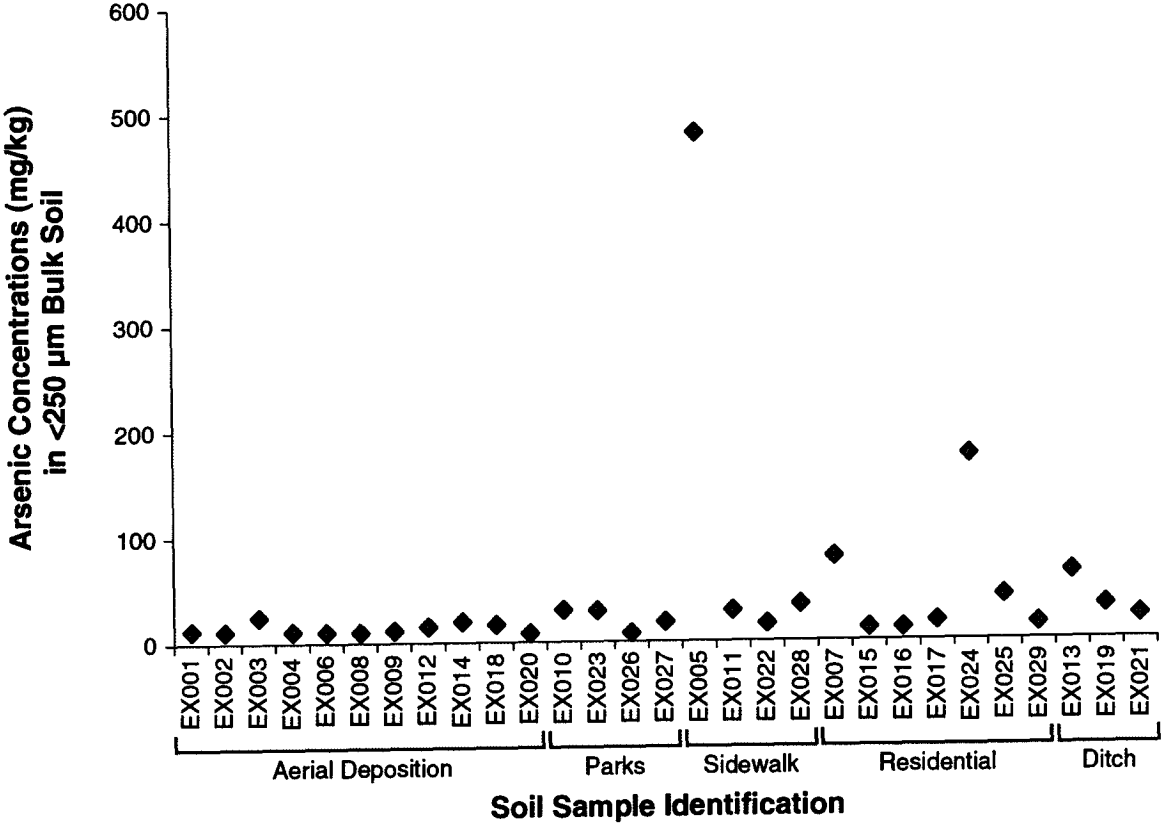


Figure 1b. Soil arsenic concentrations from Cherryvale, Kansas, organized by sample type

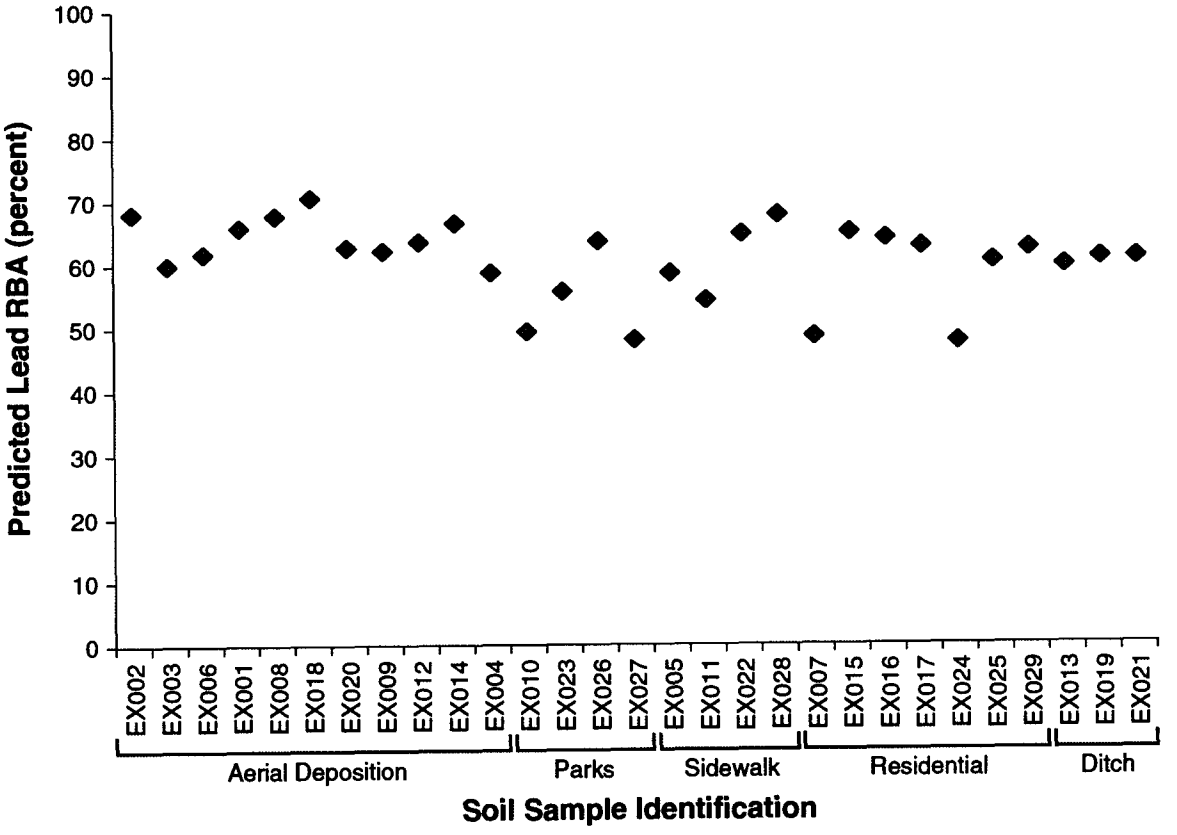


Figure 2. Predicted lead RBA from Cherryvale Soils, organized by sample type

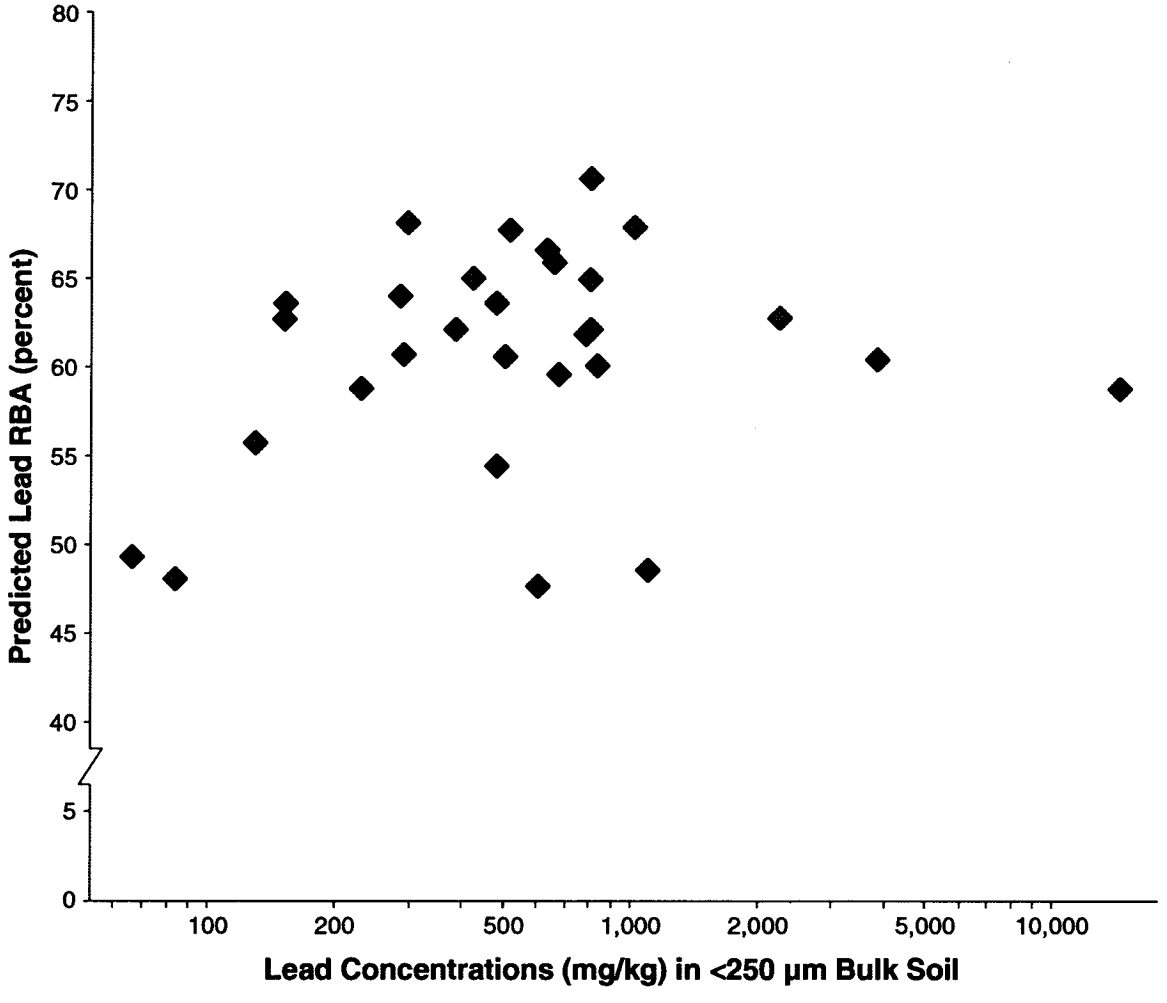


Figure 3. Effect of soil lead concentration on predicted RBA, <250-μm particle size fraction

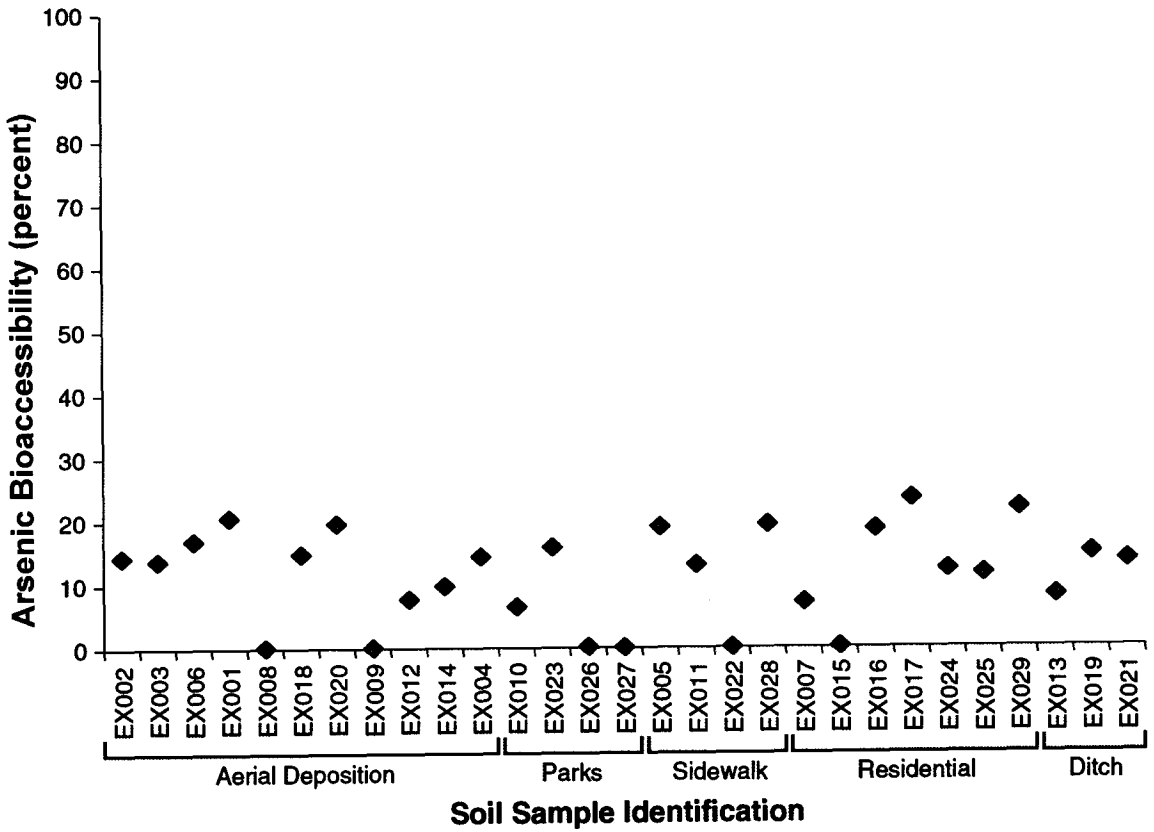


Figure 4. Arsenic bioaccessibility from Cherryvale Soils, organized by sample type

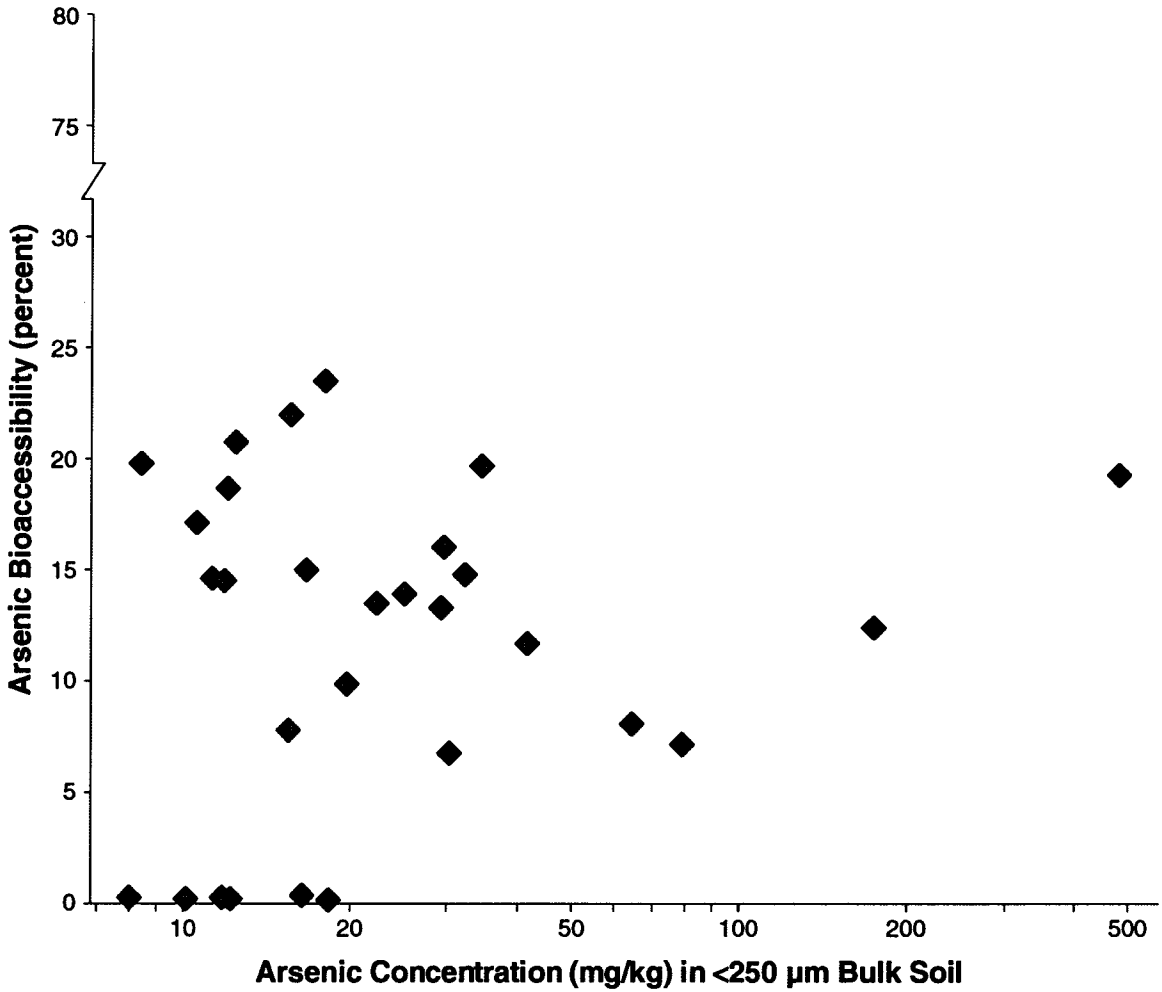
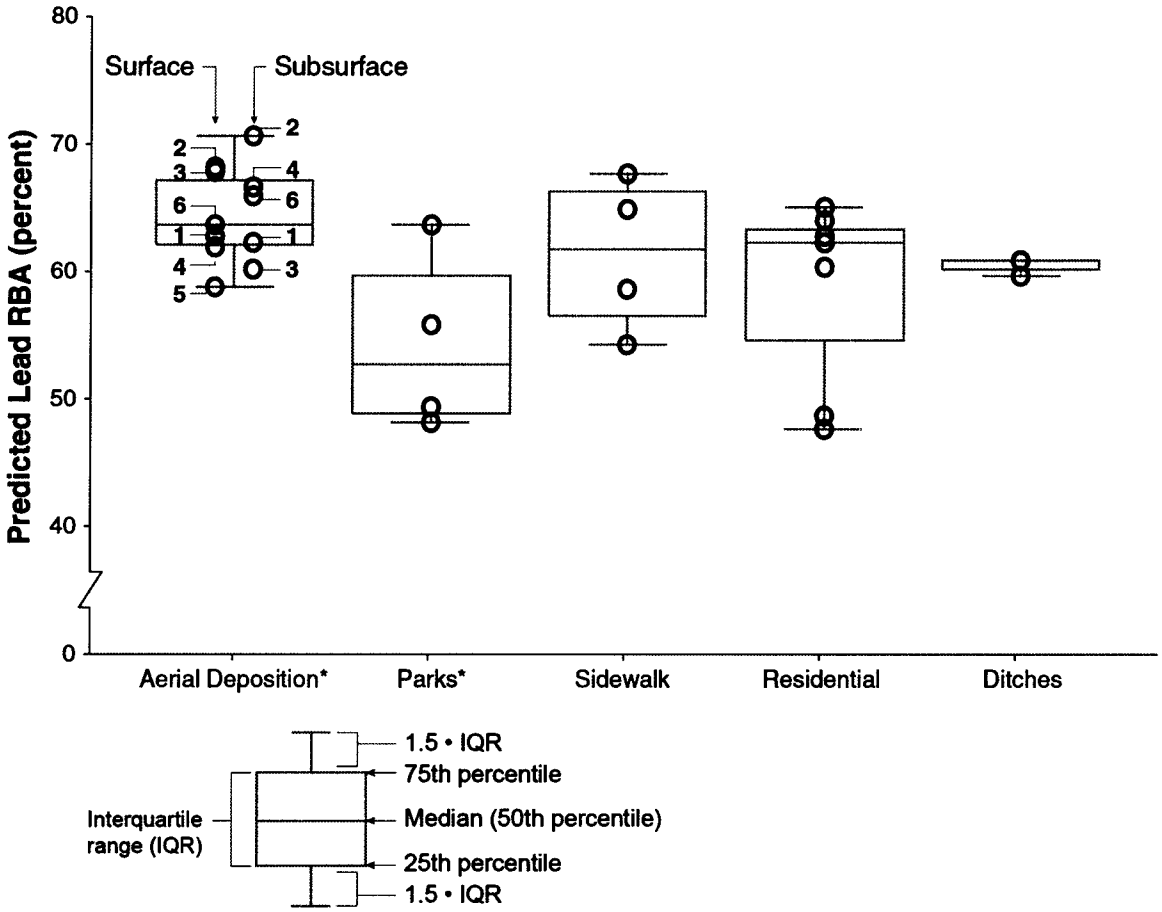


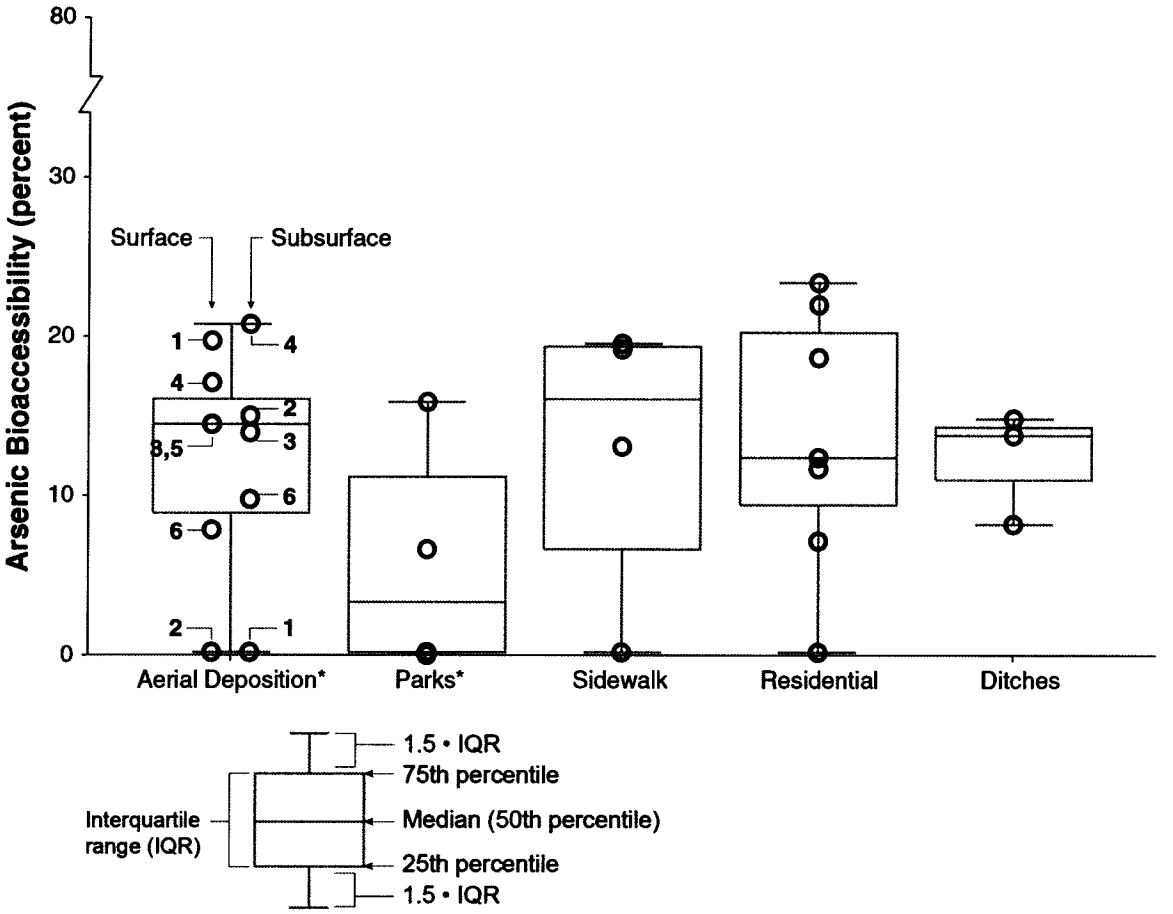
Figure 5. Effect of soil arsenic concentration on bioaccessibility, <250-μm particle size fraction



* Significant difference between aerial deposition (all samples) and parks at 0.05 significance level (i.e., 95% confidence)

Note: There is no significant difference between depth horizons of the aerial deposition samples.

Figure 6. Predicted lead RBA for each source area, with confidence limits



Note: There is no significant difference between the sample types at 0.05 significance level (i.e., 95% confidence).

Figure 7. Arsenic bioaccessibility for each source area, with confidence limits

Tables

Table 1. Metal concentrations in soil samples from Cherryvale, Kansas (<250-μm fraction)

Sample Type	Sample ID	Soil Horizon	Fe (mg/kg)	Zn (mg/kg)	As (mg/kg)	Cd (mg/kg)	Pb (mg/kg)
Historical Aerial Deposition	EX001	B	23,169	2,721	12.4	19.2	656
	EX002	A	21,284	1,503	11.9	8.9	295
	EX003	B	26,277	4,651	25.2	21.5	834
	EX004	A	24,896	1,925	11.4	9.0	230
	EX006	A	19,322	2,527	10.6	15.3	781
	EX008	A	18,564	2,222	10.2	15.0	518
	EX009	B	26,659	2,213	12.2	11.3	387
	EX012	A	26,485	2,911	15.5	17.7	481
	EX014	B	27,659	3,379	19.8	20.8	629
	EX018	B	21,715	3,231	16.8	21.3	806
	EX020	A	19,364	1,049	8.4	5.4	151
Parks/Fields	EX010		21,828	551	30.5	1.9	66
	EX023		22,019	3,032	29.6	4.6	129
	EX026		22,173	1,061	8.1	4.0	152
	EX027		23,126	1,015	18.3	2.2	84.0
Sidewalk Underlayment	EX005		66,943	120,953	481	255	14,344
	EX011		22,265	4,292	29.3	11.9	484
	EX022		20,086	5,412	16.5	21.2	802
	EX028		28,141	9,850	34.5	23.4	1,020
Residential slag/waste	EX007		43,380	5,841	79.3	14.6	1,107
	EX015		23,410	1,657	11.7	8.1	425
	EX016		35,555	1,302	12.0	4.3	286
	EX017		25,897	3,727	18.1	10.1	2,245
	EX024		40,363	2,265	175	4.4	606
	EX025		56,955	17,986	41.7	32.4	3,831
	EX029		21,680	4,438	15.7	12.2	802
Ditches	EX013		30,783	9,499	64.1	17.9	676
	EX019		22,093	3,503	32.2	8.4	290
	EX021		37,519	22,029	22.4	26.7	506
Quality Control	EX010-DUP		22,230	539	32	2	64
	EX020-DUP		19,891	1,044	9	5	152
	NIST-2711		24,559	370	105	42	1,117

Table 2. Preliminary summary of in vitro bioassay results for lead (sorted by sample type)

Sample Type	Sample ID	Soil Horizon	Pb in <250-µm Bulk Soil (mg/kg)	Mass Soil (g)	Mass Pb in Soil Tested (µg)	ICP Pb (µg/L)	Solution Amount (L)	% Pb IVBA	Predicted RBA*
Historical Aerial Deposition	EX001	B	656.4	1.0122	664.43	4,985	0.1	75	**66**
	EX002	A	294.6	1.0083	297.07	2,304	0.1	78	**68**
	EX003	B	833.5	1.0021	835.31	5,712	0.1	68	**60**
	EX004	A	229.8	1.0131	232.83	1,559	0.1	67	**59**
	EX006	A	781.1	1.0109	789.54	5,558	0.1	70	**62**
	EX008	A	518.2	1.0265	531.95	4,105	0.1	77	**68**
	EX009	B	387.3	1.0231	396.21	2,804	0.1	71	**62**
	EX012	A	481.2	0.9871	474.99	3,441	0.1	72	**64**
	EX014	B	629.5	1.0077	634.29	4,802	0.1	76	**66**
	EX018	B	805.8	1.0135	816.74	6,562	0.1	80	**71**
	EX020	A	150.7	1.0076	151.83	1,084	0.1	71	**63**
Parks/Fields	EX010		66.2	1.0229	67.69	381	0.1	56	**49**
	EX023		129.3	1.0095	130.56	828	0.1	63	**56**
	EX026		152.4	1.0261	156.41	1,133	0.1	72	**64**
	EX027		84.0	1.0186	85.53	469	0.1	55	**48**
Sidewalk Underlayment	EX005		14,343.5	1.0137	14,539.91	97,033	0.1	67	**59**
	EX011		483.8	1.0217	494.26	3,056	0.1	62	**54**
	EX022		801.9	0.9972	799.61	5,898	0.1	74	**65**
	EX028		1,019.9	1.0162	1,036.46	7,990	0.1	77	**68**
Residential slag/waste	EX007		1,106.8	1.0041	1,111.24	6,144	0.1	55	**49**
	EX015		425.2	1.0216	434.43	3,212	0.1	74	**65**
	EX016		285.7	1.0164	290.38	2,115	0.1	73	**64**
	EX017		2,244.8	1.0246	2,300.06	16,414	0.1	71	**63**
	EX024		606.0	0.9870	598.08	3,247	0.1	54	**48**
	EX025		3,831.5	1.0233	3,920.76	26,960	0.1	69	**60**
	EX029		802.1	1.0210	818.89	5,808	0.1	71	**62**
Ditches	EX013		676.4	1.0136	685.58	4,657	0.1	68	**60**
	EX019		289.7	1.0092	292.32	2,023	0.1	69	**61**
	EX021		505.6	1.0061	508.67	3,519	0.1	69	**61**

Sample Type	Sample ID	Soil Horizon	Pb in <250-µm Bulk Soil (mg/kg)	Mass Soil (g)	Mass Pb in Soil Tested (µg)	ICP Pb (µg/L)	Solution Amount (L)	% Pb IVBA	Predicted RBA*
Quality Control	EX010-DUP		64.3	1.0089	64.82	355	0.1	55	
	EX020-DUP		151.7	1.0211	154.94	1108	0.1	71	
	NIST-2711		1,117.2	1.01345	1132.24	10155	0.1	90	

*U.S. EPA. 2009. Validation assessment of in vitro lead bioaccessibility assay for predicting relative bioavailability of lead in soils and soil-like materials at superfund sites

Table 3. Preliminary summary of in vitro bioassay results for arsenic (sorted by sample type)

Sample Type	Sample ID	Soil Horizon	As in <250-µm Bulk Soil (mg/kg)	Mass Soil (g)	Mass As in Soil Tested (µg)	ICP As (µg/L)	Solution Amount (L)	%As IVBA
Historical Aerial Deposition	EX001	B	12.4	1.0122	12.57	26	0.1	21
	EX002	A	11.9	1.0083	11.99	17	0.1	14
	EX003	B	25.2	1.0021	25.21	35	0.1	14
	EX004	A	11.4	1.0131	11.54	17	0.1	15
	EX006	A	10.6	1.0109	10.73	18	0.1	17
	EX008	A	10.2	1.0265	10.45	0.212	0.1	0
	EX009	B	12.2	1.0231	12.50	0.212	0.1	0
	EX012	A	15.5	0.9871	15.33	12	0.1	8
	EX014	B	19.8	1.0077	19.95	20	0.1	10
	EX018	B	16.8	1.0135	17.00	25	0.1	15
	EX020	A	8.4	1.0076	8.44	17	0.1	20
Parks/Fields	EX010		30.5	1.0229	31.17	21	0.1	7
	EX023		29.6	1.0095	29.84	47	0.1	16
	EX026		8.1	1.0261	8.29	0.212	0.1	0
	EX027		18.3	1.0186	18.66	0.212	0.1	0
Sidewalk Underlayment	EX005		480.5	1.0137	487.12	933	0.1	19
	EX011		29.3	1.0217	29.88	39	0.1	13
	EX022		16.5	0.9972	16.44	0.212	0.1	0
	EX028		34.5	1.0162	35.11	68	0.1	19
Residential slag/waste	EX007		79.3	1.0041	79.63	57	0.1	7
	EX015		11.7	1.0216	12.00	0.212	0.1	0
	EX016		12.0	1.0164	12.23	23	0.1	19
	EX017		18.1	1.0246	18.51	43	0.1	23
	EX024		174.9	0.9870	172.64	214	0.1	12
	EX025		41.7	1.0233	42.67	50	0.1	12
	EX029		15.7	1.0210	15.98	35	0.1	22
Ditches	EX013		64.1	1.0136	65.02	53	0.1	8
	EX019		32.2	1.0092	32.53	48	0.1	15
	EX021		22.4	1.0061	22.51	31	0.1	14
Quality Control	EX010-DUP		31.9	1.0089	32.22	17	0.1	5
	EX020-DUP		8.5	1.0211	8.70	13	0.1	15
	NIST-2711		105.0	1.0135	106.39	584	0.1	55

Table 4a. QA sample results from in vitro bioaccessibility testing of lead in soil samples from Cherryvale, Kansas

Sample ID	Extraction Date	pH (s.u.)	Spike Conc. (mg/L)	Lead Conc. in Extract (mg/L)	Lead Conc. in Soil (mg/kg)	Relative Percent Difference[a] (%)	Percent Recovery (%)	Control Limits
Duplicate Extractions								
EX010	09/09/13	1.628	--	0.38		--	--	--
EX010-DUP	09/09/13	1.613	--	0.35		7.0%	--	20%
EX020	09/09/13	1.609	--	1.1		--	--	--
EX020-DUP	09/09/13	1.617	--	1.1		2.1%	--	20%
Duplicate Soil Split Samples								
EX010	09/09/13	1.628	--		66.2	--	--	--
EX010-DUP	09/09/13	1.613	--		64.3	2.9%	--	20%
EX020	09/09/13	1.609	--		150.7	--	--	--
EX020-DUP	09/09/13	1.617	--		151.7	0.70%	--	20%
QC Samples								
Bottle Blank 1	09/09/13	--	--	0.003		--	--	<0.01 mg/L
Bottle Blank 2	09/09/13	--	--	DL		--	--	<0.01 mg/L
BLANK-1	09/09/13	1.53	--	DL		--	--	--
BLANK-SPK-1	09/09/13	1.528				--	--	85 - 115%
BLANK-2	09/09/13	1.5	--	DL		--	--	--
BLANK-SPK-2	09/09/13	1.49		2.6		--	--	85 - 115%
EX010-SPK	09/09/13	1.613		2.8		--	--	--
EX020-SPK	09/09/13	1.62		3.3		--	--	--
NIST-2711 (SRM)[b]	09/09/13	1.62	--	10.2		--	--	7.72 - 10.72
NIST-2711 (SRM)[b]	09/09/13	1.62	--		1117.2	--	96%	85 - 115%

Notes:
-- – Not available or not applicable
DL – undetected (below reporting limit)
SPK -- Spike

[a] Relative percent difference = ((absolute value(c1 – c2))/average) × 100

[b] Certified values for NIST 2711 are 105 mg/kg for arsenic, and 1162 mg/kg for lead

Table 4b. QA sample results from in vitro bioaccessibility testing of arsenic in soil samples from Cherryvale, Kansas

Sample ID	Extraction Date	pH (s.u.)	Spike Conc. (mg/L)	Arsenic Conc. in Extract (mg/L)	Arsenic Conc. in Soil (mg/kg	Relative Percent Difference[a] (%)	Percent Recovery (%)	Control Limits
Duplicate Extractions								
EX010	09/09/13	1.628	--	0.021	--	--	--	--
EX010-DUP	09/09/13	1.613	--	0.017	--	20%	--	20%
EX020	09/09/13	1.609	--	0.017	--	--	--	--
EX020-DUP	09/09/13	1.617	--	0.013	--	24%	--	20%
Duplicate Soil Split Samples								
EX010	09/09/13	1.628	--	--	30.5	--	--	--
EX010-DUP	09/09/13	1.613	--	--	31.9	4.7%	--	20%
EX020	09/09/13	1.609	--	--	8.4	--	--	--
EX020-DUP	09/09/13	1.617	--	--	8.5	1.7%	--	20%
QC Samples								
Bottle Blank 1	09/09/13	--	--	DL	--	--	--	<0.01 mg/L
Bottle Blank 2	09/09/13	--	--	DL	--	--	--	<0.01 mg/L
BLANK-1	09/09/13	1.53	--	DL	--	--	--	--
BLANK-SPK-1	09/09/13	1.528	2.5	2.81	--	--	112%	85-115%
BLANK-2	09/09/13	1.5	--	DL	--	--	--	--
BLANK-SPK-2	09/09/13	1.49	2.5	2.80	--	--	112%	85-115%
EX010-SPK	09/09/13	1.613	2.5	2.42	--	--	--	--
EX020-SPK	09/09/13	1.62	2.5	2.45	--	--	--	--
NIST-2711 (SRM)[b]	09/09/13	1.62	--	0.58	--	--	--	0.50 - 0.68
NIST-2711 (SRM)[b]	09/09/13	1.62	--	--	105.0	--	100%	97 - 113

Notes: -- – Not available or not applicable
DL – undetected (below reporting limit)

[a] Relative percent difference = ((absolute value(c1 – c2))/average) × 100

[b] Certified values for NIST 2711 are 105 mg/kg for arsenic, and 1162 mg/kg for lead

Table 5. Model predictions of RBA from arsenic bioaccessibility data: Application to Cherryvale, KS

Model[f]		Cherryvale Bioaccessibility Data[a]		IVIVC Regression Equation[b,c,d]	Predicted RBA[e]	
		Average	95th Percentile		Average	95th Percentile
Rodriguez	1999	12	21	RBA = 0.88 x IVBA - 2.02	8.5	16
Makris	2008	12	21	RBA = 0.452 x IVBA + 10.04	15	20
Ruby	1996	12	21	RBA = 0.857 x IVBA + 4.3	15	22
Juhasz	2007	12	21	RBA = 0.68 x IVBA + 5.67	14	20
Wragg	2011	12	21	RBA = 1.26 x IVBA + 8.6	24	35
Denys	2012	12	21	RBA = 1.12 x IVBA - 2.2	11	21
Bradham	2011	12	21	RBA = 0.72 x IVBA + 5.6	14	21
Brattin	2013	12	21	RBA = 0.62 x IVBA + 19.7	27	33

Notes:

[a] Cherryvale

[b] Regression equations represent the relation between in vitro bioaccessibility data and animal RBA results for paired soils that have been tested both in animals and in vitro, and therefore allow for prediction of RBA from in vitro data.

[c] "RBA" denotes relative oral bioavailability of arsenic from animal studies. "IVBA" denotes in vitro bioaccessibility. "IVIVC" denotes the correlation between paired in vivo and in vitro data for the same soils.

[d] Equations from different studies have been standardized (by Brattin et al., 2013) to predict RBA based on IVBA.

[e] The predicted RBA presented in this table are values predicted by the regression equation for each model when the average or 95th percentile arsenic bioaccessibility values for Cherryvale soils are used in the regression equation.

[f] The predicted RBA presented in this table are values predicted by the regression equation for each model when the average or 95th percentile arsenic bioaccessibility values for Cherryvale soils are used in the regression equation.

Attachment A

Data Package from Laboratory for Environmental and Geological Studies

Laboratory of Environment and Geological Sciences, University of Colorado, Boulder

Project Name: EXPONENT

Run #: pH 1.5 37 C Date: 9/9/2013 Operater: Drexler

Postion in rack	Sample name	Lab#	Wt. Grams	pH start	Starting time	Stopping time	pH stop
1	EX001		1.0122	1.528	9:50	10:50	1.541
2	EX002		1.00834	1.528	9:50	10:50	1.568
3	EX003		1.00211	1.528	9:50	10:50	1.569
4	EXOO4		1.01311	1.528	9:50	10:50	1.582
5	EX005		1.01369	1.528	9:50	10:50	1.768
6	EX006		1.01087	1.528	9:50	10:50	1.589
7	EX007		1.00406	1.528	9:50	10:50	1.589
8	EX008		1.02648	1.528	9:50	10:50	1.591
9	EX009		1.02306	1.528	9:50	10:50	1.607
10	EX010		1.02291	1.528	9:50	10:50	1.628

Project Name: EXPONENT

Run #: 2 pH 1.5 37 C Date: 9/9/2013 Operater: Drexler

Postion in rack	Sample name	Lab#	Wt. Grams	pH start	Starting time	Stopping time	pH stop
1	EX010-DUP		1.0089	1.528	10:00	11:00	1.613
2	EX010-SPK		1.01293	1.528	10:00	11:00	1.613
3	BLANK-1			1.528	10:00	11:00	1.53
4	BLANK-SPK-1			1.528	10:00	11:00	1.528
5	EX011		1.02167	1.528	10:00	11:00	1.618
6	EX012		0.98707	1.528	10:00	11:00	1.625
7	EX013		1.01362	1.528	10:00	11:00	1.646
8	EX014		1.00767	1.528	10:00	11:00	1.621
9	EX015		1.02163	1.528	10:00	11:00	1.61
10	EX016		1.01641	1.528	10:00	11:00	1.611

Project Name: EXPONENT

Run #: 3 pH 1.5 37 C Date: 9/9/2013 Operater: Drexler

Postion in rack	Sample name	Lab#	Wt. Grams	pH start	Starting time	Stopping time	pH stop
1	EX017		1.0246	1.496	11:17	12:17	1.589
2	EX018		1.01353	1.496	11:17	12:17	1.534
3	EX019		1.00917	1.496	11:17	12:17	1.763
4	EX020		1.00762	1.496	11:17	12:17	1.609
5	EX020-DUP		1.02109	1.496	11:17	12:17	1.617
6	EX020-SPK		0.99696	1.496	11:17	12:17	1.62
7	BLANK-2			1.496	11:17	12:17	1.5
8	BLANK-SPK-2			1.496	11:17	12:17	1.49
9	NIST-2711		1.01345	1.496	11:17	12:17	1.62
10	EX021		1.00608	1.496	11:17	12:17	1.683

Project Name: EXPONENT

Run #: 4 pH 1.5 37 C Date: 9/9/2013 Operater: Drexler

Postion in rack	Sample name	Lab#	Wt. Grams	pH start	Starting time	Stopping time	pH stop
1	EX022		0.9972	1.496	11:20	12:20	1.579
2	EX023		1.00947	1.496	11:20	12:20	1.57
3	EX024		0.98696	1.496	11:20	12:20	1.585
4	EX025		1.0233	1.496	11:20	12:20	1.613
5	EX026		1.02614	1.496	11:20	12:20	1.638
6	EX027		1.01857	1.496	11:20	12:20	1.581
7	EX028		1.0162	1.496	11:20	12:20	1.603
8	EX029		1.02096	1.496	11:20	12:20	1.608
9							
10							

TABLE 2. Preliminary Summary Of In Vitro Bioassay Results

Sample	ID	Pb in <250u bulk soil ug/kg	mass soil (g)	calc Pb #1	ICP Pb (ug/l)	solution amt (l)	% Pb IVBA	%RBA Predicted based on Drexler and Brattin, 2007
EX001	656421.409	1.0122	664.43	4985	0.1	75	66	
EX002	294613.741	1.00834	297.07	2304	0.1	78	68	
EX003	833550	1.00211	835.31	5712	0.1	68	60	
EX004	229820	1.01311	232.83	1559	0.1	67	59	
EX005	14343548	1.01369	14539.91	97033	0.1	67	59	
EX006	781051.372	1.01087	789.54	5558	0.1	70	62	
EX007	1106751	1.00406	1111.24	6144	0.1	55	49	
EX008	518229	1.02648	531.95	4105	0.1	77	68	
EX009	387282	1.02306	396.21	2804	0.1	71	62	
EX010	66173	1.02291	67.69	381	0.1	56	49	
EX010-DUP	64252	1.0089	64.82	355	0.1	55	48	
EX011	483777	1.02167	494.26	3056	0.1	62	54	
EX012	481210	0.98707	474.99	3441	0.1	72	64	
EX013	676370.154	1.01362	685.58	4657	0.1	68	60	
EX014	629459	1.00767	634.29	4802	0.1	76	66	
EX015	425235	1.02163	434.43	3212	0.1	74	65	
EX016	285697	1.01641	290.38	2115	0.1	73	64	
EX017	2244841	1.0246	2300.06	16414	0.1	71	63	
EX018	805840	1.01353	816.74	6562	0.1	80	71	
EX019	289662	1.00917	292.32	2023	0.1	69	61	
EX020	150680	1.00762	151.83	1084	0.1	71	63	
EX020-DUP	151736	1.02109	154.94	1108	0.1	71	63	
NIST-2711	1117216.26	1.01345	1132.24	10155	0.1	90	79	
EX021	505594	1.00608	508.67	3519	0.1	69	61	
EX022	801852.565	0.9972	799.61	5898	0.1	74	65	
EX023	129335	1.00947	130.56	828	0.1	63	56	
EX024	605978	0.98696	598.08	3247	0.1	54	48	
EX025	3831491	1.0233	3920.76	26960	0.1	69	60	
EX026	152422.85	1.02614	156.41	1133	0.1	72	64	
EX027	83966.55	1.01857	85.53	469	0.1	55	48	
EX028	1019935.76	1.0162	1036.46	7990	0.1	77	68	
EX029	802075.038	1.02096	818.89	5808	0.1	71	62	

TABLE 3. Preliminary Summary Of In Vitro Bioassay Results

Sample	ID	As in <250u bulk soil ug/kg	mass soil (g)	calc Pb #1	ICP As (ug/l)	solution amt (l)	%As IVBA
EX001		12414.51	1.0122	12.57	26	0.1	21
EX002		11889.12	1.00834	11.99	17	0.1	14
EX003		25159	1.00211	25.21	35	0.1	14
EXOO4		11392	1.01311	11.54	17	0.1	15
EX005		480538	1.01369	487.12	933	0.1	19
EX006		10616.27	1.01087	10.73	18	0.1	17
EX007		79306	1.00406	79.63	57	0.1	7
EX008		10180	1.02648	10.45	0.212	0.1	0
EX009		12215	1.02306	12.50	0.212	0.1	0
EX010		30475	1.02291	31.17	21	0.1	7
EX010-DUP		31931	1.0089	32.22	17	0.1	5
EX011		29250	1.02167	29.88	39	0.1	13
EX012		15532	0.98707	15.33	12	0.1	8
EX013		64145.26	1.01362	65.02	53	0.1	8
EX014		19793	1.00767	19.95	20	0.1	10
EX015		11745	1.02163	12.00	0.212	0.1	0
EX016		12033	1.01641	12.23	23	0.1	19
EX017		18064	1.0246	18.51	43	0.1	23
EX018		16774	1.01353	17.00	25	0.1	15
EX019		32230	1.00917	32.53	48	0.1	15
EX020		8374	1.00762	8.44	17	0.1	20
EX020-DUP		8518	1.02109	8.70	13	0.1	15
NIST-2711		104980.1	1.01345	106.39	584	0.1	55
EX021		22375	1.00608	22.51	31	0.1	14
EX022		16485.33	0.9972	16.44	0.212	0.1	0
EX023		29560	1.00947	29.84	47	0.1	16
EX024		174919	0.98696	172.64	214	0.1	12
EX025		41701	1.0233	42.67	50	0.1	12
EX026		8077.635	1.02614	8.29	0.212	0.1	0
EX027		18323.72	1.01857	18.66	0.212	0.1	0
EX028		34549.49	1.0162	35.11	68	0.1	19
EX029		15652	1.02096	15.98	35	0.1	22

In Vitro extraction at detection limit of 0.212 ug/l

Sample	Cd (ug/kg)
EX001	19163
EX002	8897
EX003	21488
EX004	9027
EX005	254652
EX006	15313
EX007	14570
EX008	15002
EX009	11272
EX010	1922
EX010-DUP	1895
EX011	11946
EX012	17701
EX013	17913
EX014	20835
EX015	8097
EX016	4314
EX017	10131
EX018	21291
EX019	8408
EX020	5371
EX020-DUP	5349
NIST-2711	41927
EX021	26664
EX022	21234
EX023	4622
EX024	4391
EX025	32370
EX026	3996
EX027	2179
EX028	23417
EX029	12168
Machine Detection Limit	**0.019**

Sample	Zn (ug/kg)
EX001	2720728
EX002	1503417
EX003	4650748
EX004	1925228
EX005	120953396
EX006	2526698
EX007	5840649
EX008	2222234
EX009	2213274
EX010	551170
EX010-DUP	538729
EX011	4291843
EX012	2910929
EX013	9499141
EX014	3378707
EX015	1657337
EX016	1302494
EX017	3727281
EX018	3231408
EX019	3503421
EX020	1049385
EX020-DUP	1044296
NIST-2711	370151
EX021	22028798
EX022	5412015
EX023	3031574
EX024	2264564
EX025	17986173
EX026	1060632
EX027	1014829
EX028	9850115
EX029	4438468
Machine Detection Limit	**2.698**

Put curser here to see notes.	Fe ug/L (ug/kg)	Zn ug/L (ug/kg)	As ug/L (ug/kg)	Cd ug/L (ug/kg)	Pb ug/L (ug/kg)
Bio					
EX001	6523	21010	26	182	4985
EX002	3679	10903	17	82	2304
EX003	6137	32898	35	175	5712
EX004	7359	12734	17	79	1559
EX005	25611	1150842	933	2215	97033
EX006	4403	17309	18	132	5558
EX007	12343	45259	57	107	6144
EX008	2621	18146	DL	141	4105
EX009	4069	17223	DL	102	2804
EX010	8741	3413	21	16	381
EX011	5742	35193	39	107	3056
EX012	3657	21615	12	155	3441
EX013	16620	84532	53	138	4657
EX014	4332	26060	20	186	4802
EX015	3211	11260	DL	74	3212
EX016	5958	8515	23	34	2115
EX017	7487	29137	43	83	16414
EX018	3082	26944	25	201	6562
EX019	21707	29014	48	69	2023
EX020	5799	7537	17	47	1084
EX021	26324	209802	31	192	3519
EX022	2286	44677	DL	186	5898
EX023	11007	20290	47	37	828
EX024	4734	8017	214	32	3247
EX025	18081	158075	50	239	26960
EX026	7162	7579	DL	37	1133
EX027	10060	5749	DL	16	469
EX028	7079	91695	68	211	7990
EX029	6046	38609	35	112	5808
bottle blank 1	DL	DL	DL	DL	3
bottle blank 2	DL	DL	DL	DL	DL
Bio QA/QC					
EX010	8741	3413	21	16	381
EX010-DUP	8425	3368	17	14	355
RPD	3.7	1.3	20.0	8.5	7.0
EX010	8741	3413	21	16	381
EX010-SPK	8107	6071	2424	2686	2834
% Recovery	NA	106	96	107	98
BLANK-1	3.5	1	0	0	0
BLANK-SPK-1	DL	3042	2808	2687	2574
% Recovery	NA	122	112	107	103
EX020	5799	7537	17	47	1084
EX020-DUP	5761	7611	13	48	1108
RPD	0.7	1.0	23.9	2.0	2.1
EX020	5799	7537	17	47	1084
EX020-SPK	5247	9945	2447	2628	3347
% Recovery	NA	96	97	103	90
BLANK-2	DL	2	0	0	0
BLANK-SPK-2	DL	3143	2800	2723	2613
% Recovery	NA	126	112	109	105
NIST-2711	9052	1659	584	384	10155
3050B digest					
EX001	23168681	2720728	12415	19163	656421
EX002	21284324	1503417	11889	8897	294614
EX003	26276727	4650748	25159	21488	833550
EX004	24896344	1925228	11392	9027	229820
EX005	66943133	120953396	480538	254652	14343548
EX006	19321885	2526698	10616	15313	781051
EX007	43380078	5840649	79306	14570	1106751
EX008	18563809	2222234	10180	15002	518229
EX009	26658538	2213274	12215	11272	387282
EX010	21827598	551170	30475	1922	66173
EX011	22264633	4291843	29250	11946	483777
EX012	26485216	2910929	15532	17701	481210
EX013	30783320	9499141	64145	17913	676370
EX014	27659041	3378707	19793	20835	629459
EX015	23409716	1657337	11745	8097	425235
EX016	35554931	1302494	12033	4314	285697
EX017	25897341	3727281	18064	10131	2244841
EX018	21714527	3231408	16774	21291	805840
EX019	22092782	3503421	32230	8408	289662
EX020	19364394	1049385	8374	5371	150680
EX021	37519354	22028798	22375	26664	505594
EX022	20085573	5412015	16485	21234	801853
EX023	22019357	3031574	29560	4622	129335
EX024	40363004	2264564	174919	4391	605978
EX025	56955236	17986173	41701	32370	3831491
EX026	22172625	1060632	8078	3996	152423
EX027	23125981	1014829	18324	2179	83967
EX028	28141214	9850115	34549	23417	1019936
EX029	21679835	4438468	15652	12168	802075
3050B QA/QC					
EX010	21827598	551170	30475	1922	66173
EX010-DUP	22230077	538729	31931	1895	64252
RPD	1.8	2.3	4.7	1.4	2.9
EX010	21827598	551170	30475	1922	66173
EX010-SPK	21818998	816626	303923	266186	319431
% Recovery	NA	106	109	106	101
BLANK-1	6	0	0	0	0
BLANK-SPK-1	DL	5872	5679	5479	5138
% Recovery	NA	117	114	110	103

EX020	19364394	1049385	8374	5371	150680
EX020-DUP	19891434	1044296	8518	5349	151736
RPD	2.7	0.5	1.7	0.4	0.7
EX020	19364394	1049385	8374	5371	150680
EX020-SPK	19080468	1320970	283793	278289	408422
% Recovery	NA	109	110	109	103
BLANK-2	3	0	0	0	0
BLANK-SPK-2	DL	6061	5712	5565	5257
% Recovery	NA	121	114	111	105
NIST-2711	24558513	370151	104980	41927	1117216
Reported leach values	22000000	310000	90000	40000	1100000
RPD	11.0	17.7	15.4	4.7	1.6
Machine Detection Limit	**10.487**	**2.698**	**0.212**	**0.019**	**0.038**

Not dilution corrected

Not dilution corrected

Not dilution corrected

Not dilution corrected

Put curser here to see no

		Fe ug/L (ug/kg	Zn ug/L (ug/kg)	As ug/L (ug	Cd ug/L (ug/kg	Pb ug/L (ug/kg	digest facto	wt g
EX001 all 50x bio		6522.7	21010.1	26.0	182.3	4985.4		
EX002		3678.6	10903.2	17.4	81.7	2304.5		
EX003		6137.3	32897.6	35.0	174.8	5712.3		
EXOO4		7359.2	12734.3	16.7	79.0	1558.7		
EX005		25610.5	1150841.7	932.9	2214.5	97033.3		
EX006		4403.0	17309.5	18.4	131.9	5558.3		
EX007		12343.2	45259.1	57.4	107.1	6143.9		
EX008		2621.3	18146.4	DL	140.7	4105.1		
EX009		4069.5	17223.3	DL	102.2	2803.5		
	0	0.0	0.0	0.0	0.0	0.0		
	0	DL	DL	DL	DL	DL		
EX010		8741.2	3413.0	20.5	15.7	380.9		
EX010-DUP		8424.7	3368.3	16.8	14.4	355.0		
EX010-SPK		8106.9	6070.7	2423.7	2685.8	2834.0		
BLANK-1		DL	DL	DL	DL	DL		
BLANK-SPK-1		DL	3041.9	2807.6	2687.0	2574.3		
EX011		5742.0	35192.7	39.2	106.8	3055.6		
EX012		3656.7	21615.2	12.0	155.3	3440.8		
EX013		16620.2	84532.0	53.4	138.3	4657.3		
EX014		4332.4	26060.0	19.7	186.3	4802.4		
EX015		3210.8	11259.7	DL	74.3	3212.5		
	0	0.0	0.0	0.0	0.0	0.0		
	0	DL	DL	DL	DL	DL		
EX016		5958.3	8514.9	22.9	34.3	2114.6		
EX017		7487.1	29136.9	43.4	83.2	16414.2		
EX018		3081.9	26944.5	25.4	200.8	6562.1		
EX019		21707.4	29013.6	48.3	68.6	2023.1		
EX020		5799.0	7536.6	16.7	47.2	1084.4		
EX020-DUP		5761.1	7611.2	13.1	48.1	1107.7		
EX020-SPK		5247.2	9944.6	2446.7	2627.9	3346.5		
BLANK-2		DL	DL	DL	DL	DL		
BLANK-SPK-2		DL	3142.8	2800.2	2722.9	2612.9		
NIST-2711		9052.4	1659.1	584.3	383.9	10154.8		
	0	0.0	0.0	0.0	0.0	0.0		
	0	DL	DL	DL	DL	DL		
EX021		26323.8	209802.4	30.9	191.8	3518.7		
EX022		2286.0	44677.4	DL	186.1	5897.6		
EX023		11006.8	20289.6	47.4	37.4	828.2		
EX024		4734.2	8017.4	213.7	32.2	3247.1		
EX025		18080.6	158075.4	49.7	239.3	26959.9		
EX026		7162.0	7579.3	DL	37.4	1133.4		
EX027		10059.7	5749.1	DL	15.6	468.5		
EX028		7078.9	91695.1	68.4	211.5	7990.0		
EX029		6046.1	38609.1	35.0	111.6	5807.9		
bottle blank 1		DL	DL	DL	DL	2.8		
	0	0.0	0.0	0.0	0.0	0.0		
	0	DL	DL	DL	DL	DL		
bottle blank 2		DL	DL	DL	DL	DL		
EX001 3050		23168680.7	2720728.1	12414.5	19163.5	656421.4		
EX002		21284324.2	1503416.6	11889.1	8896.7	294613.7		
EX003		26276726.7	4650747.8	25158.9	21488.5	833549.8		
EX004		24896343.7	1925227.8	11391.8	9026.8	229820.2		
EX005		66943132.5	120953396.4	480538.4	254652.3	14343547.9		
EX006		19321884.9	2526697.6	10616.3	15312.7	781051.4		
EX007		43380077.7	5840648.9	79306.3	14569.9	1106751.0		
EX008		18563809.4	2222233.6	10180.1	15001.6	518228.9		
EX009		26658538.3	2213273.6	12214.8	11271.7	387282.3		
	0	0.0	0.0	0.0	0.0	0.0		
	0	DL	DL	DL	DL	DL		
EX010		21827598.4	551170.4	30475.1	1921.6	66173.4		
EX010-DUP		22230076.9	538728.7	31931.1	1895.4	64251.6		
EX010-SPK		21818997.7	816625.5	303923.5	266185.8	319431.0		
BLANK-1		DL	DL	DL	DL	10.1		
BLANK-SPK-1		DL	5872.4	5678.8	5479.5	5138.5		
EX011		22264633.5	4291842.7	29250.0	11945.9	483777.4		
EX012		26485215.6	2910929.3	15531.6	17701.1	481210.2		
EX013		30783320.2	9499141.2	64145.3	17913.4	676370.2		
EX014		27659040.9	3378707.2	19793.5	20835.1	629458.6		
EX015		23409716.0	1657337.2	11744.8	8097.0	425234.8		
	0	0.0	0.0	0.0	0.0	0.0		
	0	DL	DL	DL	DL	DL		
EX016		35554931.5	1302494.2	12032.8	4314.4	285696.6		
EX017		25897340.6	3727281.1	18063.6	10131.5	2244841.2		
EX018		21714526.8	3231407.5	16773.8	21290.6	805840.2		
EX019		22092781.7	3503421.3	32230.4	8408.4	289661.7		
EX020		19364394.1	1049384.8	8373.7	5371.1	150680.3		
EX020-DUP		19891434.1	1044296.5	8518.4	5349.4	151736.2		
EX020-SPK		19080467.8	1320970.2	283793.1	278288.7	408422.3		
BLANK-2		DL	DL	DL	DL	DL		
BLANK-SPK-2		DL	6060.8	5712.4	5565.2	5256.9		
NIST-2711		24558512.6	370151.1	104980.1	41927.2	1117216.3		
	0	0.0	0.0	0.0	0.0	0.0		
	0	DL	DL	DL	DL	DL		
EX021		37519354.0	22028798.1	22375.0	26663.8	505593.6		
EX022		20085573.5	5412015.2	16485.3	21234.5	801852.6		
EX023		22019356.9	3031574.5	29559.6	4622.3	129334.7		
EX024		40363003.8	2264564.4	174919.1	4391.1	605978.4		
EX025		56955235.9	17986172.9	41701.3	32370.2	3831491.2		
EX026		22172624.8	1060632.3	8077.6	3995.8	152422.8		
EX027		23125981.1	1014828.6	18323.7	2178.8	83966.5		
EX028		28141213.9	9850115.4	34549.5	23416.6	1019935.8		
EX029		21679834.7	4438468.4	15652.0	12168.3	802075.0		

	Fe ug/L (ug/kg	Zn ug/L (ug	As ug/L (ug	Cd ug/L (ug	Pb ug/L (ug/kg)	digest factor	wt g
EX001 all 50x bio	6522.65	21010.09	26.01	182.252	4985.3925		
EX002	3678.55	10903.25	17.37	81.742	2304.4725		
EX003	6137.25	32897.59	35.01	174.754	5712.3		
EXOO4	7359.2	12734.32	16.74	79.028	1558.7055		
EX005	25610.5	1150842	932.94	2214.532	97033.32099		
EX006	4403	17309.49	18.36	131.928	5558.256		
EX007	12343.2	45259.14	57.375	107.088	6143.94		
EX008	2621.25	18146.44	7.515	140.714	4105.134		
EX009	4069.45	17223.3	10.485	102.212	2803.5315		
EX010	8741.2	3413.005	20.52	15.732	380.853		
EX010-DUP	8424.65	3368.253	16.785	14.444	354.9645		
EX010-SPK	8106.9	6070.7	2423.655	2685.848	2834.0235		
BLANK-1	177.2	69.4025	-1.62	-0.046	-0.5445		
BLANK-SPK-1	86.95	3041.938	2807.55	2686.998	2574.297		
EX011	5742	35192.68	39.15	106.812	3055.635		
EX012	3656.65	21615.25	11.97	155.25	3440.7945		
EX013	16620.15	84532.03	53.37	138.322	4657.3065		
EX014	4332.4	26059.98	19.665	186.346	4802.4405		
EX015	3210.8	11259.7	4.59	74.336	3212.451		
EX016	5958.3	8514.918	22.86	34.316	2114.5905		
EX017	7487.05	29136.94	43.38	83.168	16414.1505		
EX018	3081.85	26944.49	25.425	200.79	6562.116		
EX019	21707.4	29013.65	48.33	68.632	2023.1145		
EX020	5799	7536.61	16.65	47.15	1084.446		
EX020-DUP	5761.1	7611.24	13.095	48.116	1107.711		
EX020-SPK	5247.15	9944.575	2446.65	2627.934	3346.5465		
BLANK-2	-191.75	97.8775	3.33	-0.184	-0.396		
BLANK-SPK-2	-195.45	3142.833	2800.17	2722.878	2612.8575		
NIST-2711	9052.4	1659.073	584.325	383.916	10154.7765		
EX021	26323.8	209802.4	30.915	191.82	3518.7075		
EX022	2285.95	44677.36	8.685	186.116	5897.5785		
EX023	11006.75	20289.63	47.43	37.398	828.1845		
EX024	4734.2	8017.413	213.66	32.154	3247.101		
EX025	18080.55	158075.4	49.725	239.292	26959.9275		
EX026	7162	7579.323	0.765	37.352	1133.352		
EX027	10059.65	5749.103	5.67	15.594	468.5175		
EX028	7078.85	91695.07	68.355	211.462	7990.0425		
EX029	6046.1	38609.13	35.01	111.55	5807.8845		
bottle blank 1	-85.1	57.46	0.405	-0.414	2.772		
bottle blank 2	-114.15	36.805	-0.99	-0.276	-2.8215		

EX001 3050	23168681	2720728	12415	19163	656421	49.20242863	1.01621
EX002	21284324	1503417	11889	8897	294614	48.06305873	1.0403
EX003	26276727	4650748	25159	21488	833550	48.13894826	1.03866
EX004	24896344	1925228	11392	9027	229820	48.35730244	1.03397
EX005	66943133	########	480538	254652	14343548	48.31151263	1.03495
EX006	19321885	2526698	10616	15313	781051	48.14636495	1.0385
EX007	43380078	5840649	79306	14570	1106751	48.29051574	1.0354
EX008	18563809	2222234	10180	15002	518229	49.04076268	1.01956
EX009	26658538	2213274	12215	11272	387282	48.35917325	1.03393
EX010	21827598	551170	30475	1922	66173	48.51872338	1.03053
EX010-DUP	22230077	538729	31931	1895	64252	48.36291532	1.03385
EX010-SPK	21818998	816626	303923	266186	319431	48.79953152	1.0246
BLANK-1	288.55	23.46	2.835	0.46	10.1475		
BLANK-SPK-1	45.75	5872.353	5678.775	5479.474	5138.496		
EX011	22264633	4291843	29250	11946	483777	47.79063877	1.04623
EX012	26485216	2910929	15532	17701	481210	47.78424458	1.04637
EX013	30783320	9499141	64145	17913	676370	49.99650024	1.00007
EX014	27659041	3378707	19793	20835	629459	49.55548728	1.00897
EX015	23409716	1657337	11745	8097	425235	48.61165124	1.02856
EX016	35554931	1302494	12033	4314	285697	49.57268347	1.00862
EX017	25897341	3727281	18064	10131	2244841	48.19462919	1.03746
EX018	21714527	3231408	16774	21291	805840	47.66625991	1.04896
EX019	22092782	3503421	32230	8408	289662	49.13763451	1.01755
EX020	19364394	1049385	8374	5371	150680	48.71252789	1.02643
EX020-DUP	19891434	1044296	8518	5349	151736	48.41395871	1.03276
EX020-SPK	19080468	1320970	283793	278289	408422	49.6056352	1.00795
BLANK-2	136.45	-30.94	2.07	0.322	0.5445		
BLANK-SPK-2	-102.75	6060.798	5712.435	5565.218	5256.8505		
NIST-2711	24558513	370151	104980	41927	1117216	49.10626596	1.0182
EX021	37519354	22028798	22375	26664	505594	48.62819852	1.02821
EX022	20085573	5412015	16485	21234	801853	49.91016171	1.0018
EX023	22019357	3031574	29560	4622	129335	49.16034137	1.01708
EX024	40363004	2264564	174919	4391	605978	49.15454188	1.0172
EX025	56955236	17986173	41701	32370	3831491	49.23731401	1.01549
EX026	22172625	1060632	8078	3996	152423	48.93756545	1.02171
EX027	23125981	1014829	18324	2179	83967	48.3315934	1.03452
EX028	28141214	9850115	34549	23417	1019936	48.06952776	1.04016
EX029	21679835	4438468	15652	12168	802075	48.65327728	1.02768

EX001	EXPONEN 3050B		
EX002			
EX003		1.01621	EX001
EX004		1.0403	EX002
EX005		1.03866	EX003
EX006		1.03397	EX004
EX007		1.03495	EX005
EX008		1.0385	EX006
EX009		1.0354	EX007
		1.01956	EX008
		1.03393	EX009
EX010		1.03053	EX010
EX010-DUP		1.03385	EX010-DUP
EX010-SPK		1.0246	EX010-SPK
			BLANK-1
			BLANK-SPK-1
EX011		1.04623	EX011
EX012		1.04637	EX012
EX013		1.00007	EX013
EX014		1.00897	EX014
EX015		1.02856	EX015
		1.00862	EX016
		1.03746	EX017
EX016		1.04896	EX018
EX017		1.01755	EX019
EX018		1.02643	EX020
EX019		1.03276	EX020-DUP
EX020		1.00795	EX020-SPK
EX020-DUP			BLANK-2
EX020-SPK			BLANK-SPK-2
		1.0182	NIST-2711
		1.02821	EX021
NIST-2711		1.0018	EX022
		1.01708	EX023
		1.0172	EX024
EX021		1.01549	EX025
EX022		1.02171	EX026
EX023		1.03452	EX027
EX024		1.04016	EX028
EX025		1.02768	EX029
EX026			
EX027			
EX028			
EX029			

Put curser here to see notes.	Fe ug/L (ug/kg)	Zn ug/L (ug/kg)	As ug/L (ug	Cd ug/L (u	Pb ug/L (ug/kg)	dil factor
Standard 1	5000.00	50.00	50.00	50.00	50.00	
Standard 2	9828.70	94.30	97.10	97.80	98.71	
Standard 3	49999.65	498.94	500.70	500.28	500.13	
200 ppb	272.02	204.43	198.28	198.81	202.95	
10 ppb	16.92	6.85	10.34	10.55	11.09	
10 ppb	15.83	7.48	10.40	10.56	10.98	
Standard Check 150 ppb	163.113	137.17215	143.0532	147.4236	150.25923	
Blank	7.27	-4.10	-0.06	0.02	0.00	1
Interference Check	52727.35	357.73	190.92	97.48	66.81	1
blank	0.00	0.00	0.00	0.00	0.00	1
EX001 all 50x bio	6522.65	21010.09	26.01	182.25	4985.39	50
EX002	3678.55	10903.25	17.37	81.74	2304.47	50
EX003	6137.25	32897.59	35.01	174.75	5712.30	50
EXOO4	7359.20	12734.32	16.74	79.03	1558.71	50
EX005	25610.50	1150841.73	932.94	2214.53	97033.32	50
EX006	4403.00	17309.49	18.36	131.93	5558.26	50
EX007	12343.20	45259.14	57.38	107.09	6143.94	50
EX008	2621.25	18146.44	7.52	140.71	4105.13	50
EX009	4069.45	17223.30	10.49	102.21	2803.53	50
Standard Check 150 ppb	161.89	148.51	144.12	148.94	149.65	1
Blank	0.86	0.42	0.03	0.02	-0.01	1
EX010	8741.20	3413.01	20.52	15.73	380.85	50
EX010-DUP	8424.65	3368.25	16.79	14.44	354.96	50
EX010-SPK	8106.90	6070.70	2423.66	2685.85	2834.02	50
BLANK-1	177.20	69.40	-1.62	-0.05	-0.54	50
BLANK-SPK-1	86.95	3041.94	2807.55	2687.00	2574.30	50
EX011	5742.00	35192.68	39.15	106.81	3055.64	50
EX012	3656.65	21615.25	11.97	155.25	3440.79	50
EX013	16620.15	84532.03	53.37	138.32	4657.31	50
EX014	4332.40	26059.98	19.67	186.35	4802.44	50
EX015	3210.80	11259.70	4.59	74.34	3212.45	50
Standard Check 150 ppb	160.20	146.23	139.64	144.11	144.84	1
Blank	-1.11	2.67	0.11	0.01	-0.02	1
EX016	5958.30	8514.92	22.86	34.32	2114.59	50
EX017	7487.05	29136.94	43.38	83.17	16414.15	50
EX018	3081.85	26944.49	25.43	200.79	6562.12	50
EX019	21707.40	29013.65	48.33	68.63	2023.11	50
EX020	5799.00	7536.61	16.65	47.15	1084.45	50
EX020-DUP	5761.10	7611.24	13.10	48.12	1107.71	50
EX020-SPK	5247.15	9944.58	2446.65	2627.93	3346.55	50
BLANK-2	-191.75	97.88	3.33	-0.18	-0.40	50
BLANK-SPK-2	-195.45	3142.83	2800.17	2722.88	2612.86	50
NIST-2711	9052.40	1659.07	584.33	383.92	10154.78	50
Standard Check 150 ppb	163.02	143.37	139.77	148.91	150.05	1
Blank	0.17	1.37	-0.02	0.01	-0.01	1
EX021	26323.80	209802.36	30.92	191.82	3518.71	50
EX022	2285.95	44677.36	8.69	186.12	5897.58	50
EX023	11006.75	20289.63	47.43	37.40	828.18	50
EX024	4734.20	8017.41	213.66	32.15	3247.10	50
EX025	18080.55	158075.35	49.73	239.29	26959.93	50
EX026	7162.00	7579.32	0.77	37.35	1133.35	50
EX027	10059.65	5749.10	5.67	15.59	468.52	50
EX028	7078.85	91695.07	68.36	211.46	7990.04	50
EX029	6046.10	38609.13	35.01	111.55	5807.88	50
bottle blank 1	-85.10	57.46	0.41	-0.41	2.77	50
Standard Check 150 ppb	155.45	143.27	136.33	144.51	147.09	1
Blank	-0.79	0.98	0.05	0.02	0.01	1
bottle blank 2	-114.15	36.81	-0.99	-0.28	-2.82	50

EX001 3050	470884.90	55296.62	252.32	389.48	13341.24	50
EX002	442841.65	31280.09	247.37	185.10	6129.73	50
EX003	545851.70	96610.92	522.63	446.38	17315.50	50
EX004	514841.45	39812.56	235.58	186.67	4752.54	50
EX005	1385655.90	2503614.35	9946.67	5271.05	296897.10	50
EX006	401315.55	52479.51	220.50	318.04	16222.44	50
EX007	898314.65	120948.16	1642.28	301.71	22918.60	50
EX008	378538.35	45314.01	207.59	305.90	10567.31	50
EX009	551261.25	45767.40	252.59	233.08	8008.46	50
Standard Check 150 ppb	170.29	143.05	141.03	144.03	147.58	1
Blank	0.75	0.38	-0.11	0.00	0.00	1
EX010	449879.90	11359.95	628.11	39.61	1363.87	50
EX010-DUP	459651.30	11139.29	660.24	39.19	1328.53	50
EX010-SPK	447114.90	16734.29	6228.00	5454.68	6545.78	50
BLANK-1	288.55	23.46	2.84	0.46	10.15	50
BLANK-SPK-1	45.75	5872.35	5678.78	5479.47	5138.50	50
EX011	465878.55	89805.09	612.05	249.96	10122.85	50
EX012	554266.70	60918.18	325.04	370.44	10070.48	50
EX013	615709.50	189996.12	1283.00	358.29	13528.35	50
EX014	558142.85	68180.29	399.42	420.44	12702.10	50
EX015	481565.95	34093.42	241.61	166.57	8747.59	50
Standard Check 150 ppb	171.05	142.70	143.66	145.99	147.08	1
Blank	6.25	0.17	0.02	0.01	0.00	1
EX016	717228.30	26274.44	242.73	87.03	5763.19	50
EX017	537349.10	77338.10	374.81	210.22	46578.66	50
EX018	455553.40	67792.35	351.90	446.66	16905.88	50
EX019	449610.20	71298.13	655.92	171.12	5894.91	50
EX020	397523.90	21542.40	171.90	110.26	3093.26	50
EX020-DUP	410861.55	21570.15	175.95	110.49	3134.14	50
EX020-SPK	384643.15	26629.44	5720.99	5610.02	8233.38	50
BLANK-2	136.45	-30.94	2.07	0.32	0.54	50
BLANK-SPK-2	-102.75	6060.80	5712.44	5565.22	5256.85	50
NIST-2711	500109.55	7537.76	2137.82	853.81	22750.99	50
Standard Check 150 ppb	170.74	145.41	144.01	144.61	144.14	1
Blank	-1.34	-0.71	0.08	0.00	0.00	1
EX021	771555.50	453004.61	460.13	548.32	10397.13	50
EX022	402434.55	108435.14	330.30	425.45	16065.92	50
EX023	447908.95	61667.08	601.29	94.02	2630.88	50
EX024	821144.95	46070.30	3558.56	89.33	12328.02	50
EX025	1156749.45	365295.58	846.95	657.43	77816.82	50
EX026	453079.85	21673.17	165.06	81.65	3114.64	50
EX027	478485.80	20997.21	379.13	45.08	1737.30	50
EX028	585427.30	204913.92	718.74	487.14	21217.93	50
EX029	445598.65	91226.51	321.71	250.10	16485.53	50
1000	42103.95	55310.90	55876.77	54224.48	48651.97	50
Standard Check 150 ppb	161.79	134.25	136.57	137.47	136.51	1
Blank	6.92	-1.06	0.23	0.01	0.02	1
2000	2186.88	2206.69	2219.69	2076.81	1928.07	1
5000	5278.60	5370.65	5497.06	5256.97	5123.27	1
10000	10012.64	10294.30	10842.32	10310.24	9973.68	1
blank	0.72	-0.48	3.55	0.43	0.86	1
Standard Check 150 ppb	154.23	140.70	146.06	144.84	141.19	1
Blank	-3.84	-1.05	0.64	0.09	0.16	1
Interference Check	51988.86	366.53	196.31	97.04	65.45	1

Put curser here to see not	Fe ug/L (ug/kg)	Zn ug/L (ug/l	As ug/L (ug/l	Cd ug/L (ug/l	Pb ug/L (ug/kg)	Fe ug/L (ug
Standard 1	5000.00	50.00	50.00	50.00	50.00	
Standard 2	9828.70	94.30	97.10	97.80	98.71	
Standard 3	49999.65	498.94	500.70	500.28	500.13	
200 ppb	272.02	204.43	198.28	198.81	202.95	
10 ppb	16.92	6.85	10.34	10.55	11.09	
10 ppb	15.83	7.48	10.40	10.56	10.98	
Standard Check 150 ppb	163.11	137.17	143.05	147.42	150.26	
Blank	7.27	-4.10	-0.06	0.02	0.00	
Interference Check	52727.35	357.73	190.92	97.48	66.81	
blank	0.00	0.00	0.00	0.00	0.00	
EX001 all 50x bio	130.45	420.20	0.52	3.65	99.71	
EX002	73.57	218.06	0.35	1.63	46.09	
EX003	122.75	657.95	0.70	3.50	114.25	
EXOO4	147.18	254.69	0.33	1.58	31.17	
EX005	512.21	23016.83	18.66	44.29	1940.67	
EX006	88.06	346.19	0.37	2.64	111.17	
EX007	246.86	905.18	1.15	2.14	122.88	
EX008	52.43	362.93	0.15	2.81	82.10	
EX009	81.39	344.47	0.21	2.04	56.07	
Standard Check 150 ppb	161.89	148.51	144.12	148.94	149.65	
Blank	0.86	0.42	0.03	0.02	-0.01	
EX010	174.82	68.26	0.41	0.31	7.62	
EX010-DUP	168.49	67.37	0.34	0.29	7.10	
EX010-SPK	162.14	121.41	48.47	53.72	56.68	
BLANK-1	3.54	1.39	-0.03	0.00	-0.01	
BLANK-SPK-1	1.74	60.84	56.15	53.74	51.49	
EX011	114.84	703.85	0.78	2.14	61.11	
EX012	73.13	432.30	0.24	3.11	68.82	
EX013	332.40	1690.64	1.07	2.77	93.15	
EX014	86.65	521.20	0.39	3.73	96.05	
EX015	64.22	225.19	0.09	1.49	64.25	
Standard Check 150 ppb	160.20	146.23	139.64	144.11	144.84	
Blank	-1.11	2.67	0.11	0.01	-0.02	
EX016	119.17	170.30	0.46	0.69	42.29	
EX017	149.74	582.74	0.87	1.66	328.28	
EX018	61.64	538.89	0.51	4.02	131.24	
EX019	434.15	580.27	0.97	1.37	40.46	
EX020	115.98	150.73	0.33	0.94	21.69	
EX020-DUP	115.22	152.22	0.26	0.96	22.15	
EX020-SPK	104.94	198.89	48.93	52.56	66.93	
BLANK-2	-3.84	1.96	0.07	0.00	-0.01	
BLANK-SPK-2	-3.91	62.86	56.00	54.46	52.26	
NIST-2711	181.05	33.18	11.69	7.68	203.10	
Standard Check 150 ppb	163.02	143.37	139.77	148.91	150.05	
Blank	0.17	1.37	-0.02	0.01	-0.01	
EX021	526.48	4196.05	0.62	3.84	70.37	
EX022	45.72	893.55	0.17	3.72	117.95	
EX023	220.14	405.79	0.95	0.75	16.56	
EX024	94.68	160.35	4.27	0.64	64.94	
EX025	361.61	3161.51	0.99	4.79	539.20	
EX026	143.24	151.59	0.02	0.75	22.67	
EX027	201.19	114.98	0.11	0.31	9.37	
EX028	141.58	1833.90	1.37	4.23	159.80	
EX029	120.92	772.18	0.70	2.23	116.16	
bottle blank 1	-1.70	1.15	0.01	-0.01	0.06	
Standard Check 150 ppb	155.45	143.27	136.33	144.51	147.09	
Blank	-0.79	0.98	0.05	0.02	0.01	
bottle blank 2	-2.28	0.74	-0.02	-0.01	-0.06	

	Zn ug/L (uç	As ug/L (uç	Cd ug/L (uı	Pb ug/L (ug/kg)
EX001 3050	9417.70	1105.93	5.05	7.79	266.82
EX002	8856.83	625.60	4.95	3.70	122.59
EX003	10917.03	1932.22	10.45	8.93	346.31
EX004	10296.83	796.25	4.71	3.73	95.05
EX005	27713.12	50072.29	198.93	105.42	5937.94
EX006	8026.31	1049.59	4.41	6.36	324.45
EX007	17966.29	2418.96	32.85	6.03	458.37
EX008	7570.77	906.28	4.15	6.12	211.35
EX009	11025.23	915.35	5.05	4.66	160.17
Standard Check 150 ppb	170.29	143.05	141.03	144.03	147.58
Blank	0.75	0.38	-0.11	0.00	0.00
EX010	8997.60	227.20	12.56	0.79	27.28
EX010-DUP	9193.03	222.79	13.20	0.78	26.57
EX010-SPK	8942.30	334.69	124.56	109.09	130.92
BLANK-1	5.77	0.47	0.06	0.01	0.20
BLANK-SPK-1	0.91	117.45	113.58	109.59	102.77
EX011	9317.57	1796.10	12.24	5.00	202.46
EX012	11085.33	1218.36	6.50	7.41	201.41
EX013	12314.19	3799.92	25.66	7.17	270.57
EX014	11162.86	1363.61	7.99	8.41	254.04
EX015	9631.32	681.87	4.83	3.33	174.95
Standard Check 150 ppb	171.05	142.70	143.66	145.99	147.08
Blank	6.25	0.17	0.02	0.01	0.00
EX016	14344.57	525.49	4.85	1.74	115.26
EX017	10746.98	1546.76	7.50	4.20	931.57
EX018	9111.07	1355.85	7.04	8.93	338.12
EX019	8992.20	1425.96	13.12	3.42	117.90
EX020	7950.48	430.85	3.44	2.21	61.87
EX020-DUP	8217.23	431.40	3.52	2.21	62.68
EX020-SPK	7692.86	532.59	114.42	112.20	164.67
BLANK-2	2.73	-0.62	0.04	0.01	0.01
BLANK-SPK-2	-2.06	121.22	114.25	111.30	105.14
NIST-2711	10002.19	150.76	42.76	17.08	455.02
Standard Check 150 ppb	170.74	145.41	144.01	144.61	144.14
Blank	-1.34	-0.71	0.08	0.00	0.00
EX021	15431.11	9060.09	9.20	10.97	207.94
EX022	8048.69	2168.70	6.61	8.51	321.32
EX023	8958.18	1233.34	12.03	1.88	52.62
EX024	16422.90	921.41	71.17	1.79	246.56
EX025	23134.99	7305.91	16.94	13.15	1556.34
EX026	9061.60	433.46	3.30	1.63	62.29
EX027	9569.72	419.94	7.58	0.90	34.75
EX028	11708.55	4098.28	14.37	9.74	424.36
EX029	8911.97	1824.53	6.43	5.00	329.71
1000	842.08	1106.22	1117.54	1084.49	973.04
Standard Check 150 ppb	161.79	134.25	136.57	137.47	136.51
Blank	6.92	-1.06	0.23	0.01	0.02
2000	2186.88	2206.69	2219.69	2076.81	1928.07
5000	5278.60	5370.65	5497.06	5256.97	5123.27
10000	10012.64	10294.30	10842.32	10310.24	9973.68
blank	0.72	-0.48	3.55	0.43	0.86
Standard Check 150 ppb	154.23	140.70	146.06	144.84	141.19
Blank	-3.84	-1.05	0.64	0.09	0.16
Interference Check	51988.86	366.53	196.31	97.04	65.45
Machine Detection Limit	10.487	2.698	0.212	0.019	0.038
Interference Check true va	50000	410	210	105	60

Put curser here to see notes.	Fe ug/L (ug/k	Zn ug/L (uç	As ug/L (uç	Cd ug/L (uç	Pb ug/L (ug/kg)		
Standard 1	5000	50	50	50	50		
Standard 2	9828.7	94.3	97.1	97.8	98.7		
Standard 3	49999.7	498.9	500.7	500.3	500.1		
200 ppb	272.0	204.4	198.3	198.8	202.9		
10 ppb	16.9	6.854	10.3	10.6	11.1		
10 ppb	15.827	7.48	10.40	10.56	10.98		
Standard Check 150 ppb	163.11	137.17	143.05	147.42	150.26		
Blank	7.27	-4.10	-0.06	0.02	0.00		
Interference Check	52727.35	357.73	190.92	97.48	66.81		
blank	0.00	0.00	0.00	0.00	0.00		
EX001 all 50x bio	130.45	420.20	0.52	3.65	99.71		
EX002	73.57	218.06	0.35	1.63	46.09		
EX003	122.75	657.95	0.70	3.50	114.25		
EXOO4	147.18	254.69	0.33	1.58	31.17		
EX005	512.21	23016.83	18.66	44.29	2484.48		
EX006	88.06	346.19	0.37	2.64	111.17		
EX007	246.86	905.18	1.15	2.14	122.88		
EX008	52.43	362.93	0.15	2.81	82.10		
EX009	81.39	344.47	0.21	2.04	56.07		
Standard Check 150 ppb	161.89	148.51	144.12	148.94	149.65		
Blank	0.86	0.42	0.03	0.02	-0.01		
EX010	174.82	68.26	0.41	0.31	7.62		
EX010-DUP	168.49	67.37	0.34	0.29	7.10		
EX010-SPK	162.14	121.41	48.47	53.72	56.68		
BLANK-1	3.54	1.39	-0.03	0.00	-0.01		
BLANK-SPK-1	1.74	60.84	56.15	53.74	51.49		
EX011	114.84	703.85	0.78	2.14	61.11		
EX012	73.13	432.30	0.24	3.11	68.82		
EX013	332.40	1690.64	1.07	2.77	93.15		
EX014	86.65	521.20	0.39	3.73	96.05		
EX015	64.22	225.19	0.09	1.49	64.25		
Standard Check 150 ppb	160.20	146.23	139.64	144.11	144.84		
Blank	-1.11	2.67	0.11	0.01	-0.02		
EX016	119.17	170.30	0.46	0.69	42.29		
EX017	149.74	582.74	0.87	1.66	328.28		
EX018	61.64	538.89	0.51	4.02	131.24		
EX019	434.15	580.27	0.97	1.37	40.46		
EX020	115.98	150.73	0.33	0.94	21.69		
EX020-DUP	115.22	152.22	0.26	0.96	22.15		
EX020-SPK	104.94	198.89	48.93	52.56	66.93		46.7
BLANK-2	-3.84	1.96	0.07	0.00	-0.01		
BLANK-SPK-2	-3.91	62.86	56.00	54.46	52.26		60.9
NIST-2711	181.05	33.18	11.69	7.68	203.10		
Standard Check 150 ppb	163.02	143.37	139.77	148.91	150.05		
Blank	0.17	1.37	-0.02	0.01	-0.01		
EX021	526.48	4196.05	0.62	3.84	70.37		
EX022	45.72	893.55	0.17	3.72	117.95		
EX023	220.14	405.79	0.95	0.75	16.56		
EX024	94.68	160.35	4.27	0.64	64.94		
EX025	361.61	3161.51	0.99	4.79	539.20		
EX026	143.24	151.59	0.02	0.75	22.67		
EX027	201.19	114.98	0.11	0.31	9.37		
EX028	141.58	1833.90	1.37	4.23	159.80		
EX029	120.92	772.18	0.70	2.23	116.16		
bottle blank 1	-1.70	1.15	0.01	-0.01	0.06		
Standard Check 150 ppb	155.45	143.27	136.33	144.51	147.09		
Blank	-0.79	0.98	0.05	0.02	0.01		
bottle blank 2	-2.28	0.74	-0.02	-0.01	-0.06	1	

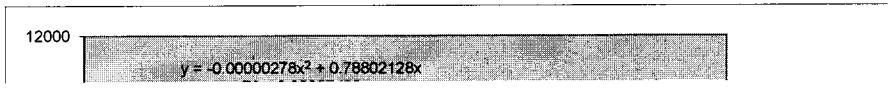
EX001 3050	9417.70	1105.93	5.05	7.79	266.82	2	
EX002	8856.83	625.6	4.9	3.7	122.6	3	
EX003	10917.03	1932.2	10.5	8.9	346.3	4	
EX004	10296.83	796.3	4.7	3.7	95.1	5	
EX005	27713.12	50072.3	198.9	105.4	7747.0	6	
EX006	8026.31	1049.6	4.4	6.4	324.4	7	
EX007	17966.29	2419.0	32.8	6.0	458.4	8	
EX008	7570.77	906.3	4.2	6.1	211.3	9	
EX009	11025.23	915.3	5.1	4.7	160.2	10	
Standard Check 150 ppb	170.29	143.1	141.0	144.0	147.6	11	
Blank	0.75	0.4	-0.1	0.0	0.0	12	-1
EX010	8997.60	227.2	12.6	0.8	27.3	12	
EX010-DUP	9193.03	222.8	13.2	0.8	26.6	12	10.487
EX010-SPK	8942.30	334.7	124.6	109.1	130.9	12	
BLANK-1	5.77	0.5	0.1	0.0	0.2	12	
BLANK-SPK-1	0.91	117.4	113.6	109.6	102.8	12	
EX011	9317.57	1796.1	12.2	5.0	202.5	12	
EX012	11085.33	1218.4	6.5	7.4	201.4	12	
EX013	12314.19	3799.9	25.7	7.2	270.6	12	
EX014	11162.86	1363.6	8.0	8.4	254.0	12	
EX015	9631.32	681.9	4.8	3.3	175.0	12	
Standard Check 150 ppb	171.05	142.7	143.7	146.0	147.1	12	
Blank	6.25	0.2	0.0	0.0	0.0	12	
EX016	14344.57	525.5	4.9	1.7	115.3	12	
EX017	10746.98	1546.8	7.5	4.2	931.6	12	
EX018	9111.07	1355.8	7.0	8.9	338.1	12	
EX019	8992.20	1426.0	13.1	3.4	117.9	12	
EX020	7950.48	430.8	3.4	2.2	61.9	12	
EX020-DUP	8217.23	431.4	3.5	2.2	62.7	12	
EX020-SPK	7692.86	532.6	114.4	112.2	164.7	12	101.2
BLANK-2	2.73	-0.6	0.0	0.0	0.0	12	
BLANK-SPK-2	-2.06	121.2	114.2	111.3	105.1	12	
NIST-2711	10002.19	150.8	42.8	17.1	455.0	12	
Standard Check 150 ppb	170.74	145.4	144.0	144.6	144.1	12	
Blank	-1.34	-0.7	0.1	0.0	0.0	12	
EX021	15431.11	9060.1	9.2	11.0	207.9	12	
EX022	8048.69	2168.7	6.6	8.5	321.3	12	
EX023	8958.18	1233.3	12.0	1.9	52.6	12	
EX024	16422.90	921.4	71.2	1.8	246.6	12	
EX025	23134.99	7305.9	16.9	13.1	1988.9	12	
EX026	9061.60	433.5	3.3	1.6	62.3	12	
EX027	9569.72	419.9	7.6	0.9	34.7	12	
EX028	11708.55	4098.3	14.4	9.7	424.4	12	
EX029	8911.97	1824.5	6.4	5.0	329.7	12	
1000	842.08	1106.2	1117.5	1084.5	973.0	12	
Standard Check 150 ppb	161.79	134.3	136.6	137.5	136.5	12	
Blank	6.92	-1.1	0.2	0.0	0.0	12	
2000	2186.88	2206.7	2219.7	2076.8	2468.2	12	
5000	5278.60	5370.7	5497.1	5257.0	6657.8	12	
10000	10012.64	10294.3	10842.3	10310.2	13278.6	12	
blank	0.72	-0.5	3.6	0.4	0.9	12	
Standard Check 150 ppb	154.23	140.7	146.1	144.8	141.2	12	
Blank	-3.84	-1.1	0.6	0.1	0.2	12	
Interference Check	51988.86	366.5	196.3	97.0	65.5	12	
Machine Detection Limit	10.487	2.698	0.212	0.019	0.038		
Interference Check true values	50000	410	210	105	60		

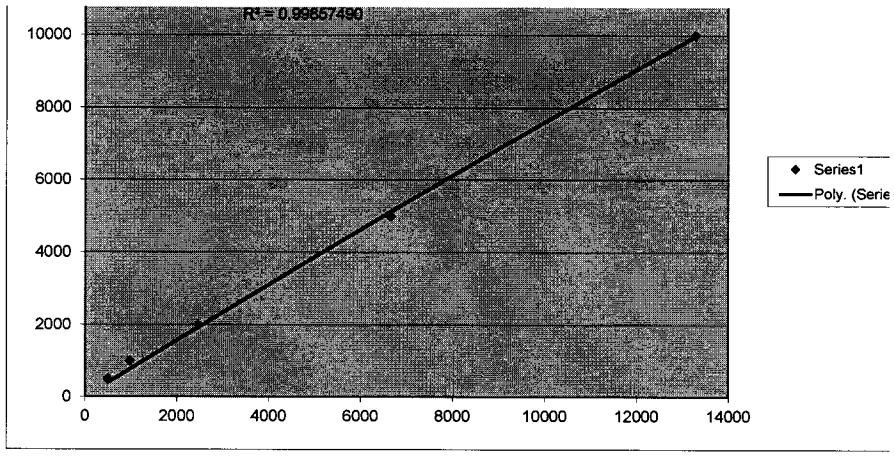
0.85	0.9	0.92	0.99

369

110.9	110.0	102.0

500	500
973.0393	1000
2468.215	2000
6657.81	5000
13278.65	10000





Put curser here to see notes.	Fe ug/L (uc	Zn ug/L (uc	As ug/L (ug/k	Cd ug/L (uc	Pb ug/L (ug/kg)		Fe ug/L (uc	Zn ug/L (ug
Standard 1	5000	50	50	50	50			
Standard 2	9828.698	94.296	97.104	97.802	98.711			
Standard 3	49999.65	498.941	500.701	500.279	500.127			
200 ppb	272.02	204.43	198.28	198.81	202.95			
10 ppb	16.92	6.85	10.34	10.55	11.09			
10 ppb	15.83	7.48	10.40	10.56	10.98			
Standard Check 150 ppb	163.11	161.38	158.95	160.24	151.78			
Blank	7.27	-4.82	-0.06	0.02	0.01			
Interference Check	52727.35	420.862	212.133	105.954	67.486			
blank	0	0	0	0	0			
EX001 all 50x bio	130.45	494.36	0.58	3.96	100.72	1		
EX002	73.57	256.55	0.39	1.78	46.56	2		
EX003	122.75	774.06	0.78	3.80	115.40	3		
EXOO4	147.18	299.63	0.37	1.72	31.49	4		
EX005	512.21	27078.63	20.73	48.14	2509.58	5		
EX006	88.06	407.28	0.41	2.87	112.29	6		
EX007	246.86	1064.92	1.28	2.33	124.12	7		
EX008	52.43	426.98	0.17	3.06	82.93	8		
EX009	81.39	405.25	0.23	2.22	56.64	9		
Standard Check 150 ppb	161.89	174.72	160.14	161.89	151.16	10		
Blank	0.86	0.49	0.03	0.02	-0.01	11	0.13	0.4
EX010	174.82	80.31	0.46	0.34	7.69	11		
EX010-DUP	168.49	79.25	0.37	0.31	7.17	11	25.114	3.174
EX010-SPK	162.14	142.84	53.86	58.39	57.25	11		
BLANK-1	3.54	1.63	-0.04	0.00	-0.01	11		
BLANK-SPK-1	1.74	71.58	62.39	58.41	52.01	11		
EX011	114.84	828.06	0.87	2.32	61.73	11		
EX012	73.13	508.59	0.27	3.38	69.51	11		
EX013	332.40	1988.99	1.19	3.01	94.09	11		
EX014	86.65	613.18	0.44	4.05	97.02	11		
EX015	64.22	264.93	0.10	1.62	64.90	11		
Standard Check 150 ppb	160.20	172.04	155.16	156.65	146.30	11		
Blank	-1.11	3.14	0.13	0.01	-0.02	11		
EX016	119.17	200.35	0.51	0.75	42.72	11		
EX017	149.74	685.58	0.96	1.81	331.60	11		
EX018	61.64	633.99	0.57	4.37	132.57	11		
EX019	434.15	682.67	1.07	1.49	40.87	11		
EX020	115.98	177.33	0.37	1.03	21.91	11		
EX020-DUP	115.22	179.09	0.29	1.05	22.38	11		
EX020-SPK	104.94	233.99	54.37	57.13	67.61	11		
BLANK-2	-3.84	2.30	0.07	0.00	-0.01	11		
BLANK-SPK-2	-3.91	73.95	62.23	59.19	52.79	11		
NIST-2711	181.05	39.04	12.99	8.35	205.15	11		
Standard Check 150 ppb	163.02	168.67	155.30	161.86	151.57	11		
Blank	0.17	1.62	-0.02	0.02	-0.02	11		
EX021	526.48	4936.53	0.69	4.17	71.09	11		
EX022	45.72	1051.23	0.19	4.05	119.14	11		
EX023	220.14	477.40	1.05	0.81	16.73	11		
EX024	94.68	188.65	4.75	0.70	65.60	11		
EX025	361.61	3719.42	1.11	5.20	544.65	11		
EX026	143.24	178.34	0.02	0.81	22.90	11		
EX027	201.19	135.27	0.13	0.34	9.47	11		
EX028	141.58	2157.53	1.52	4.60	161.42	11		
EX029	120.92	908.45	0.78	2.43	117.33	11		

bottle blank 1		-1.70	1.35	0.01	-0.01	0.06	11
Standard Check 150 ppb		155.45	168.55	151.48	157.08	148.57	11
Blank		-0.79	1.15	0.05	0.02	0.01	11
bottle blank 2		-1.28	0.87	-0.02	-0.01	-0.06	11
EX001 3050		9419.70	1301.10	5.61	8.47	269.52	11
EX002		8859.83	736.00	5.50	4.02	123.83	11
EX003		10921.03	2273.20	11.61	9.70	349.81	11
EX004		10301.83	936.77	5.24	4.06	96.01	11
EX005		27719.12	58908.57	221.04	114.59	7825.23	11
EX006		8033.31	1234.81	4.90	6.91	327.73	11
EX007		17974.29	2845.84	36.50	6.56	463.00	11
EX008		7579.77	1066.21	4.61	6.65	213.48	11
EX009		11035.23	1076.88	5.61	5.07	161.79	11
Standard Check 150 ppb		181.29	168.30	156.70	156.56	149.07	11
Blank		12.75	0.45	-0.12	0.01	0.00	11
EX010		9009.60	267.29	13.96	0.86	27.55	11
EX010-DUP		9205.03	262.10	14.67	0.85	26.84	11
EX010-SPK		8954.30	393.75	138.40	118.58	132.24	11
BLANK-1		17.77	0.55	0.06	0.01	0.21	11
BLANK-SPK-1		12.92	138.17	126.20	119.12	103.81	11
EX011		9329.57	2113.06	13.60	5.43	204.50	11
EX012		11097.33	1433.37	7.22	8.05	203.44	11
EX013		12326.19	4470.50	28.51	7.79	273.30	11
EX014		11174.86	1604.24	8.88	9.14	256.61	11
EX015		9643.32	802.20	5.37	3.62	176.72	11
Standard Check 150 ppb		183.05	167.88	159.62	158.68	148.56	11
Blank		18.25	0.20	0.02	0.01	0.00	11
EX016		14356.57	618.22	5.39	1.89	116.43	11
EX017		10758.98	1819.72	8.33	4.57	940.98	11
EX018		9123.07	1595.11	7.82	9.71	341.53	11
EX019		9004.20	1677.60	14.58	3.72	119.09	11
EX020		7962.48	506.88	3.82	2.40	62.49	11
EX020-DUP		8229.23	507.53	3.91	2.40	63.32	11
EX020-SPK		7704.86	626.58	127.13	121.96	166.33	11
BLANK-2		14.73	-0.73	0.05	0.01	0.01	11
BLANK-SPK-2		9.95	142.61	126.94	120.98	106.20	11
NIST-2711		10014.19	177.36	47.51	18.56	459.62	11
Standard Check 150 ppb		182.74	171.07	160.01	157.19	145.60	11
Blank		10.66	-0.84	0.09	0.00	0.00	11
EX021		15443.11	10658.93	10.23	11.92	210.04	11
EX022		8060.69	2551.42	7.34	9.25	324.56	11
EX023		8970.18	1450.99	13.36	2.04	53.15	11
EX024		16434.90	1084.01	79.08	1.94	249.05	11
EX025		23146.99	8595.19	18.82	14.29	2009.04	11
EX026		9073.60	509.96	3.67	1.78	62.92	11
EX027		9581.72	494.05	8.43	0.98	35.10	11
EX028		11720.55	4821.50	15.97	10.59	428.65	11
EX029		8923.97	2146.51	7.15	5.44	333.04	11
	1000	854.08	1301.43	1241.71	1178.79	982.87	11
Standard Check 150 ppb		173.79	157.95	151.74	149.42	137.89	11
Blank		18.92	-1.24	0.25	0.01	0.02	11
	2000	2198.88	2596.11	2466.32	2257.40	2493.15	11
	5000	5290.60	6318.41	6107.85	5714.10	6725.06	11
	10000	10024.64	12110.94	12047.02	11206.79	13412.78	11
blank		12.72	-0.57	3.95	0.47	0.87	11

Standard Check 150 ppb	166.23	165.53	162.29	157.43	142.62	11
Blank	8.17	-1.24	0.71	0.10	0.16	11
Interference Check	52000.86	431.22	218.12	105.48	66.11	11
Machine Detection Limit	25.114	3.174	0.236	0.020	0.038	
Interference Check true values	50000	410	210	105	60	

As ug/L (ug	Cd ug/L (ug	Pb ug/L (ug/kg)	
			1
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			10
-0.006	0	-0.002	11
			12
0.236	0.020	0.038	13
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Put curser here to see notes.	Fe ug/L (uc	Zn ug/L (uc	As ug/L (uc	Cd ug/L (uc	Pb ug/L (ug/kg)
Standard 1	5000	50	50	50	50
Standard 2	9828.698	94.296	97.104	97.802	98.711
Standard 3	49999.65	498.941	500.701	500.279	500.127
200 ppb	272.015	204.426	198.283	198.805	202.949
10 ppb	16.915	6.9	10.336	10.55	11.089
10 ppb	15.827	7.5	10.404	10.564	10.979
Standard Check 150 ppb	163.113	161.4	158.948	160.243	151.777
Blank	7.272	-4.8	-0.063	0.023	0.005
Interference Check	52727.35	420.9	212.133	105.954	67.486
blank	0.0	0.0	0.0	0.0	0.0
EX001 all 50x bio	130.3	494.0	0.6	4.0	100.7
EX002	73.3	255.7	0.4	1.8	46.6
EX003	122.4	772.9	0.8	3.8	115.4
EXOO4	146.7	298.0	0.4	1.7	31.5
EX005	511.6	27076.6	20.8	48.1	2509.6
EX006	87.3	404.9	0.4	2.9	112.3
EX007	246.0	1062.1	1.3	2.3	124.1
EX008	51.4	423.8	0.2	3.1	82.9
EX009	80.2	401.7	0.3	2.2	56.7
Standard Check 150 ppb	160.6	170.7	160.2	161.9	151.2
Blank	-0.6	-3.9	0.1	0.0	0.0
EX010	173.4	75.5	0.5	0.3	7.7
EX010-DUP	167.1	74.1	0.4	0.3	7.2
EX010-SPK	160.7	137.2	53.9	58.4	57.3
BLANK-1	2.1	-4.4	0.0	0.0	0.0
BLANK-SPK-1	0.3	65.2	62.5	58.4	52.0
EX011	113.4	821.3	0.9	2.3	61.8
EX012	71.7	501.4	0.3	3.4	69.5
EX013	331.0	1981.4	1.3	3.0	94.1
EX014	85.2	605.2	0.5	4.1	97.0
EX015	62.8	256.5	0.2	1.6	64.9
Standard Check 150 ppb	158.8	163.2	155.2	156.6	146.3
Blank	-2.5	-6.1	0.2	0.0	0.0
EX016	117.7	191.2	0.6	0.7	42.7
EX017	148.3	676.4	1.0	1.8	331.6
EX018	60.2	624.8	0.6	4.4	132.6
EX019	432.7	673.5	1.1	1.5	40.9
EX020	114.6	168.1	0.4	1.0	21.9
EX020-DUP	113.8	169.9	0.4	1.0	22.4
EX020-SPK	103.5	224.8	54.4	57.1	67.6
BLANK-2	-5.3	-6.9	0.1	0.0	0.0
BLANK-SPK-2	-5.3	64.7	62.3	59.2	52.8
NIST-2711	179.6	29.8	13.1	8.3	205.2
Standard Check 150 ppb	161.6	159.5	155.4	161.9	151.6
Blank	-1.3	-7.6	0.0	0.0	0.0
EX021	525.0	4927.3	0.8	4.2	71.1
EX022	44.3	1042.0	0.3	4.0	119.2
EX023	218.7	468.2	1.1	0.8	16.8
EX024	93.3	179.4	4.8	0.7	65.6
EX025	360.2	3710.2	1.2	5.2	544.7
EX026	141.8	169.1	0.1	0.8	22.9
EX027	199.8	126.1	0.2	0.3	9.5
EX028	140.1	2148.3	1.6	4.6	161.4
EX029	119.5	899.3	0.8	2.4	117.4
bottle blank 1	-3.1	-7.8	0.1	0.0	0.1
Standard Check 150 ppb	154.0	159.4	151.5	157.1	148.6
Blank	-2.2	-8.0	0.1	0.0	0.0
bottle blank 2	-2.7	-8.3	0.0	0.0	0.0

EX001 3050	9418.3	1291.9	5.7	8.5	269.5
EX002	8858.4	726.8	5.6	4.0	123.9
EX003	10919.6	2264.0	11.7	9.7	349.8
EX004	10300.4	927.6	5.3	4.1	96.0
EX005	27717.7	58899.4	221.1	114.6	7825.3
EX006	8031.9	1225.6	5.0	6.9	327.7
EX007	17972.9	2836.6	36.6	6.6	463.0
EX008	7578.3	1057.0	4.7	6.7	213.5
EX009	11033.8	1067.7	5.7	5.1	161.8
Standard Check 150 ppb	179.9	159.1	156.8	156.6	149.1
Blank	11.3	-8.8	-0.1	0.0	0.0
EX010	9008.2	258.1	14.0	0.9	27.6
EX010-DUP	9203.6	252.9	14.7	0.9	26.9
EX010-SPK	8952.9	384.5	138.5	118.6	132.3
BLANK-1	16.3	-8.6	0.1	0.0	0.2
BLANK-SPK-1	11.5	129.0	126.3	119.1	103.8
EX011	9328.1	2103.9	13.7	5.4	204.5
EX012	11095.9	1424.2	7.3	8.1	203.5
EX013	12324.8	4461.3	28.6	7.8	273.3
EX014	11173.4	1595.0	8.9	9.1	256.6
EX015	9641.9	793.0	5.4	3.6	176.7
Standard Check 150 ppb	181.6	158.7	159.7	158.7	148.6
Blank	16.8	-9.0	0.1	0.0	0.0
EX016	14355.1	609.0	5.5	1.9	116.5
EX017	10757.6	1810.5	8.4	4.6	941.0
EX018	9121.6	1585.9	7.9	9.7	341.6
EX019	9002.8	1668.4	14.6	3.7	119.1
EX020	7961.0	497.7	3.9	2.4	62.5
EX020-DUP	8227.8	498.3	4.0	2.4	63.3
EX020-SPK	7703.4	617.4	127.2	122.0	166.4
BLANK-2	13.3	-9.9	0.1	0.0	0.0
BLANK-SPK-2	8.5	133.4	127.0	121.0	106.2
NIST-2711	10012.8	168.2	47.6	18.6	459.6
Standard Check 150 ppb	181.3	161.9	160.1	157.2	145.6
Blank	9.2	-10.0	0.2	0.0	0.0
EX021	15441.7	10649.7	10.3	11.9	210.1
EX022	8059.3	2542.2	7.4	9.2	324.6
EX023	8968.7	1441.8	13.4	2.0	53.2
EX024	16433.5	1074.8	79.1	1.9	249.1
EX025	23145.6	8586.0	18.9	14.3	2009.1
EX026	9072.2	500.8	3.7	1.8	62.9
EX027	9580.3	484.9	8.5	1.0	35.1
EX028	11719.1	4812.3	16.0	10.6	428.7
EX029	8922.5	2137.3	7.2	5.4	333.1
1000	852.6	1292.2	1241.8	1178.8	982.9
Standard Check 150 ppb	172.4	148.7	151.8	149.4	137.9
Blank	17.5	-10.4	0.3	0.0	0.0
2000	2197.4	2586.9	2466.4	2257.4	2493.2
5000	5289.2	6309.2	6107.9	5714.1	6725.1
10000	10023.2	12101.7	12047.1	11206.8	13412.8
blank	11.3	-9.8	4.0	0.5	0.9
Standard Check 150 ppb	164.8	156.3	162.4	157.4	142.6
Blank	6.7	-10.4	0.8	0.1	0.2
Interference Check	51999.4	422.0	218.2	105.5	66.1

Put curser here to see notes.	Fe ug/L (ug/k	Zn ug/L (ug/k	As ug/L (ug	Cd ug/L (uc	Pb ug/L (ug/kg)
Standard 1	5000	50	50	50	50
Standard 2	9828.698	94.296	97.104	97.802	98.711
Standard 3	49999.652	498.941	500.701	500.279	500.127
200 ppb	272.015	204.426	198.283	198.805	202.949
10 ppb	16.915	16.658	10.336	10.55	11.089
10 ppb	15.827	17.283	10.404	10.564	10.979
Standard Check 150 ppb	163.113	171.183	158.948	160.243	151.777
Blank	7.272	4.984	-0.063	0.023	0.005
Interference Check	52727.352	430.666	212.133	105.954	67.486
blank	7.776	9.804	-0.167	0.008	-0.002
EX001 all 50x bio	138.099	503.759	0.417	3.97	100.715
EX002	81.087	265.551	0.231	1.785	46.557
EX003	130.131	782.665	0.629	3.807	115.404
EXOO4	154.44	307.835	0.229	1.726	31.495
EX005	519.336	27086.433	20.595	48.15	2509.588
EX006	95.056	414.686	0.277	2.876	112.298
EX007	253.73	1071.925	1.15	2.336	124.132
EX008	59.161	433.579	0.048	3.067	82.946
EX009	87.995	411.458	0.12	2.23	56.653
Standard Check 150 ppb	168.361	180.522	160.03	161.896	151.181
Blank	7.202	5.897	-0.073	0.026	0.006
EX010	181.17	85.31	0.355	0.35	7.714
EX010-DUP	174.839	83.857	0.272	0.322	7.191
EX010-SPK	168.484	147.044	53.758	58.396	57.273
BLANK-1	9.89	5.437	-0.137	0.007	0.009
BLANK-SPK-1	8.085	74.979	62.289	58.421	52.026
EX011	121.186	831.067	0.769	2.33	61.75
EX012	79.479	511.198	0.165	3.383	69.531
EX013	338.749	1991.193	1.085	3.015	94.107
EX014	92.994	614.98	0.336	4.059	97.039
EX015	70.562	266.338	0.001	1.624	64.918
Standard Check 150 ppb	166.55	173.04	155.057	156.654	146.319
Blank	5.239	3.747	0.024	0.02	0.002
EX016	125.512	200.955	0.407	0.754	42.739
EX017	156.087	686.179	0.863	1.816	331.619
EX018	67.983	634.592	0.464	4.373	132.588
EX019	440.494	683.278	0.973	1.5	40.891
EX020	122.326	177.936	0.269	1.033	21.928
EX020-DUP	121.568	179.692	0.19	1.054	22.398
EX020-SPK	111.289	234.594	54.269	57.137	67.627
BLANK-2	2.511	2.907	-0.027	0.004	0.012
BLANK-SPK-2	2.437	74.553	62.125	59.201	52.805
NIST-2711	187.394	39.641	12.884	8.354	205.167
Standard Check 150 ppb	169.368	169.273	155.203	161.872	151.587
Blank	6.511	2.221	-0.118	0.023	0.005
EX021	532.822	4937.13	0.586	4.178	71.105
EX022	52.065	1051.836	0.092	4.054	119.163
EX023	226.481	478.007	0.953	0.821	16.751
EX024	101.03	189.249	4.647	0.707	65.618
EX025	367.957	3720.024	1.004	5.21	544.665
EX026	149.586	178.941	-0.084	0.82	22.916
EX027	207.539	135.877	0.025	0.347	9.485
EX028	147.923	2158.135	1.418	4.605	161.435
EX029	127.268	909.054	0.677	2.433	117.351
bottle blank 1	4.644	1.956	-0.092	-0.001	0.076
Standard Check 150 ppb	161.795	169.156	151.376	157.089	148.594
Blank	5.555	1.758	-0.048	0.025	0.028
bottle blank 2	5.063	1.47	-0.123	0.002	-0.037

EX001 3050	9426.044	1301.701	5.506	8.475	269.54
EX002	8866.179	736.606	5.396	4.032	123.853
EX003	10927.38	2273.802	11.513	9.712	349.828
EX004	10308.175	937.37	5.134	4.066	96.031
EX005	27725.464	58909.177	220.936	114.596	7825.253
EX006	8039.657	1235.416	4.799	6.922	327.746
EX007	17980.639	2846.443	36.394	6.567	463.022
EX008	7586.113	1066.816	4.512	6.658	213.501
EX009	11041.571	1077.484	5.512	5.075	161.807
Standard Check 150 ppb	187.64	168.899	156.595	156.566	149.094
Blank	19.095	1.053	-0.224	0.013	0.024
EX010	9015.944	267.897	13.857	0.869	27.573
EX010-DUP	9211.372	262.705	14.571	0.86	26.859
EX010-SPK	8960.644	394.352	138.299	118.588	132.258
BLANK-1	24.117	1.156	-0.038	0.018	0.225
BLANK-SPK-1	19.261	138.777	126.094	119.127	103.828
EX011	9335.917	2113.665	13.5	5.442	204.522
EX012	11103.68	1433.973	7.122	8.061	203.464
EX013	12332.536	4471.101	28.41	7.797	273.32
EX014	11181.203	1604.846	8.775	9.148	256.628
EX015	9649.665	802.802	5.268	3.629	176.739
Standard Check 150 ppb	189.396	168.482	159.521	158.692	148.581
Blank	24.591	0.805	-0.081	0.015	0.021
EX016	14362.912	618.826	5.293	1.9	116.448
EX017	10765.328	1820.324	8.228	4.578	941.003
EX018	9129.414	1595.718	7.719	9.718	341.553
EX019	9010.55	1678.207	14.475	3.728	119.109
EX020	7968.824	507.484	3.719	2.405	62.51
EX020-DUP	8235.577	508.137	3.809	2.41	63.336
EX020-SPK	7711.209	627.179	127.032	121.965	166.351
BLANK-2	21.075	-0.124	-0.055	0.015	0.031
BLANK-SPK-2	16.291	143.211	126.842	120.991	106.219
NIST-2711	10020.537	177.963	47.406	18.569	459.636
Standard Check 150 ppb	189.088	171.677	159.913	157.195	145.621
Blank	17.003	-0.234	-0.009	0.011	0.021
EX021	15449.456	10659.536	10.124	11.928	210.063
EX022	8067.037	2552.019	7.239	9.257	324.584
EX023	8976.525	1451.594	13.261	2.052	53.169
EX024	16441.245	1084.611	78.978	1.95	249.071
EX025	23153.335	8595.794	18.72	14.3	2009.059
EX026	9079.943	510.561	3.567	1.783	62.942
EX027	9588.062	494.656	8.324	0.988	35.117
EX028	11726.892	4822.108	15.871	10.598	428.665
EX029	8930.319	2147.11	7.048	5.445	333.061
1000	860.425	1302.037	1241.605	1178.801	982.888
Standard Check 150 ppb	180.133	158.551	151.643	149.428	137.907
Blank	25.265	-0.638	0.153	0.021	0.039
2000	2205.221	2596.711	2466.222	2257.41	2493.166
5000	5296.947	6319.016	6107.746	5714.108	6725.081
10000	10030.986	12111.544	12046.92	11206.79	13412.8
blank	19.069	0.035	3.844	0.48	0.89
Standard Check 150 ppb	172.579	166.135	162.19	157.438	142.638
Blank	14.511	-0.636	0.611	0.111	0.179
Interference Check	52007.209	431.819	218.017	105.485	66.133

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 09:34:46
Sample Description:
Solution Ty Blank
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.908
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	1523	2.758			
|	Zn1	64	4011	3.262			
|	Zn2	66	676	5.152			
|	Zn3	68	420	6.058			
|	Zn4	67	224	3.172			
|	Zn	64	5330	2.148			
|	As	75	111	18.132			
|	Y	89	24	29.167			
|	Cd	111	-25	24.611			
|	Cd	114	21	31.975			
|	cd1	114	67	12.804			
|>	In	115	132858	2.82			
|	Pb	207	36	26.732			
|	Pb	206	39	25.466			
|	Pb	208	98	5.681			
|	pb1	208	254	12.617			
|-	Bi	209	61	16.511			

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57					ug/L
|	Zn1	64					ug/L
|	Zn2	66					ug/L
|	Zn3	68					ug/L
|	Zn4	67					ug/L
|	Zn	64					ug/L
|	As	75					ug/L
|	Y	89					ug/L
|	Cd	111					ug/L
|	Cd	114					ug/L
|	cd1	114					ug/L
|>	In	115					ug/L
|	Pb	207					ug/L
|	Pb	206					ug/L
|	Pb	208					ug/L
|	pb1	208					ug/L
|-	Bi	209					ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard 1

Sample Da Wednesday, September 18, 2013 09:37:20
Sample Description:
Solution Ty Standard
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard 1.909
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	76665	6.76	1523.128	2.758	
|	Zn1	64	19086	6.622	4010.765	3.262	
|	Zn2	66	9747	9.983	676.025	5.152	
|	Zn3	68	6836	10.542	419.676	6.058	
|	Zn4	67	1600	11.673	223.669	3.172	
|	Zn	64	37270	8.285	5330.136	2.148	
|	As	75	10954	12.273	111.32	18.132	
|	Y	89	40	11.368	24	29.167	
|	Cd	111	11363	9.119	-25.199	24.611	
|	Cd	114	26475	12.887	20.711	31.975	
|	cd1	114	62776	10.64	67.333	12.804	
|>	In	115	130500	4.59	132858	2.82	
|	Pb	207	18682	6.293	36.333	26.732	
|	Pb	206	23429	6.876	39.333	25.466	
|	Pb	208	46601	4.707	98.001	5.681	
|	pb1	208	134259	5.072	254.001	12.617	
|-	Bi	209	103	15.072	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.576	5000	241.1	4.8	ug/L
|	Zn1	64	0.116	50	1.4	2.8	ug/L
|	Zn2	66	0.069	50	3.01	6	ug/L
|	Zn3	68	0.049	50	3.68	7.4	ug/L
|	Zn4	67	0.011	50	5.07	10.1	ug/L
|	Zn	64	0.245	50	2.39	4.8	ug/L
|	As	75	0.083	50	4.22	8.4	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.087	50	2.62	5.2	ug/L
|	Cd	114	0.202	50	4.86	9.7	ug/L
|	cd1	114	0.48	50	3.65	7.3	ug/L
|>	In	115	130500.5				ug/L
|	Pb	207	0.143	50	1.73	3.5	ug/L
|	Pb	206	0.179	50	1.87	3.7	ug/L
|	Pb	208	0.357	50	2.29	4.6	ug/L
|	pb1	208	1.027	50	1.61	3.2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard 2
Sample Da Wednesday, September 18, 2013 09:39:55
Sample Description:
Solution Ty Standard
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard 2.910
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	141653	13.158	1523.128	2.758	
|	Zn1	64	33023	5.823	4010.765	3.262	
|	Zn2	66	18805	7.285	676.025	5.152	
|	Zn3	68	13695	11.131	419.676	6.058	
|	Zn4	67	3101	12.274	223.669	3.172	
|	Zn	64	68624	7.434	5330.136	2.148	
|	As	75	21926	12.55	111.32	18.132	
|	Y	89	44	22.005	24	29.167	
|	Cd	111	22902	10.322	-25.199	24.611	
|	Cd	114	54398	11.171	20.711	31.975	
|	cd1	114	130260	12.966	67.333	12.804	
|>	In	115	144065	2.74	132858	2.82	
|	Pb	207	38583	4.803	36.333	26.732	
|	Pb	206	48811	8.078	39.333	25.466	
|	Pb	208	96709	11.897	98.001	5.681	
|	pb1	208	279311	12.193	254.001	12.617	
|-	Bi	209	185	7.963	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.97	9638.242	1017.09	10.6	ug/L
|	Zn1	64	0.199	96.783	3.57	3.7	ug/L
|	Zn2	66	0.125	97.872	4.65	4.8	ug/L
|	Zn3	68	0.092	98.594	8.64	8.8	ug/L
|	Zn4	67	0.02	98.676	10.23	10.4	ug/L
|	Zn	64	0.436	97.558	5.01	5.1	ug/L
|	As	75	0.151	98.081	9.7	9.9	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.159	98.107	7.98	8.1	ug/L
|	Cd	114	0.377	98.541	8.51	8.6	ug/L
|	cd1	114	0.902	98.738	10.4	10.5	ug/L
|>	In	115	144065.4				ug/L
|	Pb	207	0.268	98.657	3.31	3.4	ug/L
|	Pb	206	0.338	98.831	6.28	6.4	ug/L
|	Pb	208	0.67	98.711	9.13	9.3	ug/L
|	pb1	208	1.934	98.774	9.69	9.8	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard 3
Sample Da Wednesday, September 18, 2013 09:42:31
Sample Description:
Solution Ty Standard
Blank File: C:\Elandata\Dataset\Default\Blank.908

Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard 3.911
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	849851	7.018	1523.128	2.758
|	Zn1	64	153116	7.662	4010.765	3.262
|	Zn2	66	92048	11.81	676.025	5.152
|	Zn3	68	66180	10.201	419.676	6.058
|	Zn4	67	14302	12.243	223.669	3.172
|	Zn	64	325645	9.497	5330.136	2.148
|	As	75	123044	6.428	111.32	18.132
|	Y	89	83	16.209	24	29.167
|	Cd	111	138208	1.659	-25.199	24.611
|	Cd	114	317886	2.541	20.711	31.975
|	cd1	114	757593	2.667	67.333	12.804
|>	In	115	130852	3.166	132858	2.82
|	Pb	207	211559	6.358	36.333	26.732
|	Pb	206	267367	10.91	39.333	25.466
|	Pb	208	534322	5.049	98.001	5.681
|	pb1	208	1551033	6.085	254.001	12.617
|-	Bi	209	82	12.567	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	6.479	50537.46	2207.83	4.4	ug/L
|	Zn1	64	1.14	502.367	40.2	8	ug/L
|	Zn2	66	0.699	502.003	61.85	12.3	ug/L
|	Zn3	68	0.503	501.777	51.52	10.3	ug/L
|	Zn4	67	0.108	501.637	66.64	13.3	ug/L
|	Zn	64	2.45	502.11	49.76	9.9	ug/L
|	As	75	0.94	504.339	35.72	7.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	1.057	505.617	13.62	2.7	ug/L
|	Cd	114	2.432	505.134	25.14	5	ug/L
|	cd1	114	5.792	505.08	18.22	3.6	ug/L
|>	In	115	130852.1				ug/L
|	Pb	207	1.618	503.885	36.13	7.2	ug/L
|	Pb	206	2.042	503.88	49.31	9.8	ug/L
|	Pb	208	4.085	504.079	29.75	5.9	ug/L
|	pb1	208	11.853	504.178	28.82	5.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 200 ppb
Sample Da Wednesday, September 18, 2013 09:45:08
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\200 ppb.912
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5575	9.381	1523.128	2.758
|	Zn1	64	64713	0.916	4010.765	3.262
|	Zn2	66	38660	2.248	676.025	5.152
|	Zn3	68	28632	4.358	419.676	6.058
|	Zn4	67	6012	4.019	223.669	3.172
|	Zn	64	138017	0.777	5330.136	2.148
|	As	75	51625	7.284	111.32	18.132
|	Y	89	26	23.395	24	29.167
|	Cd	111	53155	6.973	-25.199	24.611
|	Cd	114	125446	7.734	20.711	31.975
|	cd1	114	301345	6.908	67.333	12.804
|>	In	115	135098	2.841	132858	2.82
|	Pb	207	87759	5.852	36.333	26.732
|	Pb	206	113504	8.774	39.333	25.466
|	Pb	208	214295	1.988	98.001	5.681
|	pb1	208	629538	3.034	254.001	12.617
|-	Bi	209	53	23.566	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.03	232.246	23.77	10.2	ug/L
|	Zn1	64	0.449	197.802	5.15	2.6	ug/L
|	Zn2	66	0.281	201.956	4.59	2.3	ug/L
|	Zn3	68	0.209	208.476	11	5.3	ug/L
|	Zn4	67	0.043	199.394	7.35	3.7	ug/L
|	Zn	64	0.982	201.249	4.44	2.2	ug/L
|	As	75	0.381	204.654	15.86	7.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.394	188.368	13.08	6.9	ug/L
|	Cd	114	0.929	192.98	16.07	8.3	ug/L
|	cd1	114	2.23	194.456	12.04	6.2	ug/L
|>	In	115	135097.8				ug/L
|	Pb	207	0.649	202.139	6.11	3	ug/L
|	Pb	206	0.839	207.076	13.84	6.7	ug/L
|	Pb	208	1.586	195.732	6.85	3.5	ug/L
|	pb1	208	4.658	198.127	2.62	1.3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 10 ppb
Sample Da Wednesday, September 18, 2013 09:47:43
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual

Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\10 ppb.913
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	1444	10.949	1523.128	2.758
|	Zn1	64	7600	7.491	4010.765	3.262
|	Zn2	66	3359	10.281	676.025	5.152
|	Zn3	68	2443	13.42	419.676	6.058
|	Zn4	67	655	10.829	223.669	3.172
|	Zn	64	14056	9.289	5330.136	2.148
|	As	75	2920	4.953	111.32	18.132
|	Y	89	15	30.551	24	29.167
|	Cd	111	2998	7.757	-25.199	24.611
|	Cd	114	6788	4.879	20.711	31.975
|	cd1	114	16359	5.521	67.333	12.804
|>	In	115	134011	2.83	132858	2.82
|	Pb	207	4812	3.187	36.333	26.732
|	Pb	206	6085	6.181	39.333	25.466
|	Pb	208	11869	5.9	98.001	5.681
|	pb1	208	34586	5.314	254.001	12.617
|-	Bi	209	46	19.322	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	-0.001	-5.483	7.15	130.5	ug/L
|	Zn1	64	0.027	11.691	1.85	15.8	ug/L
|	Zn2	66	0.02	14.351	1.8	12.5	ug/L
|	Zn3	68	0.015	15.029	2.24	14.9	ug/L
|	Zn4	67	0.003	14.924	2.41	16.1	ug/L
|	Zn	64	0.065	13.278	1.91	14.4	ug/L
|	As	75	0.021	11.241	0.5	4.5	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.023	10.787	0.61	5.7	ug/L
|	Cd	114	0.05	10.491	0.42	4	ug/L
|	cd1	114	0.122	10.599	0.46	4.4	ug/L
|>	In	115	134011				ug/L
|	Pb	207	0.036	11.098	0.13	1.2	ug/L
|	Pb	206	0.045	11.139	0.75	6.8	ug/L
|	Pb	208	0.088	10.834	0.45	4.2	ug/L
|	pb1	208	0.256	10.894	0.42	3.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 10 ppb
Sample Da Wednesday, September 18, 2013 09:50:37
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\10 ppb.914
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	1402	7.528	1523.128	2.758
|	Zn1	64	6329	7.011	4010.765	3.262
|	Zn2	66	2608	8.858	676.025	5.152
|	Zn3	68	1806	4.463	419.676	6.058
|	Zn4	67	522	2.599	223.669	3.172
|	Zn	64	11265	6.487	5330.136	2.148
|	As	75	2840	1.856	111.32	18.132
|	Y	89	22	43.361	24	29.167
|	Cd	111	2929	1.646	-25.199	24.611
|	Cd	114	6991	2.337	20.711	31.975
|	cd1	114	16552	1.821	67.333	12.804
|>	In	115	144289	4.457	132858	2.82
|	Pb	207	4863	7.444	36.333	26.732
|	Pb	206	6263	8.231	39.333	25.466
|	Pb	208	11801	3.801	98.001	5.681
|	pb1	208	34505	3.667	254.001	12.617
|-	Bi	209	32	32.626	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	-0.002	-13.665	3.02	22.1	ug/L
|	Zn1	64	0.014	6.029	1.24	20.5	ug/L
|	Zn2	66	0.013	9.325	0.92	9.9	ug/L
|	Zn3	68	0.009	9.356	0.87	9.3	ug/L
|	Zn4	67	0.002	9.027	0.36	4	ug/L
|	Zn	64	0.038	7.785	0.95	12.2	ug/L
|	As	75	0.019	10.127	0.65	6.4	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.021	9.812	0.41	4.1	ug/L
|	Cd	114	0.048	10.053	0.66	6.5	ug/L
|	cd1	114	0.114	9.968	0.37	3.7	ug/L
|>	In	115	144288.7				ug/L
|	Pb	207	0.033	10.404	0.32	3	ug/L
|	Pb	206	0.043	10.627	0.43	4.1	ug/L
|	Pb	208	0.081	10.005	0.3	3	ug/L
|	pb1	208	0.237	10.094	0.23	2.3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 09:53:11
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.915

Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	4515	5.83	1523.128	2.758	
|	Zn1	64	59143	6.662	4010.765	3.262	
|	Zn2	66	34395	6.569	676.025	5.152	
|	Zn3	68	26586	4.382	419.676	6.058	
|	Zn4	67	6206	5.356	223.669	3.172	
|	Zn	64	126330	5.755	5330.136	2.148	
|	As	75	46371	3.431	111.32	18.132	
|	Y	89	30	25.3	24	29.167	
|	Cd	111	48809	9.197	-25.199	24.611	
|	Cd	114	115679	7.435	20.711	31.975	
|	cd1	114	281054	8.192	67.333	12.804	
|>	In	115	155075	5.542	132858	2.82	
|	Pb	207	79961	6.2	36.333	26.732	
|	Pb	206	99306	8.066	39.333	25.466	
|	Pb	208	198109	5.058	98.001	5.681	
|	pb1	208	563782	6.791	254.001	12.617	
|-	Bi	209	36	27.661	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.018	137.685	1.58	1.2	ug/L
|	Zn1	64	0.351	154.647	3.57	2.3	ug/L
|	Zn2	66	0.217	155.775	9.43	6.1	ug/L
|	Zn3	68	0.168	168.045	3.98	2.4	ug/L
|	Zn4	67	0.038	178.68	9.88	5.5	ug/L
|	Zn	64	0.775	158.778	5.14	3.2	ug/L
|	As	75	0.298	160.097	3.7	2.3	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.315	150.501	7.51	5	ug/L
|	Cd	114	0.745	154.828	2.9	1.9	ug/L
|	cd1	114	1.81	157.84	4.15	2.6	ug/L
|>	In	115	155075.2				ug/L
|	Pb	207	0.515	160.512	4.04	2.5	ug/L
|	Pb	206	0.64	157.829	5.4	3.4	ug/L
|	Pb	208	1.277	157.57	2.21	1.4	ug/L
|	pb1	208	3.632	154.485	2.39	1.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 09:55:45
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.916
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	1444	6.598	1523.128	2.758	
|	Zn1	64	2337	0.631	4010.765	3.262	
|	Zn2	66	188	5.921	676.025	5.152	
|	Zn3	68	89	15.198	419.676	6.058	
|	Zn4	67	152	7.866	223.669	3.172	
|	Zn	64	2766	0.346	5330.136	2.148	
|	As	75	117	28.312	111.32	18.132	
|	Y	89	10	21.534	24	29.167	
|	Cd	111	2	383.997	-25.199	24.611	
|	Cd	114	16	36.834	20.711	31.975	
|	cd1	114	70	15.452	67.333	12.804	
|>	In	115	154487	1.284	132858	2.82	
|	Pb	207	20	5.871	36.333	26.732	
|	Pb	206	27	27.962	39.333	25.466	
|	Pb	208	56	9.042	98.001	5.681	
|	pb1	208	158	11.72	254.001	12.617	
|-	Bi	209	5	53.927	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	-0.002	-16.535	4.13	24.9	ug/L
|	Zn1	64	-0.015	-6.634	0.11	1.7	ug/L
|	Zn2	66	-0.004	-2.779	0.05	1.9	ug/L
|	Zn3	68	-0.003	-2.575	0.09	3.7	ug/L
|	Zn4	67	-0.001	-3.269	0.32	9.9	ug/L
|	Zn	64	-0.022	-4.553	0.06	1.3	ug/L
|	As	75	0	-0.045	0.11	244.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.097	0.03	26.1	ug/L
|	Cd	114	0	-0.011	0.01	73.4	ug/L
|	cd1	114	0	-0.005	0.01	135.1	ug/L
|>	In	115	154486.7				ug/L
|	Pb	207	0	-0.046	0	5.3	ug/L
|	Pb	206	0	-0.03	0.01	41.4	ug/L
|	Pb	208	0	-0.047	0	9.3	ug/L
|	pb1	208	-0.001	-0.038	0.01	14.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Interference Check
Sample Da Wednesday, September 18, 2013 09:58:20
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Interference Check.917
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration

Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	835700	4.521	1523.128	2.758
|	Zn1	64	133539	5.827	4010.765	3.262
|	Zn2	66	77007	5.959	676.025	5.152
|	Zn3	68	55062	5.578	419.676	6.058
|	Zn4	67	14755	8.12	223.669	3.172
|	Zn	64	280362	5.759	5330.136	2.148
|	As	75	54441	3.514	111.32	18.132
|	Y	89	145	1.986	24	29.167
|	Cd	111	28451	11.392	-25.199	24.611
|	Cd	114	67744	7.619	20.711	31.975
|	cd1	114	161505	8.825	67.333	12.804
|>	In	115	162900	4.758	132858	2.82
|	Pb	207	28188	2.02	36.333	26.732
|	Pb	206	34935	8.499	39.333	25.466
|	Pb	208	68084	2.528	98.001	5.681
|	pb1	208	198970	3.812	254.001	12.617
|-	Bi	209	280	1.637	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	5.133	40042.23	3700.73	9.2	ug/L
|	Zn1	64	0.792	349.036	38.93	11.2	ug/L
|	Zn2	66	0.469	337.076	37.09	11	ug/L
|	Zn3	68	0.336	335.144	33.08	9.9	ug/L
|	Zn4	67	0.089	415.441	53.22	12.8	ug/L
|	Zn	64	1.687	345.694	37.52	10.9	ug/L
|	As	75	0.334	179.272	14.34	8	ug/L
|	Y	89	0.001				ug/L
|	Cd	111	0.176	84.015	13.24	15.8	ug/L
|	Cd	114	0.417	86.667	10.48	12.1	ug/L
|	cd1	114	0.995	86.751	11.64	13.4	ug/L
|>	In	115	162900.4				ug/L
|	Pb	207	0.173	53.931	3.72	6.9	ug/L
|	Pb	206	0.215	53.045	6.82	12.9	ug/L
|	Pb	208	0.418	51.599	3.81	7.4	ug/L
|	pb1	208	1.223	52.011	4.48	8.6	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: blank
Sample Da Wednesday, September 18, 2013 10:00:55
Sample Description:
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\blank.918
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1697	3.743	1523.128	2.758
|	Zn1	64	2127	2.718	4010.765	3.262
|	Zn2	66	185	5.965	676.025	5.152
|	Zn3	68	86	7.595	419.676	6.058
|	Zn4	67	158	5.063	223.669	3.172
|	Zn	64	2555	1.562	5330.136	2.148
|	As	75	50	84.875	111.32	18.132
|	Y	89	13	51.366	24	29.167
|	Cd	111	-19	23.668	-25.199	24.611
|	Cd	114	22	26.658	20.711	31.975
|	cd1	114	55	9.096	67.333	12.804
|>	In	115	157540	4.24	132858	2.82
|	Pb	207	16	22.416	36.333	26.732
|	Pb	206	20	13.229	39.333	25.466
|	Pb	208	39	16.928	98.001	5.681
|	pb1	208	111	9.051	254.001	12.617
|-	Bi	209	5	69.282	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	-0.001	-5.316	4.07	76.6	ug/L
|	Zn1	64	-0.017	-7.348	0.11	1.5	ug/L
|	Zn2	66	-0.004	-2.811	0.08	2.7	ug/L
|	Zn3	68	-0.003	-2.609	0.06	2.2	ug/L
|	Zn4	67	-0.001	-3.157	0.43	13.7	ug/L
|	Zn	64	-0.024	-4.896	0.09	1.9	ug/L
|	As	75	-0.001	-0.276	0.15	54.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.033	0.01	40.1	ug/L
|	Cd	114	0	-0.003	0.01	315.9	ug/L
|	cd1	114	0	-0.014	0	17.9	ug/L
|>	In	115	157539.6				ug/L
|	Pb	207	0	-0.054	0.01	11.6	ug/L
|	Pb	206	0	-0.042	0.01	13.1	ug/L
|	Pb	208	0	-0.06	0	6.5	ug/L
|	pb1	208	-0.001	-0.051	0	2.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX001 all 50x bio
Sample Da Wednesday, September 18, 2013 10:03:30
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX001 all 50x bio.919
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4407	3.738	1523.128	2.758

|	Zn1	64	161006	5.417	4010.765	3.262
|	Zn2	66	100181	2.386	676.025	5.152
|	Zn3	68	73110	3.195	419.676	6.058
|	Zn4	67	15409	4.591	223.669	3.172
|	Zn	64	349706	3.406	5330.136	2.148
|	As	75	230	9.044	111.32	18.132
|	Y	89	8348	3.631	24	29.167
|	Cd	111	1310	1.353	-25.199	24.611
|	Cd	114	3060	3.278	20.711	31.975
|	cd1	114	7322	1.472	67.333	12.804
|>	In	115	155121	1.538	132858	2.82
|	Pb	207	52875	1.224	36.333	26.732
|	Pb	206	67600	1.223	39.333	25.466
|	Pb	208	130230	2.065	98.001	5.681
|	pb1	208	379188	0.468	254.001	12.617
|-	Bi	209	93	12.414	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.017	132.259	10.11	7.6	ug/L
|	Zn1	64	1.008	444.172	30.06	6.8	ug/L
|	Zn2	66	0.641	460.426	17.91	3.9	ug/L
|	Zn3	68	0.468	467.461	22.42	4.8	ug/L
|	Zn4	67	0.098	454.887	26.49	5.8	ug/L
|	Zn	64	2.215	454.064	22.58	5	ug/L
|	As	75	0.001	0.344	0.06	18.2	ug/L
|	Y	89	0.054				ug/L
|	Cd	111	0.009	4.131	0.11	2.8	ug/L
|	Cd	114	0.02	4.065	0.08	1.9	ug/L
|	cd1	114	0.047	4.072	0.02	0.5	ug/L
|>	In	115	155121.2				ug/L
|	Pb	207	0.341	106.094	0.76	0.7	ug/L
|	Pb	206	0.436	107.5	2.96	2.8	ug/L
|	Pb	208	0.839	103.508	2.35	2.3	ug/L
|	pb1	208	2.443	103.904	1.18	1.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX002
Sample Da Wednesday, September 18, 2013 10:06:06
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX002.920
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2884	2.224	1523.128	2.758
|	Zn1	64	85858	4.362	4010.765	3.262
|	Zn2	66	51249	2.503	676.025	5.152
|	Zn3	68	37039	4.814	419.676	6.058
|	Zn4	67	7868	6.925	223.669	3.172
|	Zn	64	182014	3.917	5330.136	2.148
|	As	75	158	40.59	111.32	18.132
|	Y	89	5031	2.751	24	29.167
|	Cd	111	517	7.015	-25.199	24.611
|	Cd	114	1306	7.026	20.711	31.975
|	cd1	114	3090	5.729	67.333	12.804
|>	In	115	153980	5.194	132858	2.82
|	Pb	207	22933	6.16	36.333	26.732
|	Pb	206	30419	4.95	39.333	25.466
|	Pb	208	56713	4.192	98.001	5.681
|	pb1	208	166758	4.381	254.001	12.617
|-	Bi	209	51	6.03	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.007	56.813	4.34	7.6	ug/L
|	Zn1	64	0.528	232.491	8.74	3.8	ug/L
|	Zn2	66	0.328	235.704	9.24	3.9	ug/L
|	Zn3	68	0.238	237.254	14.75	6.2	ug/L
|	Zn4	67	0.049	230.2	14.88	6.5	ug/L
|	Zn	64	1.143	234.285	10.09	4.3	ug/L
|	As	75	0	0.093	0.2	209.2	ug/L
|	Y	89	0.033				ug/L
|	Cd	111	0.004	1.696	0.08	4.7	ug/L
|	Cd	114	0.008	1.729	0.04	2.4	ug/L
|	cd1	114	0.02	1.706	0.05	3.1	ug/L
|>	In	115	153980.5				ug/L
|	Pb	207	0.149	46.338	2.64	5.7	ug/L
|	Pb	206	0.197	48.717	2.32	4.8	ug/L
|	Pb	208	0.368	45.39	1.75	3.8	ug/L
|	pb1	208	1.082	46.019	1.85	4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX003
Sample Da Wednesday, September 18, 2013 10:08:42
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX003.921
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4179	3.543	1523.128	2.758
|	Zn1	64	263074	4.183	4010.765	3.262
|	Zn2	66	164445	2.368	676.025	5.152
|	Zn3	68	115985	2.278	419.676	6.058
|	Zn4	67	25475	3.597	223.669	3.172

|	Zn	64	568978	2.947	5330.136	2.148
|	As	75	245	44.999	111.32	18.132
|	Y	89	5974	5.881	24	29.167
|	Cd	111	1221	7.455	-25.199	24.611
|	Cd	114	2941	5.348	20.711	31.975
|	cd1	114	6899	6.623	67.333	12.804
|>	In	115	145066	5.579	132858	2.82
|	Pb	207	56957	4.627	36.333	26.732
|	Pb	206	78743	5.47	39.333	25.466
|	Pb	208	144466	3.447	98.001	5.681
|	pb1	208	421711	4.252	254.001	12.617
|-	Bi	209	54	17.666	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.017	135.517	7.81	5.8	ug/L
|	Zn1	64	1.784	785.972	11.35	1.4	ug/L
|	Zn2	66	1.13	811.727	31.48	3.9	ug/L
|	Zn3	68	0.798	796.029	35.32	4.4	ug/L
|	Zn4	67	0.174	811.548	54.54	6.7	ug/L
|	Zn	64	3.886	796.512	23.67	3	ug/L
|	As	75	0.001	0.467	0.44	94.6	ug/L
|	Y	89	0.041				ug/L
|	Cd	111	0.009	4.117	0.17	4.2	ug/L
|	Cd	114	0.02	4.183	0.17	4.2	ug/L
|	cd1	114	0.047	4.102	0.14	3.5	ug/L
|>	In	115	145066.4				ug/L
|	Pb	207	0.393	122.327	5.12	4.2	ug/L
|	Pb	206	0.543	133.993	6.52	4.9	ug/L
|	Pb	208	0.996	122.906	3.9	3.2	ug/L
|	pb1	208	2.907	123.665	4.02	3.2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EXOO4
Sample Da Wednesday, September 18, 2013 10:11:19
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EXOO4.922
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4494	2.44	1523.128	2.758
|	Zn1	64	98552	1.696	4010.765	3.262
|	Zn2	66	60444	3.564	676.025	5.152
|	Zn3	68	43534	3.759	419.676	6.058
|	Zn4	67	9473	1.809	223.669	3.172
|	Zn	64	212004	2.496	5330.136	2.148
|	As	75	161	57.184	111.32	18.132
|	Y	89	5941	4.672	24	29.167
|	Cd	111	597	2.739	-25.199	24.611
|	Cd	114	1346	4.263	20.711	31.975
|	cd1	114	3273	2.121	67.333	12.804
|>	In	115	152710	1.807	132858	2.82
|	Pb	207	16010	0.954	36.333	26.732
|	Pb	206	21542	2.983	39.333	25.466
|	Pb	208	39237	3.527	98.001	5.681
|	pb1	208	116482	1.413	254.001	12.617
|-	Bi	209	29	24.866	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.018	140.207	7.27	5.2	ug/L
|	Zn1	64	0.615	270.994	1.98	0.7	ug/L
|	Zn2	66	0.391	280.607	5.34	1.9	ug/L
|	Zn3	68	0.282	281.316	6.74	2.4	ug/L
|	Zn4	67	0.06	280.98	1.72	0.6	ug/L
|	Zn	64	1.348	276.296	2.23	0.8	ug/L
|	As	75	0	0.115	0.31	273.7	ug/L
|	Y	89	0.039				ug/L
|	Cd	111	0.004	1.962	0.02	0.9	ug/L
|	Cd	114	0.009	1.8	0.1	5.4	ug/L
|	cd1	114	0.021	1.826	0.07	3.9	ug/L
|>	In	115	152710.3				ug/L
|	Pb	207	0.105	32.582	0.89	2.7	ug/L
|	Pb	206	0.141	34.753	1.51	4.3	ug/L
|	Pb	208	0.256	31.617	1.22	3.9	ug/L
|	pb1	208	0.761	32.37	0.8	2.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX005
Sample Da Wednesday, September 18, 2013 10:13:56
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX005.923
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	10964	8.138	1523.128	2.758
|	Zn1	64	8160583	6.783	4010.765	3.262
|	Zn2	66	5237489	5.793	676.025	5.152
|	Zn3	68	3711435	8.301	419.676	6.058
|	Zn4	67	868051	9.237	223.669	3.172
|	Zn	64	17977558	6.377	5330.136	2.148
|	As	75	5787	6.507	111.32	18.132
|	Y	89	8861	5.006	24	29.167
|	Cd	111	14535	4.193	-25.199	24.611

|	Cd	114	34159	6.863	20.711	31.975
|	cd1	114	81371	6.024	67.333	12.804
|>	In	115	145289	3.599	132858	2.82
|	Pb	207	951931	6.349	36.333	26.732
|	Pb	206	1345789	7.924	39.333	25.466
|	Pb	208	3107570	5.001	98.001	5.681
|	pb1	208	8480804	5.797	254.001	12.617
|-	Bi	209	37	20.103	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.064	498.967	37.78	7.6	ug/L
|	Zn1	64	56.147	24733.4	1559.38	6.3	ug/L
|	Zn2	66	36.035	25884.56	977.67	3.8	ug/L
|	Zn3	68	25.514	25464.23	1228.13	4.8	ug/L
|	Zn4	67	5.966	27775.84	1647.48	5.9	ug/L
|	Zn	64	123.662	25345.88	1150.58	4.5	ug/L
|	As	75	0.039	20.908	0.83	4	ug/L
|	Y	89	0.061				ug/L
|	Cd	111	0.1	47.965	1.86	3.9	ug/L
|	Cd	114	0.235	48.774	1.73	3.5	ug/L
|	cd1	114	0.559	48.771	1.56	3.2	ug/L
|>	In	115	145288.7				ug/L
|	Pb	207	6.549	2039.801	75.61	3.7	ug/L
|	Pb	206	9.253	2283.466	97.89	4.3	ug/L
|	Pb	208	21.389	2639.166	100.93	3.8	ug/L
|	pb1	208	58.346	2481.7	73.16	2.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX006
Sample Da Wednesday, September 18, 2013 10:16:32
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX006.924
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	3225	1.337	1523.128	2.758
|	Zn1	64	121472	5.524	4010.765	3.262
|	Zn2	66	76780	2.278	676.025	5.152
|	Zn3	68	55495	0.76	419.676	6.058
|	Zn4	67	12090	3.831	223.669	3.172
|	Zn	64	265837	3.467	5330.136	2.148
|	As	75	121	45.943	111.32	18.132
|	Y	89	4447	4.21	24	29.167
|	Cd	111	846	6.566	-25.199	24.611
|	Cd	114	2033	9.476	20.711	31.975
|	cd1	114	4780	7.382	67.333	12.804
|>	In	115	141884	3.573	132858	2.82
|	Pb	207	52986	0.32	36.333	26.732
|	Pb	206	69264	2.809	39.333	25.466
|	Pb	208	132030	3.905	98.001	5.681
|	pb1	208	384372	2.396	254.001	12.617
|-	Bi	209	52	9.147	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.011	87.97	5.2	5.9	ug/L
|	Zn1	64	0.826	363.857	16.64	4.6	ug/L
|	Zn2	66	0.536	385.234	9.58	2.5	ug/L
|	Zn3	68	0.388	387.489	11.95	3.1	ug/L
|	Zn4	67	0.084	388.89	2.48	0.6	ug/L
|	Zn	64	1.834	375.912	11.18	3	ug/L
|	As	75	0	0.004	0.2	5163.7	ug/L
|	Y	89	0.031				ug/L
|	Cd	111	0.006	2.941	0.11	3.6	ug/L
|	Cd	114	0.014	2.942	0.22	7.3	ug/L
|	cd1	114	0.033	2.891	0.13	4.6	ug/L
|>	In	115	141883.7				ug/L
|	Pb	207	0.373	116.331	3.86	3.3	ug/L
|	Pb	206	0.488	120.42	1.32	1.1	ug/L
|	Pb	208	0.93	114.719	1.01	0.9	ug/L
|	pb1	208	2.708	115.18	1.53	1.3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX007
Sample Da Wednesday, September 18, 2013 10:19:06
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX007.925
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	6215	4.209	1523.128	2.758
|	Zn1	64	328523	4.199	4010.765	3.262
|	Zn2	66	199148	2.808	676.025	5.152
|	Zn3	68	141890	3.802	419.676	6.058
|	Zn4	67	30138	1.585	223.669	3.172
|	Zn	64	699699	3.575	5330.136	2.148
|	As	75	421	19.958	111.32	18.132
|	Y	89	7860	4.929	24	29.167
|	Cd	111	698	3.467	-25.199	24.611
|	Cd	114	1699	9.105	20.711	31.975
|	cd1	114	3990	5.783	67.333	12.804
|>	In	115	141881	5.91	132858	2.82
|	Pb	207	58678	5.8	36.333	26.732

|	Pb	206	77921	7.851	39.333	25.466
|	Pb	208	146579	6.506	98.001	5.681
|	pb1	208	425476	7.043	254.001	12.617
|-	Bi	209	91	13.504	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.032	252.784	16.94	6.7	ug/L
|	Zn1	64	2.288	1007.672	33.37	3.3	ug/L
|	Zn2	66	1.401	1006.23	46.22	4.6	ug/L
|	Zn3	68	0.998	995.922	28.53	2.9	ug/L
|	Zn4	67	0.211	983.07	49.17	5	ug/L
|	Zn	64	4.897	1003.765	36.31	3.6	ug/L
|	As	75	0.002	1.138	0.25	22.4	ug/L
|	Y	89	0.055				ug/L
|	Cd	111	0.005	2.446	0.06	2.4	ug/L
|	Cd	114	0.012	2.455	0.17	6.7	ug/L
|	cd1	114	0.028	2.409	0.08	3.4	ug/L
|>	In	115	141881.3				ug/L
|	Pb	207	0.413	128.751	1.8	1.4	ug/L
|	Pb	206	0.549	135.376	4.27	3.2	ug/L
|	Pb	208	1.032	127.368	2.5	2	ug/L
|	pb1	208	2.996	127.42	2.11	1.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX008
Sample Da Wednesday, September 18, 2013 10:21:41
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX008.926
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2545	2.42	1523.128	2.758
|	Zn1	64	138550	6.359	4010.765	3.262
|	Zn2	66	83572	4.958	676.025	5.152
|	Zn3	68	61223	3.191	419.676	6.058
|	Zn4	67	12853	2.697	223.669	3.172
|	Zn	64	296197	5.018	5330.136	2.148
|	As	75	184	20.292	111.32	18.132
|	Y	89	4879	5.286	24	29.167
|	Cd	111	954	2.375	-25.199	24.611
|	Cd	114	2328	8.993	20.711	31.975
|	cd1	114	5591	5.82	67.333	12.804
|>	In	115	153537	5.019	132858	2.82
|	Pb	207	41585	4.357	36.333	26.732
|	Pb	206	53419	0.744	39.333	25.466
|	Pb	208	100992	2.226	98.001	5.681
|	pb1	208	294643	1.237	254.001	12.617
|-	Bi	209	35	20.465	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.005	40.165	9.07	22.6	ug/L
|	Zn1	64	0.872	384.079	9.16	2.4	ug/L
|	Zn2	66	0.539	387.34	0.86	0.2	ug/L
|	Zn3	68	0.396	395.08	8.86	2.2	ug/L
|	Zn4	67	0.082	382.237	9.32	2.4	ug/L
|	Zn	64	1.889	387.188	3.36	0.9	ug/L
|	As	75	0	0.199	0.17	83	ug/L
|	Y	89	0.032				ug/L
|	Cd	111	0.006	3.067	0.17	5.6	ug/L
|	Cd	114	0.015	3.114	0.14	4.4	ug/L
|	cd1	114	0.036	3.13	0.05	1.7	ug/L
|>	In	115	153537.5				ug/L
|	Pb	207	0.271	84.328	2.7	3.2	ug/L
|	Pb	206	0.348	85.954	5.03	5.8	ug/L
|	Pb	208	0.658	81.221	4.87	6	ug/L
|	pb1	208	1.92	81.686	4.4	5.4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX009
Sample Da Wednesday, September 18, 2013 10:24:15
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX009.927
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	3166	5.631	1523.128	2.758
|	Zn1	64	136556	1.415	4010.765	3.262
|	Zn2	66	84215	5.462	676.025	5.152
|	Zn3	68	60947	5.297	419.676	6.058
|	Zn4	67	12946	4.668	223.669	3.172
|	Zn	64	294664	3.311	5330.136	2.148
|	As	75	134	61.355	111.32	18.132
|	Y	89	7680	3.629	24	29.167
|	Cd	111	756	4.859	-25.199	24.611
|	Cd	114	1707	2.84	20.711	31.975
|	cd1	114	4070	2.473	67.333	12.804
|>	In	115	148371	3.527	132858	2.82
|	Pb	207	29805	4.596	36.333	26.732
|	Pb	206	38219	3.617	39.333	25.466
|	Pb	208	71574	5.755	98.001	5.681
|	pb1	208	210590	4.231	254.001	12.617
|-	Bi	209	35	9.897	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.01	77.171	11.27	14.6	ug/L
|	Zn1	64	0.891	392.386	11.61	3	ug/L
|	Zn2	66	0.563	404.434	27.01	6.7	ug/L
|	Zn3	68	0.408	406.893	19.07	4.7	ug/L
|	Zn4	67	0.086	398.876	26.31	6.6	ug/L
|	Zn	64	1.947	399.088	17	4.3	ug/L
|	As	75	0	0.038	0.3	781.1	ug/L
|	Y	89	0.052				ug/L
|	Cd	111	0.005	2.534	0.2	7.8	ug/L
|	Cd	114	0.011	2.36	0.09	3.9	ug/L
|	cd1	114	0.027	2.348	0.05	2.3	ug/L
|>	In	115	148371.2				ug/L
|	Pb	207	0.201	62.514	2.9	4.6	ug/L
|	Pb	206	0.257	63.503	1.49	2.3	ug/L
|	Pb	208	0.482	59.452	3.36	5.7	ug/L
|	pb1	208	1.418	60.317	2.62	4.3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 10:26:50
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.928
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4947	2.898	1523.128	2.758
|	Zn1	64	60803	4.869	4010.765	3.262
|	Zn2	66	36753	1.77	676.025	5.152
|	Zn3	68	26093	4.113	419.676	6.058
|	Zn4	67	6313	4.267	223.669	3.172
|	Zn	64	129963	3.784	5330.136	2.148
|	As	75	46739	4.016	111.32	18.132
|	Y	89	26	11.538	24	29.167
|	Cd	111	49889	2.329	-25.199	24.611
|	Cd	114	116177	3.831	20.711	31.975
|	cd1	114	284710	2.911	67.333	12.804
|>	In	115	151766	1.357	132858	2.82
|	Pb	207	74932	2.439	36.333	26.732
|	Pb	206	94920	5.827	39.333	25.466
|	Pb	208	185012	4.777	98.001	5.681
|	pb1	208	540273	3.783	254.001	12.617
|-	Bi	209	42	10.911	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.021	164.888	8.8	5.3	ug/L
|	Zn1	64	0.371	163.274	10.63	6.5	ug/L
|	Zn2	66	0.237	170.347	5.35	3.1	ug/L
|	Zn3	68	0.169	168.511	8.92	5.3	ug/L
|	Zn4	67	0.04	185.928	10.66	5.7	ug/L
|	Zn	64	0.817	167.365	8.71	5.2	ug/L
|	As	75	0.307	164.811	7.78	4.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.329	157.364	4.1	2.6	ug/L
|	Cd	114	0.765	158.978	4.91	3.1	ug/L
|	cd1	114	1.876	163.543	4.47	2.7	ug/L
|>	In	115	151765.7				ug/L
|	Pb	207	0.493	153.715	3.66	2.4	ug/L
|	Pb	206	0.625	154.274	8.92	5.8	ug/L
|	Pb	208	1.218	150.315	6.64	4.4	ug/L
|	pb1	208	3.558	151.35	5.91	3.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 10:29:24
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.929
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1734	4.567	1523.128	2.758
|	Zn1	64	1717	4.429	4010.765	3.262
|	Zn2	66	150	4.672	676.025	5.152
|	Zn3	68	97	24.023	419.676	6.058
|	Zn4	67	167	3.169	223.669	3.172
|	Zn	64	2131	4.73	5330.136	2.148
|	As	75	113	35.926	111.32	18.132
|	Y	89	10	23.89	24	29.167
|	Cd	111	-2	787.748	-25.199	24.611
|	Cd	114	14	44.121	20.711	31.975
|	cd1	114	77	8.487	67.333	12.804
|>	In	115	144333	4.406	132858	2.82
|	Pb	207	25	10.583	36.333	26.732
|	Pb	206	42	16.496	39.333	25.466
|	Pb	208	67	19.975	98.001	5.681
|	pb1	208	207	19.26	254.001	12.617
|-	Bi	209	3	33.333	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	4.497	7.66	170.3	ug/L
|	Zn1	64	-0.018	-8.057	0.14	1.7	ug/L

|	Zn2	66	-0.004	-2.906	0.05	1.8 ug/L
|	Zn3	68	-0.002	-2.486	0.14	5.5 ug/L
|	Zn4	67	-0.001	-2.441	0.38	15.8 ug/L
|	Zn	64	-0.025	-5.196	0.09	1.7 ug/L
|	As	75	0	-0.023	0.17	742.5 ug/L
|	Y	89	0			ug/L
|	Cd	111	0	0.085	0.05	64.6 ug/L
|	Cd	114	0	-0.013	0.01	74.2 ug/L
|	cd1	114	0	0.002	0	199 ug/L
|>	In	115	144333.2			ug/L
|	Pb	207	0	-0.031	0.01	26.6 ug/L
|	Pb	206	0	-0.001	0.02	1933.9 ug/L
|	Pb	208	0	-0.034	0.01	40.2 ug/L
|	pb1	208	0	-0.02	0.01	72.9 ug/L
|-	Bi	209	0			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010
Sample Da Wednesday, September 18, 2013 10:31:58
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010.930
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5118	5.973	1523.128	2.758
|	Zn1	64	28904	1.907	4010.765	3.262
|	Zn2	66	17121	2.666	676.025	5.152
|	Zn3	68	12245	5.868	419.676	6.058
|	Zn4	67	2792	0.383	223.669	3.172
|	Zn	64	61062	2.708	5330.136	2.148
|	As	75	274	23.487	111.32	18.132
|	Y	89	4352	1.622	24	29.167
|	Cd	111	79	13.58	-25.199	24.611
|	Cd	114	259	6.528	20.711	31.975
|	cd1	114	619	3.267	67.333	12.804
|>	In	115	151909	2.146	132858	2.82
|	Pb	207	4151	0.87	36.333	26.732
|	Pb	206	5348	3.802	39.333	25.466
|	Pb	208	10195	5.894	98.001	5.681
|	pb1	208	29521	2.801	254.001	12.617
|-	Bi	209	7	47.889	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.022	173.396	14.5	8.4	ug/L
|	Zn1	64	0.16	70.565	3.36	4.8	ug/L
|	Zn2	66	0.108	77.359	3.81	4.9	ug/L
|	Zn3	68	0.078	77.382	6.28	8.1	ug/L
|	Zn4	67	0.017	77.771	2.14	2.8	ug/L
|	Zn	64	0.362	74.221	3.96	5.3	ug/L
|	As	75	0.001	0.519	0.23	44.6	ug/L
|	Y	89	0.028				ug/L
|	Cd	111	0.001	0.339	0.04	11.4	ug/L
|	Cd	114	0.002	0.322	0.03	8.7	ug/L
|	cd1	114	0.004	0.311	0.01	4.8	ug/L
|>	In	115	151908.8				ug/L
|	Pb	207	0.027	8.43	0.25	3	ug/L
|	Pb	206	0.035	8.619	0.47	5.4	ug/L
|	Pb	208	0.066	8.19	0.46	5.6	ug/L
|	pb1	208	0.192	8.187	0.28	3.4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010-DUP
Sample Da Wednesday, September 18, 2013 10:34:33
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010-DUP.931
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4971	0.788	1523.128	2.758
|	Zn1	64	27630	1.35	4010.765	3.262
|	Zn2	66	16358	5.242	676.025	5.152
|	Zn3	68	11759	3.481	419.676	6.058
|	Zn4	67	2752	3.099	223.669	3.172
|	Zn	64	58500	2.564	5330.136	2.148
|	As	75	231	28.19	111.32	18.132
|	Y	89	4266	5.386	24	29.167
|	Cd	111	101	7.756	-25.199	24.611
|	Cd	114	270	10.271	20.711	31.975
|	cd1	114	629	5.412	67.333	12.804
|>	In	115	155910	1.151	132858	2.82
|	Pb	207	3773	0.462	36.333	26.732
|	Pb	206	5026	2.502	39.333	25.466
|	Pb	208	9381	4.901	98.001	5.681
|	pb1	208	27407	3.515	254.001	12.617
|-	Bi	209	7	74.231	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.02	159.293	1.51	0.9	ug/L
|	Zn1	64	0.147	64.781	1.82	2.8	ug/L
|	Zn2	66	0.1	71.727	4.34	6	ug/L
|	Zn3	68	0.072	72.147	3.47	4.8	ug/L
|	Zn4	67	0.016	74.385	3.46	4.6	ug/L
|	Zn	64	0.335	68.699	2.67	3.9	ug/L

|	As	75	0.001	0.343	0.21	62.4 ug/L
|	Y	89	0.027			ug/L
|	Cd	111	0.001	0.401	0.02	5.5 ug/L
|	Cd	114	0.002	0.328	0.04	11.6 ug/L
|	cd1	114	0.004	0.308	0.02	6.5 ug/L
|>	In	115	155910.3			ug/L
|	Pb	207	0.024	7.453	0.11	1.5 ug/L
|	Pb	206	0.032	7.883	0.23	2.9 ug/L
|	Pb	208	0.059	7.336	0.44	6 ug/L
|	pb1	208	0.174	7.398	0.34	4.6 ug/L
|-	Bi	209	0			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010-SPK
Sample Da Wednesday, September 18, 2013 10:37:08
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010-SPK.932
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5003	3.005	1523.128	2.758
|	Zn1	64	49283	2.393	4010.765	3.262
|	Zn2	66	29935	1.977	676.025	5.152
|	Zn3	68	21230	1.77	419.676	6.058
|	Zn4	67	4802	0.804	223.669	3.172
|	Zn	64	105249	1.849	5330.136	2.148
|	As	75	16536	1.787	111.32	18.132
|	Y	89	4563	0.995	24	29.167
|	Cd	111	19519	1.098	-25.199	24.611
|	Cd	114	44899	4.216	20.711	31.975
|	cd1	114	107355	2.732	67.333	12.804
|>	In	115	150913	1.513	132858	2.82
|	Pb	207	29583	4.284	36.333	26.732
|	Pb	206	37387	1.551	39.333	25.466
|	Pb	208	72763	0.351	98.001	5.681
|	pb1	208	211021	0.612	254.001	12.617
|-	Bi	209	6	50.756	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.022	169.173	5.41	3.2	ug/L
|	Zn1	64	0.296	130.549	1.97	1.5	ug/L
|	Zn2	66	0.193	138.822	0.84	0.6	ug/L
|	Zn3	68	0.138	137.258	2.6	1.9	ug/L
|	Zn4	67	0.03	140.316	1.27	0.9	ug/L
|	Zn	64	0.657	134.717	1.16	0.9	ug/L
|	As	75	0.109	58.333	0.52	0.9	ug/L
|	Y	89	0.03				ug/L
|	Cd	111	0.13	61.967	0.43	0.7	ug/L
|	Cd	114	0.297	61.765	2.06	3.3	ug/L
|	cd1	114	0.711	61.983	1.19	1.9	ug/L
|>	In	115	150912.7				ug/L
|	Pb	207	0.196	60.959	1.7	2.8	ug/L
|	Pb	206	0.248	61.081	1.86	3	ug/L
|	Pb	208	0.481	59.407	0.73	1.2	ug/L
|	pb1	208	1.397	59.404	1.05	1.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-1
Sample Da Wednesday, September 18, 2013 10:39:44
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-1.933
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1670	0.852	1523.128	2.758
|	Zn1	64	1628	4.118	4010.765	3.262
|	Zn2	66	142	12.151	676.025	5.152
|	Zn3	68	98	12.884	419.676	6.058
|	Zn4	67	188	7.39	223.669	3.172
|	Zn	64	2055	2.791	5330.136	2.148
|	As	75	102	37.52	111.32	18.132
|	Y	89	4	66.144	24	29.167
|	Cd	111	-11	115.862	-25.199	24.611
|	Cd	114	14	24.206	20.711	31.975
|	cd1	114	75	82.412	67.333	12.804
|>	In	115	157033	1.353	132858	2.82
|	Pb	207	32	15.871	36.333	26.732
|	Pb	206	32	25.525	39.333	25.466
|	Pb	208	63	11.984	98.001	5.681
|	pb1	208	194	4.127	254.001	12.617
|-	Bi	209	4	83.32	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	-0.001	-6.469	1.45	22.4	ug/L
|	Zn1	64	-0.02	-8.733	0.14	1.6	ug/L
|	Zn2	66	-0.004	-3.007	0.08	2.6	ug/L
|	Zn3	68	-0.003	-2.531	0.09	3.4	ug/L
|	Zn4	67	0	-2.263	0.43	19.1	ug/L
|	Zn	64	-0.027	-5.541	0.04	0.8	ug/L
|	As	75	0	-0.1	0.13	130.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.057	0.04	69.4	ug/L
|	Cd	114	0	-0.014	0	30.4	ug/L

|	cd1	114	0	-0.002	0.03	1488.6	ug/L
|>	In	115	157033.1				ug/L
|	Pb	207	0	-0.021	0.01	48.1	ug/L
|	Pb	206	0	-0.023	0.01	55.1	ug/L
|	Pb	208	0	-0.042	0.01	12.7	ug/L
|	pb1	208	-0.001	-0.029	0	6.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-SPK-1
Sample Da Wednesday, September 18, 2013 10:42:20
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-SPK-1.934
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	1608	3.785	1523.128	2.758	
|	Zn1	64	24854	3.426	4010.765	3.262	
|	Zn2	66	14455	5.346	676.025	5.152	
|	Zn3	68	10564	2.123	419.676	6.058	
|	Zn4	67	2422	1.835	223.669	3.172	
|	Zn	64	52294	3.07	5330.136	2.148	
|	As	75	19446	1.984	111.32	18.132	
|	Y	89	33	25.49	24	29.167	
|	Cd	111	19194	3.289	-25.199	24.611	
|	Cd	114	45629	0.388	20.711	31.975	
|	cd1	114	106983	0.589	67.333	12.804	
|>	In	115	146529	5.256	132858	2.82	
|	Pb	207	27366	2.413	36.333	26.732	
|	Pb	206	34059	4.907	39.333	25.466	
|	Pb	208	66308	2.72	98.001	5.681	
|	pb1	208	194621	2.12	254.001	12.617	
|-	Bi	209	4	15.746	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0	-3.544	7.4	208.8	ug/L
|	Zn1	64	0.14	61.538	4.24	6.9	ug/L
|	Zn2	66	0.094	67.434	6.93	10.3	ug/L
|	Zn3	68	0.069	68.971	4.87	7.1	ug/L
|	Zn4	67	0.015	69.222	2.97	4.3	ug/L
|	Zn	64	0.318	65.085	5	7.7	ug/L
|	As	75	0.132	70.908	4.72	6.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.132	62.931	5.15	8.2	ug/L
|	Cd	114	0.312	64.773	3.27	5	ug/L
|	cd1	114	0.731	63.74	3.42	5.4	ug/L
|>	In	115	146529.1				ug/L
|	Pb	207	0.187	58.207	3.62	6.2	ug/L
|	Pb	206	0.232	57.294	0.36	0.6	ug/L
|	Pb	208	0.453	55.84	3.1	5.6	ug/L
|	pb1	208	1.328	56.487	2.28	4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX011
Sample Da Wednesday, September 18, 2013 10:44:56
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX011.935
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	3879	7.144	1523.128	2.758	
|	Zn1	64	273659	5.555	4010.765	3.262	
|	Zn2	66	169987	3.583	676.025	5.152	
|	Zn3	68	117505	0.936	419.676	6.058	
|	Zn4	67	25793	4.154	223.669	3.172	
|	Zn	64	586944	3.938	5330.136	2.148	
|	As	75	361	30.862	111.32	18.132	
|	Y	89	2833	4.052	24	29.167	
|	Cd	111	766	7.593	-25.199	24.611	
|	Cd	114	1795	8.024	20.711	31.975	
|	cd1	114	4243	6.779	67.333	12.804	
|>	In	115	144607	0.315	132858	2.82	
|	Pb	207	31158	2.447	36.333	26.732	
|	Pb	206	40806	2.9	39.333	25.466	
|	Pb	208	77241	1.483	98.001	5.681	
|	pb1	208	226502	2.162	254.001	12.617	
|-	Bi	209	19	11.945	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.015	119.821	14.87	12.4	ug/L
|	Zn1	64	1.862	820.299	45.41	5.5	ug/L
|	Zn2	66	1.17	840.715	29.69	3.5	ug/L
|	Zn3	68	0.809	807.823	6.4	0.8	ug/L
|	Zn4	67	0.177	822.672	35.51	4.3	ug/L
|	Zn	64	4.019	823.667	32.01	3.9	ug/L
|	As	75	0.002	0.89	0.41	46.1	ug/L
|	Y	89	0.019				ug/L
|	Cd	111	0.005	2.624	0.19	7.2	ug/L
|	Cd	114	0.012	2.547	0.21	8.1	ug/L
|	cd1	114	0.029	2.514	0.17	6.8	ug/L
|>	In	115	144607.4				ug/L
|	Pb	207	0.215	67.03	1.6	2.4	ug/L
|	Pb	206	0.282	69.564	2.01	2.9	ug/L

|	Pb	208	0.533	65.815	0.89	1.4	ug/L
|	pb1	208	1.564	66.54	1.35	2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX012
Sample Da Wednesday, September 18, 2013 10:47:33
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX012.936
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens.	RSD
|-	Fe	57	2704	10.821	1523.128	2.758	
|	Zn1	64	153515	8.222	4010.765	3.262	
|	Zn2	66	96106	7.115	676.025	5.152	
|	Zn3	68	68162	4.252	419.676	6.058	
|	Zn4	67	14527	4.206	223.669	3.172	
|	Zn	64	332310	6.791	5330.136	2.148	
|	As	75	164	22.03	111.32	18.132	
|	Y	89	4278	9.112	24	29.167	
|	Cd	111	981	8.406	-25.199	24.611	
|	Cd	114	2312	8.556	20.711	31.975	
|	cd1	114	5559	7.804	67.333	12.804	
|>	In	115	140412	4.945	132858	2.82	
|	Pb	207	32838	7.229	36.333	26.732	
|	Pb	206	41630	10.022	39.333	25.466	
|	Pb	208	79837	8.594	98.001	5.681	
|	pb1	208	233293	9.891	254.001	12.617	
|-	Bi	209	23	28.511	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.008	60.53	9.46	15.6	ug/L
|	Zn1	64	1.063	468.374	34.04	7.3	ug/L
|	Zn2	66	0.679	487.892	22.75	4.7	ug/L
|	Zn3	68	0.483	481.599	15.73	3.3	ug/L
|	Zn4	67	0.102	474.635	30.42	6.4	ug/L
|	Zn	64	2.327	476.935	26.04	5.5	ug/L
|	As	75	0	0.183	0.17	90.5	ug/L
|	Y	89	0.03				ug/L
|	Cd	111	0.007	3.43	0.11	3.3	ug/L
|	Cd	114	0.016	3.384	0.12	3.6	ug/L
|	cd1	114	0.039	3.405	0.1	2.9	ug/L
|>	In	115	140411.8				ug/L
|	Pb	207	0.233	72.717	2.25	3.1	ug/L
|	Pb	206	0.296	72.982	4.09	5.6	ug/L
|	Pb	208	0.567	69.998	3.28	4.7	ug/L
|	pb1	208	1.657	70.496	4.2	6	ug/L

|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX013
Sample Da Wednesday, September 18, 2013 10:50:10
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX013.937
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens.	RSD
|-	Fe	57	7774	2.441	1523.128	2.758	
|	Zn1	64	628339	4.587	4010.765	3.262	
|	Zn2	66	393604	6.951	676.025	5.152	
|	Zn3	68	273648	3.204	419.676	6.058	
|	Zn4	67	59259	4.023	223.669	3.172	
|	Zn	64	1354850	4.284	5330.136	2.148	
|	As	75	376	29.759	111.32	18.132	
|	Y	89	4718	4.222	24	29.167	
|	Cd	111	968	4.797	-25.199	24.611	
|	Cd	114	2146	4.583	20.711	31.975	
|	cd1	114	5220	2.216	67.333	12.804	
|>	In	115	141745	3.64	132858	2.82	
|	Pb	207	44936	2.751	36.333	26.732	
|	Pb	206	63041	2.199	39.333	25.466	
|	Pb	208	112900	0.48	98.001	5.681	
|	pb1	208	331608	1.12	254.001	12.617	
|-	Bi	209	14	44.607	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.043	338.861	21.99	6.5	ug/L
|	Zn1	64	4.41	1942.8	149.49	7.7	ug/L
|	Zn2	66	2.777	1994.723	187.69	9.4	ug/L
|	Zn3	68	1.93	1926.379	123.41	6.4	ug/L
|	Zn4	67	0.417	1942.328	149.61	7.7	ug/L
|	Zn	64	9.535	1954.222	146.23	7.5	ug/L
|	As	75	0.002	0.975	0.43	43.8	ug/L
|	Y	89	0.033				ug/L
|	Cd	111	0.007	3.364	0.25	7.5	ug/L
|	Cd	114	0.015	3.114	0.11	3.7	ug/L
|	cd1	114	0.036	3.168	0.06	1.8	ug/L
|>	In	115	141745.4				ug/L
|	Pb	207	0.317	98.815	6.32	6.4	ug/L
|	Pb	206	0.445	109.829	6.24	5.7	ug/L
|	Pb	208	0.796	98.264	3.24	3.3	ug/L
|	pb1	208	2.34	99.536	4.56	4.6	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report

Sample ID: EX014
Sample Da Wednesday, September 18, 2013 10:52:46
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX014.938
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	3400	4.014	1523.128	2.758	
|	Zn1	64	204720	2.644	4010.765	3.262	
|	Zn2	66	128003	2.134	676.025	5.152	
|	Zn3	68	91986	1.11	419.676	6.058	
|	Zn4	67	19764	1.847	223.669	3.172	
|	Zn	64	444473	1.817	5330.136	2.148	
|	As	75	275	13.679	111.32	18.132	
|	Y	89	6808	5.178	24	29.167	
|	Cd	111	1296	2.147	-25.199	24.611	
|	Cd	114	3244	2.791	20.711	31.975	
|	cd1	114	7690	1.423	67.333	12.804	
|>	In	115	153420	3.534	132858	2.82	
|	Pb	207	50035	3.25	36.333	26.732	
|	Pb	206	65931	1.77	39.333	25.466	
|	Pb	208	121364	1.857	98.001	5.681	
|	pb1	208	356090	2.158	254.001	12.617	
|-	Bi	209	45	22.096	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.011	83.722	12.17	14.5	ug/L
|	Zn1	64	1.305	574.866	20.8	3.6	ug/L
|	Zn2	66	0.83	595.99	17.33	2.9	ug/L
|	Zn3	68	0.597	595.596	15.4	2.6	ug/L
|	Zn4	67	0.127	592.37	19.86	3.4	ug/L
|	Zn	64	2.859	585.921	17.27	2.9	ug/L
|	As	75	0.001	0.514	0.12	23.9	ug/L
|	Y	89	0.044				ug/L
|	Cd	111	0.009	4.137	0.23	5.6	ug/L
|	Cd	114	0.021	4.365	0.23	5.2	ug/L
|	cd1	114	0.05	4.33	0.16	3.7	ug/L
|>	In	115	153419.7				ug/L
|	Pb	207	0.326	101.508	0.68	0.7	ug/L
|	Pb	206	0.43	106.042	3.19	3	ug/L
|	Pb	208	0.791	97.608	4.31	4.4	ug/L
|	pb1	208	2.321	98.716	3.8	3.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX015
Sample Da Wednesday, September 18, 2013 10:55:21
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX015.939
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	2897	2.732	1523.128	2.758	
|	Zn1	64	84511	3.303	4010.765	3.262	
|	Zn2	66	51663	0.702	676.025	5.152	
|	Zn3	68	38105	2.513	419.676	6.058	
|	Zn4	67	8486	2.675	223.669	3.172	
|	Zn	64	182766	2.157	5330.136	2.148	
|	As	75	177	30.011	111.32	18.132	
|	Y	89	4321	2.961	24	29.167	
|	Cd	111	505	9.569	-25.199	24.611	
|	Cd	114	1235	2.086	20.711	31.975	
|	cd1	114	2907	3.204	67.333	12.804	
|>	In	115	152171	3.076	132858	2.82	
|	Pb	207	32864	2.001	36.333	26.732	
|	Pb	206	43157	1.876	39.333	25.466	
|	Pb	208	83277	2.387	98.001	5.681	
|	pb1	208	237654	1.069	254.001	12.617	
|-	Bi	209	18	29.397	60.667	16.511	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.008	59.236	8.46	14.3	ug/L
|	Zn1	64	0.526	231.525	11.68	5	ug/L
|	Zn2	66	0.335	240.342	5.99	2.5	ug/L
|	Zn3	68	0.247	246.877	7.81	3.2	ug/L
|	Zn4	67	0.054	251.856	5.07	2	ug/L
|	Zn	64	1.162	238.089	8.64	3.6	ug/L
|	As	75	0	0.173	0.17	100.1	ug/L
|	Y	89	0.028				ug/L
|	Cd	111	0.004	1.683	0.2	11.9	ug/L
|	Cd	114	0.008	1.654	0.03	1.7	ug/L
|	cd1	114	0.019	1.623	0.08	4.9	ug/L
|>	In	115	152170.7				ug/L
|	Pb	207	0.216	67.222	2.18	3.2	ug/L
|	Pb	206	0.283	69.953	2.28	3.3	ug/L
|	Pb	208	0.547	67.458	1.75	2.6	ug/L
|	pb1	208	1.561	66.385	1.98	3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 10:57:55
Sample Description:
Solution Ty QC Std

Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.940
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5026	4.721	1523.128	2.758
|	Zn1	64	62202	4.568	4010.765	3.262
|	Zn2	66	36703	3.951	676.025	5.152
|	Zn3	68	26741	5.181	419.676	6.058
|	Zn4	67	6277	2.503	223.669	3.172
|	Zn	64	131922	4.183	5330.136	2.148
|	As	75	48214	3.222	111.32	18.132
|	Y	89	30	27.285	24	29.167
|	Cd	111	51666	3.47	-25.199	24.611
|	Cd	114	119477	5.145	20.711	31.975
|	cd1	114	295749	3.983	67.333	12.804
|>	In	115	154015	0.436	132858	2.82
|	Pb	207	74429	2.193	36.333	26.732
|	Pb	206	96258	1.504	39.333	25.466
|	Pb	208	181268	2.785	98.001	5.681
|	pb1	208	525820	1.693	254.001	12.617
|-	Bi	209	30	26.034	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.021	165.174	12.76	7.7	ug/L
|	Zn1	64	0.374	164.634	8.89	5.4	ug/L
|	Zn2	66	0.233	167.542	7.37	4.4	ug/L
|	Zn3	68	0.17	170.158	9.73	5.7	ug/L
|	Zn4	67	0.039	181.926	5.1	2.8	ug/L
|	Zn	64	0.817	167.36	8.09	4.8	ug/L
|	As	75	0.312	167.509	6.08	3.6	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.336	160.576	5.77	3.6	ug/L
|	Cd	114	0.776	161.147	8.9	5.5	ug/L
|	cd1	114	1.92	167.421	7.35	4.4	ug/L
|>	In	115	154014.6				ug/L
|	Pb	207	0.483	150.443	3.16	2.1	ug/L
|	Pb	206	0.625	154.169	2.99	1.9	ug/L
|	Pb	208	1.176	145.126	3.84	2.6	ug/L
|	pb1	208	3.412	145.134	2.39	1.6	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 11:00:49
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.941
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4943	4.68	1523.128	2.758
|	Zn1	64	59859	1.572	4010.765	3.262
|	Zn2	66	36139	3.675	676.025	5.152
|	Zn3	68	26564	1.722	419.676	6.058
|	Zn4	67	6363	4.892	223.669	3.172
|	Zn	64	128924	1.505	5330.136	2.148
|	As	75	48144	2.342	111.32	18.132
|	Y	89	31	32.599	24	29.167
|	Cd	111	49877	4.909	-25.199	24.611
|	Cd	114	114207	4.88	20.711	31.975
|	cd1	114	284073	4.67	67.333	12.804
|>	In	115	152749	0.796	132858	2.82
|	Pb	207	78535	0.789	36.333	26.732
|	Pb	206	96933	2.946	39.333	25.466
|	Pb	208	187756	3.172	98.001	5.681
|	pb1	208	548693	2.342	254.001	12.617
|-	Bi	209	31	12.083	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.021	162.974	10.69	6.6	ug/L
|	Zn1	64	0.362	159.325	2.07	1.3	ug/L
|	Zn2	66	0.231	166.268	4.95	3	ug/L
|	Zn3	68	0.171	170.429	4.09	2.4	ug/L
|	Zn4	67	0.04	186.079	8.19	4.4	ug/L
|	Zn	64	0.804	164.764	1.37	0.8	ug/L
|	As	75	0.314	168.636	3.44	2	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.327	156.264	6.44	4.1	ug/L
|	Cd	114	0.747	155.263	6.43	4.1	ug/L
|	cd1	114	1.859	162.098	6.54	4	ug/L
|>	In	115	152748.5				ug/L
|	Pb	207	0.514	160.072	1.81	1.1	ug/L
|	Pb	206	0.634	156.55	5.44	3.5	ug/L
|	Pb	208	1.229	151.59	5.42	3.6	ug/L
|	pb1	208	3.591	152.719	4.11	2.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 11:03:24
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum

Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.942
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	1733	2.935	1523.128	2.758
|	Zn1	64	1353	2.497	4010.765	3.262
|	Zn2	66	113	5.875	676.025	5.152
|	Zn3	68	79	7.339	419.676	6.058
|	Zn4	67	183	3.196	223.669	3.172
|	Zn	64	1728	1.799	5330.136	2.148
|	As	75	81	32.786	111.32	18.132
|	Y	89	8	43.301	24	29.167
|	Cd	111	7	161.461	-25.199	24.611
|	Cd	114	17	46.318	20.711	31.975
|	cd1	114	107	16.409	67.333	12.804
|>	In	115	148591	1.259	132858	2.82
|	Pb	207	25	19.472	36.333	26.732
|	Pb	206	34	23.542	39.333	25.466
|	Pb	208	50	12.773	98.001	5.681
|	pb1	208	175	10.46	254.001	12.617
|-	Bi	209	3	105.357	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0	1.555	2.26	145.4	ug/L
|	Zn1	64	-0.021	-9.287	0.14	1.5	ug/L
|	Zn2	66	-0.004	-3.107	0.03	0.8	ug/L
|	Zn3	68	-0.003	-2.624	0.04	1.4	ug/L
|	Zn4	67	0	-2.095	0.11	5.3	ug/L
|	Zn	64	-0.028	-5.839	0.06	1	ug/L
|	As	75	0	-0.155	0.1	63.3	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.111	0.03	30.2	ug/L
|	Cd	114	0	-0.008	0.01	142.5	ug/L
|	cd1	114	0	0.018	0.01	59.3	ug/L
|>	In	115	148591.2				ug/L
|	Pb	207	0	-0.032	0.01	33.8	ug/L
|	Pb	206	0	-0.016	0.01	87.9	ug/L
|	Pb	208	0	-0.049	0.01	10.7	ug/L
|	pb1	208	-0.001	-0.031	0.01	18.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX016
Sample Da Wednesday, September 18, 2013 11:05:58
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX016.943
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	3872	3.271	1523.128	2.758
|	Zn1	64	66833	2.676	4010.765	3.262
|	Zn2	66	40488	1.447	676.025	5.152
|	Zn3	68	29016	1.219	419.676	6.058
|	Zn4	67	6313	0.871	223.669	3.172
|	Zn	64	142649	1.761	5330.136	2.148
|	As	75	186	46.741	111.32	18.132
|	Y	89	7719	2.067	24	29.167
|	Cd	111	251	4.706	-25.199	24.611
|	Cd	114	600	5.77	20.711	31.975
|	cd1	114	1427	2.888	67.333	12.804
|>	In	115	150994	3.591	132858	2.82
|	Pb	207	21483	3.579	36.333	26.732
|	Pb	206	27768	6.714	39.333	25.466
|	Pb	208	52689	1.533	98.001	5.681
|	pb1	208	155092	2.59	254.001	12.617
|-	Bi	209	15	35.277	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.014	110.949	13.65	12.3	ug/L
|	Zn1	64	0.413	181.779	5.92	3.3	ug/L
|	Zn2	66	0.263	189.133	7.97	4.2	ug/L
|	Zn3	68	0.189	188.814	7.92	4.2	ug/L
|	Zn4	67	0.04	186.961	6.21	3.3	ug/L
|	Zn	64	0.905	185.55	6.69	3.6	ug/L
|	As	75	0	0.204	0.29	143.7	ug/L
|	Y	89	0.051				ug/L
|	Cd	111	0.002	0.888	0.04	4.9	ug/L
|	Cd	114	0.004	0.793	0.05	6.1	ug/L
|	cd1	114	0.009	0.781	0.04	5.3	ug/L
|>	In	115	150994.1				ug/L
|	Pb	207	0.142	44.263	2.03	4.6	ug/L
|	Pb	206	0.184	45.299	2.22	4.9	ug/L
|	Pb	208	0.348	42.998	1.57	3.6	ug/L
|	pb1	208	1.026	43.632	1.4	3.2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX017
Sample Da Wednesday, September 18, 2013 11:08:33
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth

Dataset Fil C:\Elandata\Dataset\Default\EX017.944
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4490	5.065	1523.128	2.758
|	Zn1	64	222812	2.017	4010.765	3.262
|	Zn2	66	138345	5.487	676.025	5.152
|	Zn3	68	100562	1.387	419.676	6.058
|	Zn4	67	21357	4.201	223.669	3.172
|	Zn	64	483075	2.268	5330.136	2.148
|	As	75	435	1.706	111.32	18.132
|	Y	89	5736	1.039	24	29.167
|	Cd	111	550	6.314	-25.199	24.611
|	Cd	114	1424	3.607	20.711	31.975
|	cd1	114	3347	4.706	67.333	12.804
|>	In	115	152397	1.058	132858	2.82
|	Pb	207	170524	3.804	36.333	26.732
|	Pb	206	220619	4.011	39.333	25.466
|	Pb	208	424256	5.656	98.001	5.681
|	pb1	208	1225678	4.867	254.001	12.617
|-	Bi	209	69	14.803	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.018	140.428	12.59	9	ug/L
|	Zn1	64	1.432	630.866	18.79	3	ug/L
|	Zn2	66	0.903	648.666	41.47	6.4	ug/L
|	Zn3	68	0.657	655.497	14.22	2.2	ug/L
|	Zn4	67	0.138	644.708	28.43	4.4	ug/L
|	Zn	64	3.13	641.613	21.3	3.3	ug/L
|	As	75	0.002	1.082	0.03	2.3	ug/L
|	Y	89	0.037				ug/L
|	Cd	111	0.004	1.816	0.12	6.7	ug/L
|	Cd	114	0.009	1.909	0.07	3.9	ug/L
|	cd1	114	0.021	1.871	0.09	5	ug/L
|>	In	115	152397.3				ug/L
|	Pb	207	1.119	348.481	13.86	4	ug/L
|	Pb	206	1.447	357.126	11.95	3.3	ug/L
|	Pb	208	2.783	343.382	18.61	5.4	ug/L
|	pb1	208	8.041	341.998	16.04	4.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX018
Sample Da Wednesday, September 18, 2013 11:11:08
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX018.945
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2902	5.28	1523.128	2.758
|	Zn1	64	214611	1.023	4010.765	3.262
|	Zn2	66	132165	2.542	676.025	5.152
|	Zn3	68	95130	2.328	419.676	6.058
|	Zn4	67	20119	4.09	223.669	3.172
|	Zn	64	462025	1.542	5330.136	2.148
|	As	75	254	19.397	111.32	18.132
|	Y	89	6445	4.35	24	29.167
|	Cd	111	1416	1.599	-25.199	24.611
|	Cd	114	3339	5.121	20.711	31.975
|	cd1	114	7959	3.669	67.333	12.804
|>	In	115	154944	2.146	132858	2.82
|	Pb	207	70379	1.727	36.333	26.732
|	Pb	206	90127	2.894	39.333	25.466
|	Pb	208	168921	0.97	98.001	5.681
|	pb1	208	497374	0.383	254.001	12.617
|-	Bi	209	72	10.001	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.007	56.68	6.54	11.5	ug/L
|	Zn1	64	1.355	596.97	9.68	1.6	ug/L
|	Zn2	66	0.848	609.022	2.42	0.4	ug/L
|	Zn3	68	0.611	609.769	18.26	3	ug/L
|	Zn4	67	0.128	596.688	19.15	3.2	ug/L
|	Zn	64	2.942	603.025	7.96	1.3	ug/L
|	As	75	0.001	0.433	0.19	43.7	ug/L
|	Y	89	0.041				ug/L
|	Cd	111	0.009	4.463	0.14	3.1	ug/L
|	Cd	114	0.021	4.443	0.14	3.1	ug/L
|	cd1	114	0.051	4.434	0.07	1.7	ug/L
|>	In	115	154943.7				ug/L
|	Pb	207	0.454	141.445	3.99	2.8	ug/L
|	Pb	206	0.581	143.46	1.76	1.2	ug/L
|	Pb	208	1.09	134.466	3.07	2.3	ug/L
|	pb1	208	3.209	136.49	2.48	1.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX019
Sample Da Wednesday, September 18, 2013 11:13:43
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.908
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX019.946
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:

Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	10139	2.767	1523.128	2.758
|	Zn1	64	239891	1.8	4010.765	3.262
|	Zn2	66	149009	0.681	676.025	5.152
|	Zn3	68	105030	2.856	419.676	6.058
|	Zn4	67	22542	1.017	223.669	3.172
|	Zn	64	516472	1.24	5330.136	2.148
|	As	75	380	23.806	111.32	18.132
|	Y	89	4174	4.647	24	29.167
|	Cd	111	505	7.32	-25.199	24.611
|	Cd	114	1142	2.942	20.711	31.975
|	cd1	114	2845	0.601	67.333	12.804
|>	In	115	151300	3.286	132858	2.82
|	Pb	207	20470	4.896	36.333	26.732
|	Pb	206	28659	0.966	39.333	25.466
|	Pb	208	51898	1.066	98.001	5.681
|	pb1	208	152209	1.215	254.001	12.617
|-	Bi	209	30	20.817	60.667	16.511

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.056	433.966	31	7.1	ug/L
|	Zn1	64	1.557	685.882	34.23	5	ug/L
|	Zn2	66	0.981	704.387	27.58	3.9	ug/L
|	Zn3	68	0.691	690.03	25.64	3.7	ug/L
|	Zn4	67	0.147	686.466	28.08	4.1	ug/L
|	Zn	64	3.376	692.04	29.03	4.2	ug/L
|	As	75	0.002	0.896	0.32	35.4	ug/L
|	Y	89	0.027				ug/L
|	Cd	111	0.004	1.689	0.13	7.8	ug/L
|	Cd	114	0.007	1.538	0.09	6	ug/L
|	cd1	114	0.018	1.597	0.06	3.9	ug/L
|>	In	115	151300.4				ug/L
|	Pb	207	0.135	42.046	0.93	2.2	ug/L
|	Pb	206	0.189	46.712	1.86	4	ug/L
|	Pb	208	0.342	42.258	1.24	2.9	ug/L
|	pb1	208	1.005	42.732	1.18	2.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 11:21:01
Sample Description:
Solution Ty Blank
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.947
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1891	4.601		
|	Zn1	64	3213	22.883		
|	Zn2	66	1417	30.351		
|	Zn3	68	988	27.675		
|	Zn4	67	342	29.263		
|	Zn	64	5960	25.687		
|	As	75	-66	59.429		
|	Y	89	26	26.942		
|	Cd	111	0	734.366		
|	Cd	114	12	23.664		
|	cd1	114	33	28.907		
|>	In	115	135607	1.722		
|	Pb	207	31	3.226		
|	Pb	206	38	31.579		
|	Pb	208	81	8.903		
|	pb1	208	230	13.266		
|-	Bi	209	3	43.301		

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57					ug/L
|	Zn1	64					ug/L
|	Zn2	66					ug/L
|	Zn3	68					ug/L
|	Zn4	67					ug/L
|	Zn	64					ug/L
|	As	75					ug/L
|	Y	89					ug/L
|	Cd	111					ug/L
|	Cd	114					ug/L
|	cd1	114					ug/L
|>	In	115					ug/L
|	Pb	207					ug/L
|	Pb	206					ug/L
|	Pb	208					ug/L
|	pb1	208					ug/L
|-	Bi	209					ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard 1
Sample Da Wednesday, September 18, 2013 11:23:35
Sample Description:
Solution Ty Standard
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard 1.948
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD

|-	Fe	57	127955	2.224	1890.53	4.601
|	Zn1	64	33451	2.503	3212.619	22.883
|	Zn2	66	20041	1.009	1417.117	30.351
|	Zn3	68	14042	0.115	988.39	27.675
|	Zn4	67	3212	2.484	341.673	29.263
|	Zn	64	70745	1.198	5959.799	25.687
|	As	75	21207	0.696	-66.107	59.429
|	Y	89	56	15.568	26.333	26.942
|	Cd	111	22209	3.156	0.408	734.366
|	Cd	114	51944	1.249	11.555	23.664
|	cd1	114	124437	0.44	33	28.907
|>	In	115	137275	1.031	135606.8	1.722
|	Pb	207	32525	1.301	31	3.226
|	Pb	206	40075	0.985	38	31.579
|	Pb	208	79264	2.076	81	8.903
|	pb1	208	230498	0.033	230.001	13.266
|-	Bi	209	49	25.345	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.918	5000	68.59	1.4	ug/L
|	Zn1	64	0.22	50	1.75	3.5	ug/L
|	Zn2	66	0.136	50	1.1	2.2	ug/L
|	Zn3	68	0.095	50	0.5	1	ug/L
|	Zn4	67	0.021	50	1.04	2.1	ug/L
|	Zn	64	0.471	50	1.11	2.2	ug/L
|	As	75	0.155	50	0.58	1.2	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.162	50	1.12	2.2	ug/L
|	Cd	114	0.378	50	0.91	1.8	ug/L
|	cd1	114	0.906	50	0.32	0.6	ug/L
|>	In	115	137274.9				ug/L
|	Pb	207	0.237	50	0.37	0.7	ug/L
|	Pb	206	0.292	50	0.99	2	ug/L
|	Pb	208	0.577	50	0.98	2	ug/L
|	pb1	208	1.678	50	0.5	1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard 2
Sample Da Wednesday, September 18, 2013 11:26:11
Sample Description:
Solution Ty Standard
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard 2.949
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	249916	1.309	1890.53	4.601
|	Zn1	64	52109	1.417	3212.619	22.883
|	Zn2	66	32673	2.057	1417.117	30.351
|	Zn3	68	22875	0.969	988.39	27.675
|	Zn4	67	5040	0.92	341.673	29.263
|	Zn	64	112696	0.983	5959.799	25.687
|	As	75	39517	1.843	-66.107	59.429
|	Y	89	52	37.993	26.333	26.942
|	Cd	111	42959	1.774	0.408	734.366
|	Cd	114	100957	2.039	11.555	23.664
|	cd1	114	239189	0.362	33	28.907
|>	In	115	146838	2.6	135606.8	1.722
|	Pb	207	64848	1.626	31	3.226
|	Pb	206	83750	0.762	38	31.579
|	Pb	208	157733	2.238	81	8.903
|	pb1	208	462445	1.388	230.001	13.266
|-	Bi	209	98	7.143	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.689	9828.698	342.29	3.5	ug/L
|	Zn1	64	0.331	93.843	3.06	3.3	ug/L
|	Zn2	66	0.212	94.743	4.67	4.9	ug/L
|	Zn3	68	0.149	94.715	2.57	2.7	ug/L
|	Zn4	67	0.032	94.123	3.55	3.8	ug/L
|	Zn	64	0.724	94.296	3.35	3.5	ug/L
|	As	75	0.27	97.104	3.46	3.6	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.293	97.931	1.38	1.4	ug/L
|	Cd	114	0.688	98.043	4.59	4.7	ug/L
|	cd1	114	1.629	97.802	2.77	2.8	ug/L
|>	In	115	146838				ug/L
|	Pb	207	0.442	98.576	1.78	1.8	ug/L
|	Pb	206	0.57	99.544	2.67	2.7	ug/L
|	Pb	208	1.074	98.542	3.68	3.7	ug/L
|	pb1	208	3.149	98.711	3.33	3.4	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard 3
Sample Da Wednesday, September 18, 2013 11:28:46
Sample Description:
Solution Ty Standard
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard 3.950
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1222578	3.002	1890.53	4.601
|	Zn1	64	241374	2.511	3212.619	22.883
|	Zn2	66	152581	3.097	1417.117	30.351
|	Zn3	68	110936	2.253	988.39	27.675

|	Zn4	67	23619	2.794	341.673	29.263
|	Zn	64	528510	2.229	5959.799	25.687
|	As	75	203258	0.883	-66.107	59.429
|	Y	89	70	27.368	26.333	26.942
|	Cd	111	209656	2.247	0.408	734.366
|	Cd	114	508421	1.077	11.555	23.664
|	cd1	114	1197552	0.214	33	28.907
|>	In	115	142106	1.916	135606.8	1.722
|	Pb	207	319720	1.516	31	3.226
|	Pb	206	408312	1.216	38	31.579
|	Pb	208	788322	0.996	81	8.903
|	pb1	208	2278904	0.364	230.001	13.266
|-	Bi	209	138	7.699	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	8.591	49999.65	1664.5	3.3	ug/L
|	Zn1	64	1.675	498.714	3.72	0.7	ug/L
|	Zn2	66	1.063	498.729	9.43	1.9	ug/L
|	Zn3	68	0.773	499.664	2.31	0.5	ug/L
|	Zn4	67	0.164	499.236	23.58	4.7	ug/L
|	Zn	64	3.675	498.941	2.19	0.4	ug/L
|	As	75	1.431	500.701	5.53	1.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	1.476	499.709	18.78	3.8	ug/L
|	Cd	114	3.579	500.468	14.59	2.9	ug/L
|	cd1	114	8.429	500.279	10.26	2.1	ug/L
|>	In	115	142106.4				ug/L
|	Pb	207	2.25	500.111	8.4	1.7	ug/L
|	Pb	206	2.873	500.073	8.46	1.7	ug/L
|	Pb	208	5.549	500.423	13.87	2.8	ug/L
|	pb1	208	16.038	500.127	7.91	1.6	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 200 ppb
Sample Da Wednesday, September 18, 2013 11:31:23
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\200 ppb.951
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	8569	1.769	1890.53	4.601
|	Zn1	64	100010	1.909	3212.619	22.883
|	Zn2	66	63443	1.336	1417.117	30.351
|	Zn3	68	45510	1.357	988.39	27.675
|	Zn4	67	9827	1.241	341.673	29.263
|	Zn	64	218789	0.847	5959.799	25.687
|	As	75	79965	2.636	-66.107	59.429
|	Y	89	56	12.468	26.333	26.942
|	Cd	111	83846	0.648	0.408	734.366
|	Cd	114	199841	1.098	11.555	23.664
|	cd1	114	473013	0.871	33	28.907
|>	In	115	141227	1.935	135606.8	1.722
|	Pb	207	128939	0.436	31	3.226
|	Pb	206	164501	2.238	38	31.579
|	Pb	208	317263	1.772	81	8.903
|	pb1	208	919135	0.13	230.001	13.266
|-	Bi	209	92	16.412	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.047	272.015	3.84	1.4	ug/L
|	Zn1	64	0.685	203.924	7.98	3.9	ug/L
|	Zn2	66	0.439	205.842	1.48	0.7	ug/L
|	Zn3	68	0.315	203.557	5.21	2.6	ug/L
|	Zn4	67	0.067	204.466	4.76	2.3	ug/L
|	Zn	64	1.506	204.426	5.28	2.6	ug/L
|	As	75	0.567	198.283	3.49	1.8	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.594	201.045	3.49	1.7	ug/L
|	Cd	114	1.415	197.89	2.86	1.4	ug/L
|	cd1	114	3.35	198.805	2.84	1.4	ug/L
|>	In	115	141227.2				ug/L
|	Pb	207	0.913	202.928	3.41	1.7	ug/L
|	Pb	206	1.165	202.729	6.87	3.4	ug/L
|	Pb	208	2.246	202.56	2.2	1.1	ug/L
|	pb1	208	6.508	202.949	4.1	2	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 10 ppb
Sample Da Wednesday, September 18, 2013 11:33:59
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\10 ppb.952
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2347	1.113	1890.53	4.601
|	Zn1	64	10808	5.002	3212.619	22.883
|	Zn2	66	6546	5.175	1417.117	30.351
|	Zn3	68	4713	7.494	988.39	27.675
|	Zn4	67	1146	8.969	341.673	29.263
|	Zn	64	23212	5.599	5959.799	25.687
|	As	75	4047	2.462	-66.107	59.429
|	Y	89	48	15.023	26.333	26.942

|	Cd	111	4407	4.365	0.408	734.366
|	Cd	114	10466	0.374	11.555	23.664
|	cd1	114	24794	0.87	33	28.907
|>	In	115	139290	0.464	135606.8	1.722
|	Pb	207	6893	0.68	31	3.226
|	Pb	206	8863	0.56	38	31.579
|	Pb	208	16799	4.517	81	8.903
|	pb1	208	49764	1.562	230.001	13.266
|-	Bi	209	384	2.225	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.003	16.915	1.3	7.7	ug/L
|	Zn1	64	0.054	16.051	1.17	7.3	ug/L
|	Zn2	66	0.037	17.143	1.15	6.7	ug/L
|	Zn3	68	0.027	17.151	1.64	9.6	ug/L
|	Zn4	67	0.006	17.398	2.35	13.5	ug/L
|	Zn	64	0.123	16.658	1.28	7.7	ug/L
|	As	75	0.03	10.336	0.21	2.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.032	10.71	0.42	3.9	ug/L
|	Cd	114	0.075	10.495	0.08	0.8	ug/L
|	cd1	114	0.178	10.55	0.05	0.5	ug/L
|>	In	115	139289.7				ug/L
|	Pb	207	0.049	10.949	0.13	1.2	ug/L
|	Pb	206	0.063	11.025	0.03	0.3	ug/L
|	Pb	208	0.12	10.824	0.54	5	ug/L
|	pb1	208	0.356	11.089	0.2	1.8	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 10 ppb
Sample Da Wednesday, September 18, 2013 11:36:52
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\10 ppb.953
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2326	4.524	1890.53	4.601
|	Zn1	64	11099	8.729	3212.619	22.883
|	Zn2	66	6674	8.554	1417.117	30.351
|	Zn3	68	4900	7.477	988.39	27.675
|	Zn4	67	1167	3.452	341.673	29.263
|	Zn	64	23840	7.986	5959.799	25.687
|	As	75	4077	3.086	-66.107	59.429
|	Y	89	45	17.693	26.333	26.942
|	Cd	111	4451	0.925	0.408	734.366
|	Cd	114	10208	0.629	11.555	23.664
|	cd1	114	24870	0.167	33	28.907
|>	In	115	139700	4.352	135606.8	1.722
|	Pb	207	6758	2.742	31	3.226
|	Pb	206	8997	1.469	38	31.579
|	Pb	208	16810	2.476	81	8.903
|	pb1	208	49354	0.604	230.001	13.266
|-	Bi	209	441	5.333	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.003	15.827	4.51	28.5	ug/L
|	Zn1	64	0.056	16.689	3.06	18.3	ug/L
|	Zn2	66	0.038	17.592	2.88	16.4	ug/L
|	Zn3	68	0.028	18.032	2.66	14.8	ug/L
|	Zn4	67	0.006	17.826	1.79	10.1	ug/L
|	Zn	64	0.127	17.283	2.84	16.4	ug/L
|	As	75	0.03	10.404	0.74	7.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.032	10.798	0.44	4	ug/L
|	Cd	114	0.073	10.221	0.5	4.9	ug/L
|	cd1	114	0.178	10.564	0.44	4.2	ug/L
|>	In	115	139700				ug/L
|	Pb	207	0.048	10.71	0.33	3.1	ug/L
|	Pb	206	0.064	11.176	0.61	5.5	ug/L
|	Pb	208	0.12	10.815	0.64	5.9	ug/L
|	pb1	208	0.352	10.979	0.51	4.7	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 11:39:26
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.954
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5760	0.4	1890.53	4.601
|	Zn1	64	82374	1.607	3212.619	22.883
|	Zn2	66	50538	0.477	1417.117	30.351
|	Zn3	68	37483	1.819	988.39	27.675
|	Zn4	67	8700	3.099	341.673	29.263
|	Zn	64	179095	1.179	5959.799	25.687
|	As	75	62290	0.808	-66.107	59.429
|	Y	89	48	31.527	26.333	26.942
|	Cd	111	64567	1.008	0.408	734.366
|	Cd	114	150561	0.75	11.555	23.664
|	cd1	114	370640	0.618	33	28.907
|>	In	115	137273	1.149	135606.8	1.722

|	Pb	207	94548	2.902	31	3.226
|	Pb	206	118641	2.04	38	31.579
|	Pb	208	228395	2.408	81	8.903
|	pb1	208	668342	1.095	230.001	13.266
|-	Bi	209	36	31.514	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.028	163.113	2.99	1.8	ug/L
|	Zn1	64	0.576	171.666	4.23	2.5	ug/L
|	Zn2	66	0.358	167.818	2.72	1.6	ug/L
|	Zn3	68	0.266	171.727	3.47	2	ug/L
|	Zn4	67	0.061	185.544	7.36	4	ug/L
|	Zn	64	1.261	171.183	3.45	2	ug/L
|	As	75	0.454	158.948	1.5	0.9	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.47	159.259	2.54	1.6	ug/L
|	Cd	114	1.097	153.364	0.65	0.4	ug/L
|	cd1	114	2.7	160.243	0.86	0.5	ug/L
|>	In	115	137272.7				ug/L
|	Pb	207	0.688	153.03	3.16	2.1	ug/L
|	Pb	206	0.864	150.351	1.57	1	ug/L
|	Pb	208	1.664	150.031	4.9	3.3	ug/L
|	pb1	208	4.867	151.777	1.44	0.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 11:42:01
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.955
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2016	2.75	1890.53	4.601
|	Zn1	64	5196	17.077	3212.619	22.883
|	Zn2	66	2903	16.87	1417.117	30.351
|	Zn3	68	2073	15.474	988.39	27.675
|	Zn4	67	567	14.403	341.673	29.263
|	Zn	64	10739	16.453	5959.799	25.687
|	As	75	-87	45.388	-66.107	59.429
|	Y	89	27	17.722	26.333	26.942
|	Cd	111	5	181.582	0.408	734.366
|	Cd	114	17	69.993	11.555	23.664
|	cd1	114	83	20.412	33	28.907
|>	In	115	133008	4.505	135606.8	1.722
|	Pb	207	37	19.003	31	3.226
|	Pb	206	42	26.02	38	31.579
|	Pb	208	89	14.034	81	8.903
|	pb1	208	247	16.42	230.001	13.266
|-	Bi	209	3	33.333	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	7.272	6.26	86.1	ug/L
|	Zn1	64	0.015	4.568	1.88	41.1	ug/L
|	Zn2	66	0.011	5.323	1.58	29.7	ug/L
|	Zn3	68	0.008	5.348	1.38	25.8	ug/L
|	Zn4	67	0.002	5.327	1.95	36.6	ug/L
|	Zn	64	0.037	4.984	1.68	33.6	ug/L
|	As	75	0	-0.063	0.11	181.8	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.012	0.02	199.1	ug/L
|	Cd	114	0	0.006	0.01	217.8	ug/L
|	cd1	114	0	0.023	0.01	31.2	ug/L
|>	In	115	133008				ug/L
|	Pb	207	0	0.012	0.01	114.6	ug/L
|	Pb	206	0	0.007	0.02	225.2	ug/L
|	Pb	208	0	0.007	0.01	150.5	ug/L
|	pb1	208	0	0.005	0.01	199.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Interference Check
Sample Da Wednesday, September 18, 2013 11:44:35
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Interference Check.956
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1165372	2.001	1890.53	4.601
|	Zn1	64	195484	2.007	3212.619	22.883
|	Zn2	66	114571	1.124	1417.117	30.351
|	Zn3	68	80495	0.322	988.39	27.675
|	Zn4	67	22341	1.204	341.673	29.263
|	Zn	64	412892	1.234	5959.799	25.687
|	As	75	77773	1.209	-66.107	59.429
|	Y	89	212	3.566	26.333	26.942
|	Cd	111	39507	1.163	0.408	734.366
|	Cd	114	97099	1.273	11.555	23.664
|	cd1	114	229258	1.141	33	28.907
|>	In	115	128447	2.291	135606.8	1.722
|	Pb	207	38590	2.31	31	3.226
|	Pb	206	49165	0.587	38	31.579
|	Pb	208	95034	0.586	81	8.903
|	pb1	208	278069	0.752	230.001	13.266

|-	Bi	209	332	8.487	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	9.06	52727.35	628.49	1.2	ug/L
|	Zn1	64	1.499	446.408	18.06	4	ug/L
|	Zn2	66	0.882	413.724	13.95	3.4	ug/L
|	Zn3	68	0.62	400.358	10.29	2.6	ug/L
|	Zn4	67	0.171	522.593	7.53	1.4	ug/L
|	Zn	64	3.172	430.666	14.57	3.4	ug/L
|	As	75	0.606	212.133	7.12	3.4	ug/L
|	Y	89	0.001				ug/L
|	Cd	111	0.308	104.182	3.42	3.3	ug/L
|	Cd	114	0.756	105.727	2.44	2.3	ug/L
|	cd1	114	1.785	105.954	2.58	2.4	ug/L
|>	In	115	128446.9				ug/L
|	Pb	207	0.3	66.776	3.08	4.6	ug/L
|	Pb	206	0.383	66.592	1.84	2.8	ug/L
|	Pb	208	0.74	66.698	1.65	2.5	ug/L
|	pb1	208	2.164	67.486	2.02	3	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: blank
Sample Da Wednesday, September 18, 2013 11:47:10
Sample Description:
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\blank.957
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2009	1.95	1890.53	4.601
|	Zn1	64	7384	13.605	3212.619	22.883
|	Zn2	66	4180	13.829	1417.117	30.351
|	Zn3	68	2967	14.521	988.39	27.675
|	Zn4	67	747	11.133	341.673	29.263
|	Zn	64	15278	13.617	5959.799	25.687
|	As	75	-127	28.174	-66.107	59.429
|	Y	89	35	18.769	26.333	26.942
|	Cd	111	3	113.818	0.408	734.366
|	Cd	114	19	39.203	11.555	23.664
|	cd1	114	51	27.935	33	28.907
|>	In	115	131491	0.286	135606.8	1.722
|	Pb	207	35	11.658	31	3.226
|	Pb	206	38	27.894	38	31.579
|	Pb	208	67	11.912	81	8.903
|	pb1	208	215	8.075	230.001	13.266
|-	Bi	209	2	50	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	7.776	1.48	19.1	ug/L
|	Zn1	64	0.032	9.665	2.24	23.2	ug/L
|	Zn2	66	0.021	10.005	2.03	20.3	ug/L
|	Zn3	68	0.015	9.866	2.09	21.2	ug/L
|	Zn4	67	0.003	9.634	1.89	19.6	ug/L
|	Zn	64	0.072	9.804	2.12	21.6	ug/L
|	As	75	0	-0.167	0.1	57.5	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.007	0.01	131.3	ug/L
|	Cd	114	0	0.008	0.01	97.1	ug/L
|	cd1	114	0	0.008	0.01	75.7	ug/L
|>	In	115	131490.9				ug/L
|	Pb	207	0	0.008	0.01	86.7	ug/L
|	Pb	206	0	0.002	0.01	718.3	ug/L
|	Pb	208	0	-0.008	0.01	70.3	ug/L
|	pb1	208	0	-0.002	0	220.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX001 all 50x bio
Sample Da Wednesday, September 18, 2013 11:49:45
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX001 all 50x bio.958
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5075	1.5	1890.53	4.601
|	Zn1	64	232973	1.224	3212.619	22.883
|	Zn2	66	145912	1.655	1417.117	30.351
|	Zn3	68	105009	1.8	988.39	27.675
|	Zn4	67	22076	0.415	341.673	29.263
|	Zn	64	505969	0.916	5959.799	25.687
|	As	75	95	43.433	-66.107	59.429
|	Y	89	10265	2.434	26.333	26.942
|	Cd	111	1663	0.144	0.408	734.366
|	Cd	114	3790	1.087	11.555	23.664
|	cd1	114	9051	1.018	33	28.907
|>	In	115	134890	3.566	135606.8	1.722
|	Pb	207	60994	1.243	31	3.226
|	Pb	206	79218	2.247	38	31.579
|	Pb	208	148496	1.96	81	8.903
|	pb1	208	435386	1.485	230.001	13.266
|-	Bi	209	104	1.923	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.024	138.099	11.2	8.1	ug/L

|	Zn1	64	1.705	507.828	24.15	4.8 ug/L
|	Zn2	66	1.072	503.035	23.16	4.6 ug/L
|	Zn3	68	0.772	498.5	9.55	1.9 ug/L
|	Zn4	67	0.161	491.637	19.95	4.1 ug/L
|	Zn	64	3.711	503.759	20.52	4.1 ug/L
|	As	75	0.001	0.417	0.11	25.4 ug/L
|	Y	89	0.076			ug/L
|	Cd	111	0.012	4.176	0.16	3.7 ug/L
|	Cd	114	0.028	3.92	0.12	3.2 ug/L
|	cd1	114	0.067	3.97	0.12	2.9 ug/L
|>	In	115	134889.9			ug/L
|	Pb	207	0.452	100.52	2.76	2.7 ug/L
|	Pb	206	0.588	102.288	5.74	5.6 ug/L
|	Pb	208	1.101	99.339	4.89	4.9 ug/L
|	pb1	208	3.23	100.715	4.98	4.9 ug/L
|-	Bi	209	0.001			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX002
Sample Da Wednesday, September 18, 2013 11:52:21
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX002.959
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	3699	1.917	1890.53	4.601
|	Zn1	64	123316	1.645	3212.619	22.883
|	Zn2	66	75509	3.229	1417.117	30.351
|	Zn3	68	54923	1.345	988.39	27.675
|	Zn4	67	11760	2.557	341.673	29.263
|	Zn	64	265507	1.969	5959.799	25.687
|	As	75	24	236.715	-66.107	59.429
|	Y	89	6104	3.05	26.333	26.942
|	Cd	111	696	6.756	0.408	734.366
|	Cd	114	1696	2.883	11.555	23.664
|	cd1	114	4024	1.79	33	28.907
|>	In	115	132800	2.598	135606.8	1.722
|	Pb	207	27861	1.746	31	3.226
|	Pb	206	36490	2.049	38	31.579
|	Pb	208	67171	2.521	81	8.903
|	pb1	208	198444	1.086	230.001	13.266
|-	Bi	209	59	9.437	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.014	81.087	7.24	8.9	ug/L
|	Zn1	64	0.905	269.567	7.27	2.7	ug/L
|	Zn2	66	0.558	261.88	8.63	3.3	ug/L
|	Zn3	68	0.406	262.571	3.74	1.4	ug/L
|	Zn4	67	0.086	262.363	10.14	3.9	ug/L
|	Zn	64	1.956	265.551	6.76	2.5	ug/L
|	As	75	0.001	0.231	0.14	62.7	ug/L
|	Y	89	0.046				ug/L
|	Cd	111	0.005	1.774	0.09	4.9	ug/L
|	Cd	114	0.013	1.775	0.09	5.2	ug/L
|	cd1	114	0.03	1.785	0.08	4.3	ug/L
|>	In	115	132799.7				ug/L
|	Pb	207	0.21	46.588	0.43	0.9	ug/L
|	Pb	206	0.275	47.777	0.63	1.3	ug/L
|	Pb	208	0.505	45.583	1.63	3.6	ug/L
|	pb1	208	1.493	46.557	0.7	1.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX003
Sample Da Wednesday, September 18, 2013 11:54:57
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX003.960
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5084	2.546	1890.53	4.601
|	Zn1	64	375085	1.839	3212.619	22.883
|	Zn2	66	234832	2.113	1417.117	30.351
|	Zn3	68	168395	1.455	988.39	27.675
|	Zn4	67	35625	1.855	341.673	29.263
|	Zn	64	813936	1.793	5959.799	25.687
|	As	75	185	40.748	-66.107	59.429
|	Y	89	7317	1.146	26.333	26.942
|	Cd	111	1619	2.63	0.408	734.366
|	Cd	114	3767	0.554	11.555	23.664
|	cd1	114	9023	0.339	33	28.907
|>	In	115	140232	3.411	135606.8	1.722
|	Pb	207	70551	0.059	31	3.226
|	Pb	206	97491	1.091	38	31.579
|	Pb	208	176296	4.08	81	8.903
|	pb1	208	518652	1.268	230.001	13.266
|-	Bi	209	60	23.333	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.022	130.131	12.55	9.6	ug/L
|	Zn1	64	2.653	790.126	32.92	4.2	ug/L
|	Zn2	66	1.665	781.144	27.14	3.5	ug/L
|	Zn3	68	1.195	771.808	30.15	3.9	ug/L
|	Zn4	67	0.252	767.407	35.19	4.6	ug/L

|	Zn	64	5.765	782.665	30.64	3.9	ug/L
|	As	75	0.002	0.629	0.17	27.8	ug/L
|	Y	89	0.052				ug/L
|	Cd	111	0.012	3.908	0.08	2	ug/L
|	Cd	114	0.027	3.748	0.15	4	ug/L
|	cd1	114	0.064	3.807	0.12	3.1	ug/L
|>	In	115	140232.4				ug/L
|	Pb	207	0.503	111.865	3.91	3.5	ug/L
|	Pb	206	0.695	121.004	2.85	2.4	ug/L
|	Pb	208	1.259	113.522	8.62	7.6	ug/L
|	pb1	208	3.701	115.404	5.46	4.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EXOO4
Sample Da Wednesday, September 18, 2013 11:57:34
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EXOO4.961
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	5437	3.997	1890.53	4.601
|	Zn1	64	144806	3.143	3212.619	22.883
|	Zn2	66	88394	3.678	1417.117	30.351
|	Zn3	68	63594	2.417	988.39	27.675
|	Zn4	67	13621	1.663	341.673	29.263
|	Zn	64	310416	2.816	5959.799	25.687
|	As	75	22	445.581	-66.107	59.429
|	Y	89	6881	1.721	26.333	26.942
|	Cd	111	717	3.921	0.408	734.366
|	Cd	114	1615	2.639	11.555	23.664
|	cd1	114	3939	2.248	33	28.907
|>	In	115	134310	0.352	135606.8	1.722
|	Pb	207	18499	2.456	31	3.226
|	Pb	206	25120	1.36	38	31.579
|	Pb	208	45958	2.357	81	8.903
|	pb1	208	135883	0.98	230.001	13.266
|-	Bi	209	29	31.653	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.027	154.44	8.66	5.6	ug/L
|	Zn1	64	1.055	314.029	11.19	3.6	ug/L
|	Zn2	66	0.648	303.849	12.35	4.1	ug/L
|	Zn3	68	0.466	301.239	8.44	2.8	ug/L
|	Zn4	67	0.099	301.451	5.52	1.8	ug/L
|	Zn	64	2.267	307.835	9.96	3.2	ug/L
|	As	75	0.001	0.229	0.26	113.1	ug/L
|	Y	89	0.051				ug/L
|	Cd	111	0.005	1.808	0.08	4.2	ug/L
|	Cd	114	0.012	1.67	0.04	2.3	ug/L
|	cd1	114	0.029	1.726	0.04	2.3	ug/L
|>	In	115	134310.2				ug/L
|	Pb	207	0.138	30.563	0.65	2.1	ug/L
|	Pb	206	0.187	32.5	0.46	1.4	ug/L
|	Pb	208	0.342	30.805	0.66	2.2	ug/L
|	pb1	208	1.01	31.495	0.2	0.6	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX005
Sample Da Wednesday, September 18, 2013 12:00:11
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX005.962
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	13575	2.759	1890.53	4.601
|	Zn1	64	12094439	1.02	3212.619	22.883
|	Zn2	66	7570292	0.682	1417.117	30.351
|	Zn3	68	5367904	1.758	988.39	27.675
|	Zn4	67	1220206	2.544	341.673	29.263
|	Zn	64	26252841	0.968	5959.799	25.687
|	As	75	7680	0.91	-66.107	59.429
|	Y	89	10694	1.553	26.333	26.942
|	Cd	111	18658	1.821	0.408	734.366
|	Cd	114	44883	2.743	11.555	23.664
|	cd1	114	106767	1.773	33	28.907
|>	In	115	131561	0.583	135606.8	1.722
|	Pb	207	1161812	1.691	31	3.226
|	Pb	206	1609157	2.261	38	31.579
|	Pb	208	3954343	2.123	81	8.903
|	pb1	208	10588167	1.083	230.001	13.266
|-	Bi	209	40	15.207	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.089	519.336	13.22	2.5	ug/L
|	Zn1	64	91.909	27369.26	328.05	1.2	ug/L
|	Zn2	66	57.534	26988.53	288.32	1.1	ug/L
|	Zn3	68	40.795	26358.69	499.42	1.9	ug/L
|	Zn4	67	9.272	28260.83	568.21	2	ug/L
|	Zn	64	199.51	27086.43	309	1.1	ug/L
|	As	75	0.059	20.595	0.23	1.1	ug/L
|	Y	89	0.081				ug/L
|	Cd	111	0.142	48.018	1.1	2.3	ug/L

|	Cd	114	0.341	47.69	1.03	2.2 ug/L
|	cd1	114	0.811	48.15	0.58	1.2 ug/L
|>	In	115	131561			ug/L
|	Pb	207	8.831	1962.928	36.62	1.9 ug/L
|	Pb	206	12.232	2128.767	59.34	2.8 ug/L
|	Pb	208	30.055	2710.551	42.3	1.6 ug/L
|	pb1	208	80.478	2509.588	12.56	0.5 ug/L
|-	Bi	209	0			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX006
Sample Da Wednesday, September 18, 2013 12:02:47
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX006.963
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	4040	2.412	1890.53	4.601
|	Zn1	64	191068	1.54	3212.619	22.883
|	Zn2	66	119863	1.396	1417.117	30.351
|	Zn3	68	84352	1.295	988.39	27.675
|	Zn4	67	18265	1.891	341.673	29.263
|	Zn	64	413548	1.143	5959.799	25.687
|	As	75	41	7.688	-66.107	59.429
|	Y	89	5408	0.395	26.333	26.942
|	Cd	111	1122	1.671	0.408	734.366
|	Cd	114	2731	2.828	11.555	23.664
|	cd1	114	6497	2.399	33	28.907
|>	In	115	133509	2.461	135606.8	1.722
|	Pb	207	67162	0.524	31	3.226
|	Pb	206	87385	2.015	38	31.579
|	Pb	208	164463	2.975	81	8.903
|	pb1	208	480703	1.698	230.001	13.266
|-	Bi	209	57	17.208	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.016	95.056	6.59	6.9	ug/L
|	Zn1	64	1.408	419.239	9.61	2.3	ug/L
|	Zn2	66	0.888	416.321	5.14	1.2	ug/L
|	Zn3	68	0.625	403.652	9.97	2.5	ug/L
|	Zn4	67	0.134	409.519	14.09	3.4	ug/L
|	Zn	64	3.054	414.686	8.03	1.9	ug/L
|	As	75	0.001	0.277	0.01	3.6	ug/L
|	Y	89	0.04				ug/L
|	Cd	111	0.008	2.844	0.07	2.5	ug/L
|	Cd	114	0.02	2.85	0.11	4	ug/L
|	cd1	114	0.048	2.876	0.13	4.4	ug/L
|>	In	115	133509.4				ug/L
|	Pb	207	0.503	111.802	2.28	2	ug/L
|	Pb	206	0.655	113.924	4.47	3.9	ug/L
|	Pb	208	1.232	111.133	5.79	5.2	ug/L
|	pb1	208	3.601	112.298	4.56	4.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX007
Sample Da Wednesday, September 18, 2013 12:05:21
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX007.964
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	7633	1.147	1890.53	4.601
|	Zn1	64	490529	2.977	3212.619	22.883
|	Zn2	66	304765	2.5	1417.117	30.351
|	Zn3	68	211978	2.812	988.39	27.675
|	Zn4	67	45952	0.693	341.673	29.263
|	Zn	64	1053225	1.58	5959.799	25.687
|	As	75	371	6.517	-66.107	59.429
|	Y	89	9609	2.721	26.333	26.942
|	Cd	111	928	1.584	0.408	734.366
|	Cd	114	2221	0.772	11.555	23.664
|	cd1	114	5253	1.654	33	28.907
|>	In	115	132663	0.474	135606.8	1.722
|	Pb	207	72780	1.38	31	3.226
|	Pb	206	97457	1.708	38	31.579
|	Pb	208	180380	1.937	81	8.903
|	pb1	208	528320	1.035	230.001	13.266
|-	Bi	209	128	17.38	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.044	253.73	2.72	1.1	ug/L
|	Zn1	64	3.674	1094.12	36.75	3.4	ug/L
|	Zn2	66	2.287	1072.669	21.85	2	ug/L
|	Zn3	68	1.591	1027.784	32.89	3.2	ug/L
|	Zn4	67	0.344	1048.141	8.9	0.8	ug/L
|	Zn	64	7.895	1071.925	19.9	1.9	ug/L
|	As	75	0.003	1.15	0.07	5.8	ug/L
|	Y	89	0.072				ug/L
|	Cd	111	0.007	2.367	0.03	1.2	ug/L
|	Cd	114	0.017	2.329	0.02	0.9	ug/L
|	cd1	114	0.039	2.336	0.05	2	ug/L
|>	In	115	132663.1				ug/L
|	Pb	207	0.548	121.889	1.14	0.9	ug/L

|	Pb	206	0.734	127.804	2.68	2.1	ug/L
|	Pb	208	1.359	122.567	1.79	1.5	ug/L
|	pb1	208	3.981	124.132	0.93	0.7	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX008
Sample Da Wednesday, September 18, 2013 12:07:56
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX008.965
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	3177	1.861	1890.53	4.601
|	Zn1	64	196544	0.748	3212.619	22.883
|	Zn2	66	123159	0.697	1417.117	30.351
|	Zn3	68	88408	2.539	988.39	27.675
|	Zn4	67	18544	0.665	341.673	29.263
|	Zn	64	426655	0.469	5959.799	25.687
|	As	75	-47	240.787	-66.107	59.429
|	Y	89	5597	4.306	26.333	26.942
|	Cd	111	1214	4.293	0.408	734.366
|	Cd	114	2845	1.858	11.555	23.664
|	cd1	114	6843	3.312	33	28.907
|>	In	115	131798	1.17	135606.8	1.722
|	Pb	207	49328	2.682	31	3.226
|	Pb	206	63226	1.871	38	31.579
|	Pb	208	120151	1.272	81	8.903
|	pb1	208	350748	0.592	230.001	13.266
|-	Bi	209	40	21.795	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.01	59.161	1.8	3	ug/L
|	Zn1	64	1.468	437.041	3.09	0.7	ug/L
|	Zn2	66	0.924	433.495	7.3	1.7	ug/L
|	Zn3	68	0.664	428.8	15.09	3.5	ug/L
|	Zn4	67	0.138	421.231	6.48	1.5	ug/L
|	Zn	64	3.194	433.579	6.37	1.5	ug/L
|	As	75	0	0.048	0.3	624.1	ug/L
|	Y	89	0.042				ug/L
|	Cd	111	0.009	3.117	0.12	4	ug/L
|	Cd	114	0.021	3.006	0.04	1.3	ug/L
|	cd1	114	0.052	3.067	0.1	3.2	ug/L
|>	In	115	131797.9				ug/L
|	Pb	207	0.374	83.158	2.9	3.5	ug/L
|	Pb	206	0.48	83.454	2.4	2.9	ug/L
|	Pb	208	0.911	82.167	1.02	1.2	ug/L
|	pb1	208	2.66	82.946	1.42	1.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX009
Sample Da Wednesday, September 18, 2013 12:10:30
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX009.966
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	3898	3.021	1890.53	4.601
|	Zn1	64	191943	1.02	3212.619	22.883
|	Zn2	66	117363	0.975	1417.117	30.351
|	Zn3	68	84985	2.908	988.39	27.675
|	Zn4	67	18238	0.709	341.673	29.263
|	Zn	64	412529	1.2	5959.799	25.687
|	As	75	-19	36.869	-66.107	59.429
|	Y	89	8660	0.637	26.333	26.942
|	Cd	111	912	1.802	0.408	734.366
|	Cd	114	2116	2.27	11.555	23.664
|	cd1	114	5073	1.252	33	28.907
|>	In	115	134181	1.597	135606.8	1.722
|	Pb	207	33317	2.928	31	3.226
|	Pb	206	44264	0.917	38	31.579
|	Pb	208	83656	1.055	81	8.903
|	pb1	208	243970	1.442	230.001	13.266
|-	Bi	209	33	12.121	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.015	87.995	7.77	8.8	ug/L
|	Zn1	64	1.407	418.947	2.52	0.6	ug/L
|	Zn2	66	0.864	405.442	5.53	1.4	ug/L
|	Zn3	68	0.626	404.513	9.89	2.4	ug/L
|	Zn4	67	0.133	406.648	3.67	0.9	ug/L
|	Zn	64	3.031	411.458	3.8	0.9	ug/L
|	As	75	0	0.12	0.02	14.8	ug/L
|	Y	89	0.064				ug/L
|	Cd	111	0.007	2.3	0.04	1.5	ug/L
|	Cd	114	0.016	2.194	0.08	3.8	ug/L
|	cd1	114	0.038	2.23	0.06	2.7	ug/L
|>	In	115	134181.4				ug/L
|	Pb	207	0.248	55.143	1.59	2.9	ug/L
|	Pb	206	0.33	57.372	1.24	2.2	ug/L
|	Pb	208	0.623	56.187	1.37	2.4	ug/L
|	pb1	208	1.817	56.653	1.06	1.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 12:13:05
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.967
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5733	2.245	1890.53	4.601
|	Zn1	64	85217	1.195	3212.619	22.883
|	Zn2	66	52065	0.585	1417.117	30.351
|	Zn3	68	37722	1.021	988.39	27.675
|	Zn4	67	8694	1.223	341.673	29.263
|	Zn	64	183698	0.934	5959.799	25.687
|	As	75	61090	2.111	-66.107	59.429
|	Y	89	59	10.31	26.333	26.942
|	Cd	111	62529	3.101	0.408	734.366
|	Cd	114	149966	1.213	11.555	23.664
|	cd1	114	364800	0.301	33	28.907
|>	In	115	133748	1.503	135606.8	1.722
|	Pb	207	91963	3.963	31	3.226
|	Pb	206	114637	1.365	38	31.579
|	Pb	208	222660	2.383	81	8.903
|	pb1	208	648496	1.157	230.001	13.266
|-	Bi	209	30	11.578	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.029	168.361	6.67	4	ug/L
|	Zn1	64	0.614	182.695	2.49	1.4	ug/L
|	Zn2	66	0.379	177.723	1.97	1.1	ug/L
|	Zn3	68	0.275	177.55	3.43	1.9	ug/L
|	Zn4	67	0.062	190.48	2.3	1.2	ug/L
|	Zn	64	1.33	180.522	2.47	1.4	ug/L
|	As	75	0.457	160.03	5.19	3.2	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.468	158.285	4.42	2.8	ug/L
|	Cd	114	1.121	156.822	4.22	2.7	ug/L
|	cd1	114	2.728	161.896	2.77	1.7	ug/L
|>	In	115	133747.6				ug/L
|	Pb	207	0.687	152.757	4.44	2.9	ug/L
|	Pb	206	0.857	149.15	3.87	2.6	ug/L
|	Pb	208	1.665	150.145	5.8	3.9	ug/L
|	pb1	208	4.848	151.181	3.7	2.4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 12:15:39
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.968
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2008	1.892	1890.53	4.601
|	Zn1	64	5589	15.281	3212.619	22.883
|	Zn2	66	3089	17.081	1417.117	30.351
|	Zn3	68	2269	17.778	988.39	27.675
|	Zn4	67	601	15.268	341.673	29.263
|	Zn	64	11548	16.197	5959.799	25.687
|	As	75	-91	40.373	-66.107	59.429
|	Y	89	27	25.956	26.333	26.942
|	Cd	111	5	96.14	0.408	734.366
|	Cd	114	24	27.797	11.555	23.664
|	cd1	114	89	13.355	33	28.907
|>	In	115	132270	2.184	135606.8	1.722
|	Pb	207	39	18.49	31	3.226
|	Pb	206	48	22.235	38	31.579
|	Pb	208	80	17.134	81	8.903
|	pb1	208	252	8.932	230.001	13.266
|-	Bi	209	2	50	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	7.202	0.76	10.5	ug/L
|	Zn1	64	0.019	5.538	2.02	36.4	ug/L
|	Zn2	66	0.013	6.06	1.94	32	ug/L
|	Zn3	68	0.01	6.389	2.1	32.8	ug/L
|	Zn4	67	0.002	6.181	2.21	35.8	ug/L
|	Zn	64	0.043	5.897	2.01	34.1	ug/L
|	As	75	0	-0.073	0.1	142	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.012	0.01	104	ug/L
|	Cd	114	0	0.014	0.01	55.1	ug/L
|	cd1	114	0	0.026	0.01	23.8	ug/L
|>	In	115	132270				ug/L
|	Pb	207	0	0.015	0.01	81	ug/L
|	Pb	206	0	0.014	0.01	106.3	ug/L
|	Pb	208	0	0	0.01	1990.7	ug/L
|	pb1	208	0	0.006	0.01	90.4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010
Sample Da Wednesday, September 18, 2013 12:18:13
Sample De BIO

Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010.969
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	6029	1.57	1890.53	4.601
|	Zn1	64	41911	3.115	3212.619	22.883
|	Zn2	66	25586	2.612	1417.117	30.351
|	Zn3	68	18375	3.282	988.39	27.675
|	Zn4	67	4052	4.352	341.673	29.263
|	Zn	64	89923	2.638	5959.799	25.687
|	As	75	71	71.269	-66.107	59.429
|	Y	89	5008	0.352	26.333	26.942
|	Cd	111	134	12.436	0.408	734.366
|	Cd	114	358	6.375	11.555	23.664
|	cd1	114	821	1.473	33	28.907
|>	In	115	133757	0.479	135606.8	1.722
|	Pb	207	4705	1.703	31	3.226
|	Pb	206	6166	1.481	38	31.579
|	Pb	208	11315	2.776	81	8.903
|	pb1	208	33316	1.776	230.001	13.266
|-	Bi	209	6	61.974	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.031	181.17	2.87	1.6	ug/L
|	Zn1	64	0.29	86.259	3.18	3.7	ug/L
|	Zn2	66	0.181	84.829	2.36	2.8	ug/L
|	Zn3	68	0.13	84.058	3.26	3.9	ug/L
|	Zn4	67	0.028	84.637	3.58	4.2	ug/L
|	Zn	64	0.628	85.31	2.62	3.1	ug/L
|	As	75	0.001	0.355	0.13	37	ug/L
|	Y	89	0.037				ug/L
|	Cd	111	0.001	0.337	0.04	12.7	ug/L
|	Cd	114	0.003	0.362	0.02	6.7	ug/L
|	cd1	114	0.006	0.35	0.01	1.5	ug/L
|>	In	115	133757.4				ug/L
|	Pb	207	0.035	7.767	0.11	1.5	ug/L
|	Pb	206	0.046	7.974	0.13	1.7	ug/L
|	Pb	208	0.084	7.575	0.18	2.4	ug/L
|	pb1	208	0.247	7.714	0.13	1.6	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010-DUP
Sample Da Wednesday, September 18, 2013 12:20:48
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010-DUP.970
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5914	2.855	1890.53	4.601
|	Zn1	64	40997	2.902	3212.619	22.883
|	Zn2	66	25675	3.415	1417.117	30.351
|	Zn3	68	18153	1.182	988.39	27.675
|	Zn4	67	4162	3.754	341.673	29.263
|	Zn	64	88987	2.372	5959.799	25.687
|	As	75	39	45.119	-66.107	59.429
|	Y	89	5002	1.844	26.333	26.942
|	Cd	111	133	9.457	0.408	734.366
|	Cd	114	322	10.304	11.555	23.664
|	cd1	114	760	5.888	33	28.907
|>	In	115	134560	3.524	135606.8	1.722
|	Pb	207	4348	2.282	31	3.226
|	Pb	206	5730	1.142	38	31.579
|	Pb	208	10662	2.531	81	8.903
|	pb1	208	31237	0.468	230.001	13.266
|-	Bi	209	10	52.068	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.03	174.839	10.3	5.9	ug/L
|	Zn1	64	0.281	83.733	3.64	4.3	ug/L
|	Zn2	66	0.18	84.606	0.6	0.7	ug/L
|	Zn3	68	0.128	82.515	2.64	3.2	ug/L
|	Zn4	67	0.028	86.6	1.44	1.7	ug/L
|	Zn	64	0.618	83.857	2.36	2.8	ug/L
|	As	75	0.001	0.272	0.04	15.8	ug/L
|	Y	89	0.037				ug/L
|	Cd	111	0.001	0.334	0.02	6.6	ug/L
|	Cd	114	0.002	0.323	0.05	14.1	ug/L
|	cd1	114	0.005	0.322	0.03	9.1	ug/L
|>	In	115	134560.1				ug/L
|	Pb	207	0.032	7.134	0.13	1.8	ug/L
|	Pb	206	0.042	7.366	0.18	2.5	ug/L
|	Pb	208	0.079	7.094	0.16	2.2	ug/L
|	pb1	208	0.231	7.191	0.22	3.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010-SPK
Sample Da Wednesday, September 18, 2013 12:23:23
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum

Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010-SPK.971
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens.	RSD
|-	Fe	57	5751	2.219	1890.53	4.601	
|	Zn1	64	70128	2.018	3212.619	22.883	
|	Zn2	66	43612	2.62	1417.117	30.351	
|	Zn3	68	30667	3.851	988.39	27.675	
|	Zn4	67	6716	4.835	341.673	29.263	
|	Zn	64	151124	2.347	5959.799	25.687	
|	As	75	20535	1.337	-66.107	59.429	
|	Y	89	5032	2.393	26.333	26.942	
|	Cd	111	23403	1.177	0.408	734.366	
|	Cd	114	55011	1.912	11.555	23.664	
|	cd1	114	131966	1.646	33	28.907	
|>	In	115	134090	0.795	135606.8	1.722	
|	Pb	207	34303	2.268	31	3.226	
|	Pb	206	43258	1.504	38	31.579	
|	Pb	208	84542	2.61	81	8.903	
|	pb1	208	246475	1.424	230.001	13.266	
|-	Bi	209	12	16.667	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.029	168.484	4.03	2.4	ug/L
|	Zn1	64	0.499	148.691	3.23	2.2	ug/L
|	Zn2	66	0.315	147.659	3.14	2.1	ug/L
|	Zn3	68	0.221	143.069	5.85	4.1	ug/L
|	Zn4	67	0.048	144.949	6.18	4.3	ug/L
|	Zn	64	1.083	147.044	3.33	2.3	ug/L
|	As	75	0.154	53.758	0.99	1.8	ug/L
|	Y	89	0.037				ug/L
|	Cd	111	0.175	59.089	0.43	0.7	ug/L
|	Cd	114	0.41	57.353	0.64	1.1	ug/L
|	cd1	114	0.984	58.396	0.81	1.4	ug/L
|>	In	115	134089.7				ug/L
|	Pb	207	0.256	56.818	1.6	2.8	ug/L
|	Pb	206	0.322	56.101	1.29	2.3	ug/L
|	Pb	208	0.63	56.809	1.45	2.5	ug/L
|	pb1	208	1.837	57.273	1.21	2.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-1
Sample Da Wednesday, September 18, 2013 12:25:59
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual

Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-1.972
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens.	RSD
|-	Fe	57	2140	1.319	1890.53	4.601	
|	Zn1	64	5540	16.238	3212.619	22.883	
|	Zn2	66	3089	18.236	1417.117	30.351	
|	Zn3	68	2205	16.467	988.39	27.675	
|	Zn4	67	647	11.061	341.673	29.263	
|	Zn	64	11481	16.501	5959.799	25.687	
|	As	75	-119	94.201	-66.107	59.429	
|	Y	89	25	25.069	26.333	26.942	
|	Cd	111	3	24.866	0.408	734.366	
|	Cd	114	13	22.855	11.555	23.664	
|	cd1	114	48	4.778	33	28.907	
|>	In	115	136874	1.612	135606.8	1.722	
|	Pb	207	44	22.254	31	3.226	
|	Pb	206	49	13.497	38	31.579	
|	Pb	208	87	4.144	81	8.903	
|	pb1	208	270	7.143	230.001	13.266	
|-	Bi	209	3	17.321	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.002	9.89	2.38	24.1	ug/L
|	Zn1	64	0.017	5.014	2.08	41.5	ug/L
|	Zn2	66	0.012	5.702	2.04	35.8	ug/L
|	Zn3	68	0.009	5.711	1.81	31.7	ug/L
|	Zn4	67	0.002	6.753	1.78	26.3	ug/L
|	Zn	64	0.04	5.437	1.99	36.7	ug/L
|	As	75	0	-0.137	0.29	212.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.006	0	30.3	ug/L
|	Cd	114	0	0.002	0	200.9	ug/L
|	cd1	114	0	0.007	0	20	ug/L
|>	In	115	136874.3				ug/L
|	Pb	207	0	0.021	0.02	71.8	ug/L
|	Pb	206	0	0.014	0.01	58.5	ug/L
|	Pb	208	0	0.003	0	88.5	ug/L
|	pb1	208	0	0.009	0	40.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-SPK-1
Sample Da Wednesday, September 18, 2013 12:28:35
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam

Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-SPK-1.973
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2051	7.611	1890.53	4.601
|	Zn1	64	37552	1.691	3212.619	22.883
|	Zn2	66	22419	2.973	1417.117	30.351
|	Zn3	68	16239	3.745	988.39	27.675
|	Zn4	67	3643	4.092	341.673	29.263
|	Zn	64	79853	2.199	5959.799	25.687
|	As	75	23777	1.916	-66.107	59.429
|	Y	89	43	11.628	26.333	26.942
|	Cd	111	23331	1.422	0.408	734.366
|	Cd	114	54912	3.453	11.555	23.664
|	cd1	114	131819	0.385	33	28.907
|>	In	115	133959	2.741	135606.8	1.722
|	Pb	207	31737	4.392	31	3.226
|	Pb	206	39841	1.901	38	31.579
|	Pb	208	75900	2.776	81	8.903
|	pb1	208	223624	0.533	230.001	13.266
|-	Bi	209	3	33.333	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	8.085	8.68	107.3	ug/L
|	Zn1	64	0.257	76.44	1.03	1.3	ug/L
|	Zn2	66	0.157	73.601	0.7	0.9	ug/L
|	Zn3	68	0.114	73.646	3.36	4.6	ug/L
|	Zn4	67	0.025	75.258	4.21	5.6	ug/L
|	Zn	64	0.552	74.979	1.45	1.9	ug/L
|	As	75	0.178	62.289	1.2	1.9	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.174	58.996	1.95	3.3	ug/L
|	Cd	114	0.41	57.373	3.49	6.1	ug/L
|	cd1	114	0.984	58.421	1.77	3	ug/L
|>	In	115	133959.1				ug/L
|	Pb	207	0.237	52.596	1.04	2	ug/L
|	Pb	206	0.297	51.721	0.86	1.7	ug/L
|	Pb	208	0.567	51.094	2.72	5.3	ug/L
|	pb1	208	1.668	52.026	1.29	2.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX011
Sample Da Wednesday, September 18, 2013 12:31:11
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX011.974

Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4629	2.611	1890.53	4.601
|	Zn1	64	380054	1.499	3212.619	22.883
|	Zn2	66	235299	0.555	1417.117	30.351
|	Zn3	68	170358	0.774	988.39	27.675
|	Zn4	67	35217	1.806	341.673	29.263
|	Zn	64	820928	0.675	5959.799	25.687
|	As	75	228	27.046	-66.107	59.429
|	Y	89	3235	1.67	26.333	26.942
|	Cd	111	931	0.436	0.408	734.366
|	Cd	114	2167	3.77	11.555	23.664
|	cd1	114	5259	2.62	33	28.907
|>	In	115	133153	0.612	135606.8	1.722
|	Pb	207	37214	2.123	31	3.226
|	Pb	206	48980	0.395	38	31.579
|	Pb	208	89333	1.356	81	8.903
|	pb1	208	263890	0.058	230.001	13.266
|-	Bi	209	29	25.236	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.021	121.186	5.98	4.9	ug/L
|	Zn1	64	2.83	842.881	7.64	0.9	ug/L
|	Zn2	66	1.757	824.052	2.68	0.3	ug/L
|	Zn3	68	1.272	821.981	9.97	1.2	ug/L
|	Zn4	67	0.262	798.582	19.23	2.4	ug/L
|	Zn	64	6.121	831.067	0.77	0.1	ug/L
|	As	75	0.002	0.769	0.16	20.8	ug/L
|	Y	89	0.024				ug/L
|	Cd	111	0.007	2.367	0.02	0.7	ug/L
|	Cd	114	0.016	2.264	0.1	4.4	ug/L
|	cd1	114	0.039	2.33	0.07	3	ug/L
|>	In	115	133152.5				ug/L
|	Pb	207	0.279	62.068	0.96	1.5	ug/L
|	Pb	206	0.368	63.968	0.32	0.5	ug/L
|	Pb	208	0.67	60.458	1.19	2	ug/L
|	pb1	208	1.98	61.75	0.4	0.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX012
Sample Da Wednesday, September 18, 2013 12:33:48
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX012.975
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac

Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	3575	3.722	1890.53	4.601
|	Zn1	64	230542	1.498	3212.619	22.883
|	Zn2	66	141134	1.809	1417.117	30.351
|	Zn3	68	100360	2.32	988.39	27.675
|	Zn4	67	21467	1.604	341.673	29.263
|	Zn	64	493503	1.652	5959.799	25.687
|	As	75	-2	2310.911	-66.107	59.429
|	Y	89	5089	5.188	26.333	26.942
|	Cd	111	1341	2.209	0.408	734.366
|	Cd	114	3106	1.533	11.555	23.664
|	cd1	114	7415	0.988	33	28.907
|>	In	115	129557	0.859	135606.8	1.722
|	Pb	207	40141	0.116	31	3.226
|	Pb	206	52987	1.753	38	31.579
|	Pb	208	98426	1.438	81	8.903
|	pb1	208	289098	1.574	230.001	13.266
|-	Bi	209	35	5.714	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.014	79.479	5.96	7.5	ug/L
|	Zn1	64	1.756	522.863	8.24	1.6	ug/L
|	Zn2	66	1.079	506.132	10.19	2	ug/L
|	Zn3	68	0.767	495.803	11.04	2.2	ug/L
|	Zn4	67	0.163	497.352	4.96	1	ug/L
|	Zn	64	3.765	511.198	8.71	1.7	ug/L
|	As	75	0	0.165	0.14	86.5	ug/L
|	Y	89	0.039				ug/L
|	Cd	111	0.01	3.505	0.08	2.2	ug/L
|	Cd	114	0.024	3.341	0.07	2	ug/L
|	cd1	114	0.057	3.383	0.04	1.2	ug/L
|>	In	115	129556.9				ug/L
|	Pb	207	0.31	68.822	0.65	1	ug/L
|	Pb	206	0.409	71.131	1.44	2	ug/L
|	Pb	208	0.759	68.462	0.81	1.2	ug/L
|	pb1	208	2.23	69.531	0.92	1.3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX013
Sample Da Wednesday, September 18, 2013 12:36:25
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX013.976
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	9368	1.297	1890.53	4.601
|	Zn1	64	888373	2.063	3212.619	22.883
|	Zn2	66	545137	2.266	1417.117	30.351
|	Zn3	68	392795	1.047	988.39	27.675
|	Zn4	67	83672	1.368	341.673	29.263
|	Zn	64	1909977	1.061	5959.799	25.687
|	As	75	339	21.522	-66.107	59.429
|	Y	89	5283	4.45	26.333	26.942
|	Cd	111	1169	5.131	0.408	734.366
|	Cd	114	2776	2.899	11.555	23.664
|	cd1	114	6629	1.13	33	28.907
|>	In	115	129847	0.625	135606.8	1.722
|	Pb	207	53176	1.354	31	3.226
|	Pb	206	74263	1.623	38	31.579
|	Pb	208	132577	0.872	81	8.903
|	pb1	208	392067	1.104	230.001	13.266
|-	Bi	209	16	12.745	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.058	338.749	4.96	1.5	ug/L
|	Zn1	64	6.818	2030.404	46.36	2.3	ug/L
|	Zn2	66	4.188	1964.694	54.8	2.8	ug/L
|	Zn3	68	3.018	1949.977	32.54	1.7	ug/L
|	Zn4	67	0.642	1956.453	18.67	1	ug/L
|	Zn	64	14.666	1991.193	32.16	1.6	ug/L
|	As	75	0.003	1.085	0.2	18.6	ug/L
|	Y	89	0.04				ug/L
|	Cd	111	0.009	3.048	0.14	4.6	ug/L
|	Cd	114	0.021	2.978	0.1	3.2	ug/L
|	cd1	114	0.051	3.015	0.02	0.6	ug/L
|>	In	115	129846.6				ug/L
|	Pb	207	0.409	90.984	1.67	1.8	ug/L
|	Pb	206	0.572	99.481	1.21	1.2	ug/L
|	Pb	208	1.02	92.035	1.34	1.5	ug/L
|	pb1	208	3.018	94.107	1.16	1.2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX014
Sample Da Wednesday, September 18, 2013 12:39:01
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX014.977
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	3998	1.991	1890.53	4.601
|	Zn1	64	282884	1.047	3212.619	22.883
|	Zn2	66	175876	1.398	1417.117	30.351
|	Zn3	68	125402	2.202	988.39	27.675
|	Zn4	67	27162	1.885	341.673	29.263
|	Zn	64	611324	0.838	5959.799	25.687
|	As	75	63	53.082	-66.107	59.429
|	Y	89	7862	1.647	26.333	26.942
|	Cd	111	1675	1.773	0.408	734.366
|	Cd	114	3879	2.109	11.555	23.664
|	cd1	114	9172	1.787	33	28.907
|>	In	115	133668	1.292	135606.8	1.722
|	Pb	207	57941	2.288	31	3.226
|	Pb	206	74664	2.339	38	31.579
|	Pb	208	143747	2.168	81	8.903
|	pb1	208	416116	1.617	230.001	13.266
|-	Bi	209	68	16.449	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.016	92.994	5.59	6	ug/L
|	Zn1	64	2.093	623.217	9.27	1.5	ug/L
|	Zn2	66	1.305	612.343	7.92	1.3	ug/L
|	Zn3	68	0.931	601.417	6.88	1.1	ug/L
|	Zn4	67	0.201	611.779	14.36	2.3	ug/L
|	Zn	64	4.53	614.98	4.23	0.7	ug/L
|	As	75	0.001	0.336	0.09	26.8	ug/L
|	Y	89	0.059				ug/L
|	Cd	111	0.013	4.242	0.13	3	ug/L
|	Cd	114	0.029	4.046	0.09	2.2	ug/L
|	cd1	114	0.068	4.059	0.09	2.2	ug/L
|>	In	115	133667.7				ug/L
|	Pb	207	0.433	96.299	1.75	1.8	ug/L
|	Pb	206	0.558	97.188	3.4	3.5	ug/L
|	Pb	208	1.075	96.936	1.88	1.9	ug/L
|	pb1	208	3.112	97.039	2.3	2.4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX015
Sample Da Wednesday, September 18, 2013 12:41:36
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX015.978
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	3368	0.953	1890.53	4.601
|	Zn1	64	121539	2.142	3212.619	22.883
|	Zn2	66	73778	3.529	1417.117	30.351
|	Zn3	68	52451	2.926	988.39	27.675
|	Zn4	67	11320	2.533	341.673	29.263
|	Zn	64	259089	0.762	5959.799	25.687
|	As	75	-64	120.917	-66.107	59.429
|	Y	89	4681	0.199	26.333	26.942
|	Cd	111	621	1.208	0.408	734.366
|	Cd	114	1477	3.386	11.555	23.664
|	cd1	114	3565	2.241	33	28.907
|>	In	115	129258	2.934	135606.8	1.722
|	Pb	207	37552	1.042	31	3.226
|	Pb	206	48221	0.948	38	31.579
|	Pb	208	91932	1.849	81	8.903
|	pb1	208	269130	0.747	230.001	13.266
|-	Bi	209	21	39.867	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.012	70.562	3.74	5.3	ug/L
|	Zn1	64	0.917	273.185	12.9	4.7	ug/L
|	Zn2	66	0.56	262.818	1.78	0.7	ug/L
|	Zn3	68	0.399	257.767	14.98	5.8	ug/L
|	Zn4	67	0.085	259.551	14.34	5.5	ug/L
|	Zn	64	1.962	266.338	9.02	3.4	ug/L
|	As	75	0	0.001	0.2	29093.8	ug/L
|	Y	89	0.036				ug/L
|	Cd	111	0.005	1.626	0.04	2.2	ug/L
|	Cd	114	0.011	1.588	0.09	5.8	ug/L
|	cd1	114	0.027	1.624	0.08	4.7	ug/L
|>	In	115	129258.2				ug/L
|	Pb	207	0.29	64.55	1.37	2.1	ug/L
|	Pb	206	0.373	64.918	2.26	3.5	ug/L
|	Pb	208	0.711	64.125	2.15	3.4	ug/L
|	pb1	208	2.082	64.918	2.22	3.4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 12:44:11
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.979
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5793	0.587	1890.53	4.601
|	Zn1	64	83109	0.901	3212.619	22.883
|	Zn2	66	50878	1.971	1417.117	30.351

|	Zn3	68	36904	1.273	988.39	27.675
|	Zn4	67	8567	1.033	341.673	29.263
|	Zn	64	179458	1.003	5959.799	25.687
|	As	75	60251	1.377	-66.107	59.429
|	Y	89	50	8.959	26.333	26.942
|	Cd	111	62948	1.978	0.408	734.366
|	Cd	114	147123	1.648	11.555	23.664
|	cd1	114	359292	1.019	33	28.907
|>	In	115	136135	1.622	135606.8	1.722
|	Pb	207	89983	1.419	31	3.226
|	Pb	206	114222	1.051	38	31.579
|	Pb	208	217252	1.349	81	8.903
|	pb1	208	638886	0.327	230.001	13.266
|-	Bi	209	30	12.019	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.029	166.55	4.71	2.8	ug/L
|	Zn1	64	0.587	174.773	3.36	1.9	ug/L
|	Zn2	66	0.363	170.442	4.42	2.6	ug/L
|	Zn3	68	0.264	170.496	5.12	3	ug/L
|	Zn4	67	0.06	184.185	5.13	2.8	ug/L
|	Zn	64	1.275	173.04	3.85	2.2	ug/L
|	As	75	0.443	155.057	3.48	2.2	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.462	156.544	0.71	0.5	ug/L
|	Cd	114	1.081	151.134	3.35	2.2	ug/L
|	cd1	114	2.639	156.654	2.94	1.9	ug/L
|>	In	115	136135.5				ug/L
|	Pb	207	0.661	146.897	3.35	2.3	ug/L
|	Pb	206	0.839	146.005	3.63	2.5	ug/L
|	Pb	208	1.595	143.89	2.51	1.7	ug/L
|	pb1	208	4.692	146.319	2.52	1.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 12:46:45
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.980
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1917	2.968	1890.53	4.601
|	Zn1	64	4466	11.944	3212.619	22.883
|	Zn2	66	2478	13.272	1417.117	30.351
|	Zn3	68	1776	15.767	988.39	27.675
|	Zn4	67	517	7.204	341.673	29.263
|	Zn	64	9237	12.738	5959.799	25.687
|	As	75	-54	92.113	-66.107	59.429
|	Y	89	24	10.634	26.333	26.942
|	Cd	111	0	349.687	0.408	734.366
|	Cd	114	18	55.68	11.555	23.664
|	cd1	114	74	20.417	33	28.907
|>	In	115	129152	0.646	135606.8	1.722
|	Pb	207	35	14.286	31	3.226
|	Pb	206	41	13.58	38	31.579
|	Pb	208	76	17.883	81	8.903
|	pb1	208	225	3.56	230.001	13.266
|-	Bi	209	2	65.465	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	5.239	2.34	44.6	ug/L
|	Zn1	64	0.011	3.247	1.26	38.8	ug/L
|	Zn2	66	0.009	4.1	1.22	29.8	ug/L
|	Zn3	68	0.006	4.18	1.43	34.1	ug/L
|	Zn4	67	0.001	4.525	0.94	20.8	ug/L
|	Zn	64	0.028	3.747	1.27	33.8	ug/L
|	As	75	0	0.024	0.14	575.3	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0	0	1780.2	ug/L
|	Cd	114	0	0.008	0.01	141.9	ug/L
|	cd1	114	0	0.02	0.01	36	ug/L
|>	In	115	129151.9				ug/L
|	Pb	207	0	0.009	0.01	87.6	ug/L
|	Pb	206	0	0.006	0.01	116.7	ug/L
|	Pb	208	0	-0.001	0.01	1888.6	ug/L
|	pb1	208	0	0.002	0	138.6	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX016
Sample Da Wednesday, September 18, 2013 12:49:19
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX016.981
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4627	1.394	1890.53	4.601
|	Zn1	64	92719	0.487	3212.619	22.883
|	Zn2	66	56315	1.857	1417.117	30.351
|	Zn3	68	40820	1.074	988.39	27.675
|	Zn4	67	8757	2.63	341.673	29.263
|	Zn	64	198610	0.49	5959.799	25.687
|	As	75	88	57.212	-66.107	59.429

|	Y	89	8739	1.571	26.333	26.942
|	Cd	111	299	1.636	0.408	734.366
|	Cd	114	688	1.368	11.555	23.664
|	cd1	114	1687	1.165	33	28.907
|>	In	115	130315	0.406	135606.8	1.722
|	Pb	207	24649	1.319	31	3.226
|	Pb	206	32656	2.698	38	31.579
|	Pb	208	59865	2.115	81	8.903
|	pb1	208	178832	1.626	230.001	13.266
|-	Bi	209	22	31.416	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.022	125.512	2.14	1.7	ug/L
|	Zn1	64	0.688	204.825	1.82	0.9	ug/L
|	Zn2	66	0.422	197.828	4.58	2.3	ug/L
|	Zn3	68	0.306	197.678	1.54	0.8	ug/L
|	Zn4	67	0.065	197.134	5.06	2.6	ug/L
|	Zn	64	1.48	200.955	1.84	0.9	ug/L
|	As	75	0.001	0.407	0.14	33.3	ug/L
|	Y	89	0.067				ug/L
|	Cd	111	0.002	0.777	0.01	1.6	ug/L
|	Cd	114	0.005	0.727	0.01	1.1	ug/L
|	cd1	114	0.013	0.754	0.01	1.4	ug/L
|>	In	115	130314.6				ug/L
|	Pb	207	0.189	41.993	0.54	1.3	ug/L
|	Pb	206	0.25	43.559	1	2.3	ug/L
|	Pb	208	0.459	41.376	0.76	1.8	ug/L
|	pb1	208	1.371	42.739	0.53	1.2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX017
Sample Da Wednesday, September 18, 2013 12:51:54
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX017.982
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5371	3.001	1890.53	4.601
|	Zn1	64	313125	1.353	3212.619	22.883
|	Zn2	66	191099	2.122	1417.117	30.351
|	Zn3	68	138344	0.878	988.39	27.675
|	Zn4	67	28837	1.084	341.673	29.263
|	Zn	64	671405	0.663	5959.799	25.687
|	As	75	261	26.602	-66.107	59.429
|	Y	89	6527	3.289	26.333	26.942
|	Cd	111	731	5.386	0.408	734.366
|	Cd	114	1695	3.174	11.555	23.664
|	cd1	114	4063	2.066	33	28.907
|>	In	115	131746	2.272	135606.8	1.722
|	Pb	207	195384	0.906	31	3.226
|	Pb	206	251732	2.738	38	31.579
|	Pb	208	475594	1.684	81	8.903
|	pb1	208	1400609	0.809	230.001	13.266
|-	Bi	209	83	9.41	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.027	156.087	1.95	1.3	ug/L
|	Zn1	64	2.354	701.084	25.44	3.6	ug/L
|	Zn2	66	1.44	675.661	16.08	2.4	ug/L
|	Zn3	68	1.043	673.952	13.36	2	ug/L
|	Zn4	67	0.216	659.626	8.29	1.3	ug/L
|	Zn	64	5.054	686.179	17.75	2.6	ug/L
|	As	75	0.002	0.863	0.18	20.7	ug/L
|	Y	89	0.049				ug/L
|	Cd	111	0.006	1.879	0.11	5.9	ug/L
|	Cd	114	0.013	1.787	0.02	0.9	ug/L
|	cd1	114	0.031	1.816	0.01	0.5	ug/L
|>	In	115	131746.2				ug/L
|	Pb	207	1.483	329.676	6.05	1.8	ug/L
|	Pb	206	1.912	332.682	15.15	4.6	ug/L
|	Pb	208	3.611	325.67	11.33	3.5	ug/L
|	pb1	208	10.634	331.619	10.26	3.1	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX018
Sample Da Wednesday, September 18, 2013 12:54:29
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX018.983
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	3389	5.671	1890.53	4.601
|	Zn1	64	291519	0.379	3212.619	22.883
|	Zn2	66	175715	2.349	1417.117	30.351
|	Zn3	68	129842	2.061	988.39	27.675
|	Zn4	67	27549	1.403	341.673	29.263
|	Zn	64	624624	1.174	5959.799	25.687
|	As	75	112	49.155	-66.107	59.429
|	Y	89	7219	1.516	26.333	26.942
|	Cd	111	1760	2.131	0.408	734.366
|	Cd	114	4085	1.694	11.555	23.664
|	cd1	114	9786	1.512	33	28.907

|>	In	115	132423	2.579	135606.8	1.722
|	Pb	207	76671	1.74	31	3.226
|	Pb	206	102039	2.169	38	31.579
|	Pb	208	191826	1.782	81	8.903
|	pb1	208	563090	1.162	230.001	13.266
|-	Bi	209	84	5.39	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.012	67.983	11.68	17.2	ug/L
|	Zn1	64	2.179	648.761	15.2	2.3	ug/L
|	Zn2	66	1.317	617.57	1.57	0.3	ug/L
|	Zn3	68	0.973	628.964	13.71	2.2	ug/L
|	Zn4	67	0.206	626.725	18.37	2.9	ug/L
|	Zn	64	4.674	634.592	10.47	1.6	ug/L
|	As	75	0.001	0.464	0.14	30.2	ug/L
|	Y	89	0.054				ug/L
|	Cd	111	0.013	4.5	0.04	0.8	ug/L
|	Cd	114	0.031	4.303	0.1	2.3	ug/L
|	cd1	114	0.074	4.373	0.09	2	ug/L
|>	In	115	132422.7				ug/L
|	Pb	207	0.579	128.667	1.75	1.4	ug/L
|	Pb	206	0.771	134.155	6.18	4.6	ug/L
|	Pb	208	1.448	130.616	2.07	1.6	ug/L
|	pb1	208	4.252	132.588	2.66	2	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX019
Sample Da Wednesday, September 18, 2013 12:57:04
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX019.984
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	12074	1.323	1890.53	4.601
|	Zn1	64	317395	0.641	3212.619	22.883
|	Zn2	66	198751	3.026	1417.117	30.351
|	Zn3	68	138327	1.359	988.39	27.675
|	Zn4	67	29458	3.19	341.673	29.263
|	Zn	64	683931	0.577	5959.799	25.687
|	As	75	309	15.472	-66.107	59.429
|	Y	89	4819	2.717	26.333	26.942
|	Cd	111	611	10.421	0.408	734.366
|	Cd	114	1452	7.757	11.555	23.664
|	cd1	114	3437	4.279	33	28.907
|>	In	115	134726	0.797	135606.8	1.722
|	Pb	207	23906	0.841	31	3.226
|	Pb	206	33450	1.996	38	31.579
|	Pb	208	59693	0.909	81	8.903
|	pb1	208	176883	1.702	230.001	13.266
|-	Bi	209	38	10.526	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.076	440.494	10.19	2.3	ug/L
|	Zn1	64	2.332	694.533	8.72	1.3	ug/L
|	Zn2	66	1.465	687.107	19.89	2.9	ug/L
|	Zn3	68	1.02	658.752	14.15	2.1	ug/L
|	Zn4	67	0.216	658.89	24.89	3.8	ug/L
|	Zn	64	5.033	683.278	7.87	1.2	ug/L
|	As	75	0.003	0.973	0.13	13.3	ug/L
|	Y	89	0.036				ug/L
|	Cd	111	0.005	1.533	0.15	9.7	ug/L
|	Cd	114	0.011	1.495	0.12	8.3	ug/L
|	cd1	114	0.025	1.5	0.08	5.1	ug/L
|>	In	115	134725.6				ug/L
|	Pb	207	0.177	39.391	0.17	0.4	ug/L
|	Pb	206	0.248	43.164	1.12	2.6	ug/L
|	Pb	208	0.443	39.909	0.67	1.7	ug/L
|	pb1	208	1.311	40.891	0.81	2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX020
Sample Da Wednesday, September 18, 2013 12:59:39
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX020.985
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4658	3.061	1890.53	4.601
|	Zn1	64	83656	1.177	3212.619	22.883
|	Zn2	66	51159	1.195	1417.117	30.351
|	Zn3	68	37608	3.407	988.39	27.675
|	Zn4	67	8078	3.771	341.673	29.263
|	Zn	64	180501	1.316	5959.799	25.687
|	As	75	37	186.856	-66.107	59.429
|	Y	89	5911	1.757	26.333	26.942
|	Cd	111	428	5.208	0.408	734.366
|	Cd	114	946	4.185	11.555	23.664
|	cd1	114	2351	1.528	33	28.907
|>	In	115	133257	1.485	135606.8	1.722
|	Pb	207	13288	0.739	31	3.226
|	Pb	206	17110	4.813	38	31.579
|	Pb	208	31789	2.491	81	8.903

|	pb1	208	93916	1.084	230.001	13.266
|-	Bi	209	19	53.415	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.021	122.326	7.59	6.2	ug/L
|	Zn1	64	0.604	179.898	1.31	0.7	ug/L
|	Zn2	66	0.374	175.223	4.2	2.4	ug/L
|	Zn3	68	0.275	177.602	3.53	2	ug/L
|	Zn4	67	0.058	177.05	4.28	2.4	ug/L
|	Zn	64	1.311	177.936	1.14	0.6	ug/L
|	As	75	0.001	0.269	0.18	67.7	ug/L
|	Y	89	0.044				ug/L
|	Cd	111	0.003	1.086	0.05	4.5	ug/L
|	Cd	114	0.007	0.981	0.06	5.6	ug/L
|	cd1	114	0.017	1.033	0.03	2.8	ug/L
|>	In	115	133257.5				ug/L
|	Pb	207	0.1	22.117	0.38	1.7	ug/L
|	Pb	206	0.128	22.297	1.02	4.6	ug/L
|	Pb	208	0.238	21.468	0.84	3.9	ug/L
|	pb1	208	0.703	21.928	0.45	2.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX020-DUP
Sample Da Wednesday, September 18, 2013 13:02:15
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX020-DUP.986
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4682	5.025	1890.53	4.601
|	Zn1	64	84518	2.599	3212.619	22.883
|	Zn2	66	52887	2.957	1417.117	30.351
|	Zn3	68	38075	2.063	988.39	27.675
|	Zn4	67	8295	1.382	341.673	29.263
|	Zn	64	183775	2.183	5959.799	25.687
|	As	75	8	1084.554	-66.107	59.429
|	Y	89	6007	1.757	26.333	26.942
|	Cd	111	434	6.441	0.408	734.366
|	Cd	114	1018	3.366	11.555	23.664
|	cd1	114	2419	1.868	33	28.907
|>	In	115	134388	1.186	135606.8	1.722
|	Pb	207	13332	0.956	31	3.226
|	Pb	206	17391	0.404	38	31.579
|	Pb	208	33225	2.609	81	8.903
|	pb1	208	96743	0.453	230.001	13.266
|-	Bi	209	24	7.217	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.021	121.568	8.12	6.7	ug/L
|	Zn1	64	0.605	180.213	3.41	1.9	ug/L
|	Zn2	66	0.383	179.725	6.03	3.4	ug/L
|	Zn3	68	0.276	178.348	3.01	1.7	ug/L
|	Zn4	67	0.059	180.493	4.8	2.7	ug/L
|	Zn	64	1.324	179.692	3.53	2	ug/L
|	As	75	0.001	0.19	0.21	112.3	ug/L
|	Y	89	0.045				ug/L
|	Cd	111	0.003	1.092	0.08	7.3	ug/L
|	Cd	114	0.007	1.047	0.04	3.7	ug/L
|	cd1	114	0.018	1.054	0.02	2	ug/L
|>	In	115	134388.5				ug/L
|	Pb	207	0.099	22.002	0.33	1.5	ug/L
|	Pb	206	0.129	22.474	0.25	1.1	ug/L
|	Pb	208	0.247	22.249	0.81	3.6	ug/L
|	pb1	208	0.718	22.398	0.37	1.6	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX020-SPK
Sample Da Wednesday, September 18, 2013 13:04:51
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX020-SPK.987
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4581	1.03	1890.53	4.601
|	Zn1	64	113385	3.157	3212.619	22.883
|	Zn2	66	70715	2.435	1417.117	30.351
|	Zn3	68	50629	2.34	988.39	27.675
|	Zn4	67	10802	2.297	341.673	29.263
|	Zn	64	245531	2.482	5959.799	25.687
|	As	75	21424	0.785	-66.107	59.429
|	Y	89	5619	1.958	26.333	26.942
|	Cd	111	23430	0.511	0.408	734.366
|	Cd	114	56147	1.798	11.555	23.664
|	cd1	114	133430	1.076	33	28.907
|>	In	115	138563	0.788	135606.8	1.722
|	Pb	207	42230	0.57	31	3.226
|	Pb	206	53407	0.526	38	31.579
|	Pb	208	102345	2.37	81	8.903
|	pb1	208	300736	0.93	230.001	13.266
|-	Bi	209	17	16.654	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit

|-	Fe	57	0.019	111.289	2.43	2.2 ug/L
|	Zn1	64	0.795	236.614	7.01	3 ug/L
|	Zn2	66	0.5	234.477	4.03	1.7 ug/L
|	Zn3	68	0.358	231.362	4.36	1.9 ug/L
|	Zn4	67	0.075	229.921	4.04	1.8 ug/L
|	Zn	64	1.728	234.594	4.79	2 ug/L
|	As	75	0.155	54.269	0.3	0.6 ug/L
|	Y	89	0.04			ug/L
|	Cd	111	0.169	57.249	0.19	0.3 ug/L
|	Cd	114	0.405	56.648	0.67	1.2 ug/L
|	cd1	114	0.963	57.137	0.23	0.4 ug/L
|>	In	115	138563.1			ug/L
|	Pb	207	0.305	67.692	0.15	0.2 ug/L
|	Pb	206	0.385	67.03	0.32	0.5 ug/L
|	Pb	208	0.738	66.556	1.16	1.7 ug/L
|	pb1	208	2.169	67.627	0.23	0.3 ug/L
|-	Bi	209	0			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-2
Sample Da Wednesday, September 18, 2013 13:07:27
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-2.988
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1922	1.643	1890.53	4.601
|	Zn1	64	4225	15.078	3212.619	22.883
|	Zn2	66	2323	17.64	1417.117	30.351
|	Zn3	68	1662	15.542	988.39	27.675
|	Zn4	67	529	9.112	341.673	29.263
|	Zn	64	8740	15.452	5959.799	25.687
|	As	75	-77	100.834	-66.107	59.429
|	Y	89	12	17.843	26.333	26.942
|	Cd	111	0	212.427	0.408	734.366
|	Cd	114	13	20.32	11.555	23.664
|	cd1	114	41	9.16	33	28.907
|>	In	115	133791	3.606	135606.8	1.722
|	Pb	207	35	17.06	31	3.226
|	Pb	206	44	6.996	38	31.579
|	Pb	208	95	18.965	81	8.903
|	pb1	208	277	7.872	230.001	13.266
|-	Bi	209	6	44.096	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0	2.511	2.09	83.3	ug/L
|	Zn1	64	0.008	2.356	1.42	60.3	ug/L
|	Zn2	66	0.007	3.247	1.41	43.4	ug/L
|	Zn3	68	0.005	3.318	1.2	36	ug/L
|	Zn4	67	0.001	4.391	1.17	26.7	ug/L
|	Zn	64	0.021	2.907	1.35	46.6	ug/L
|	As	75	0	-0.027	0.2	738.8	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0	0	2290.3	ug/L
|	Cd	114	0	0.002	0	189.7	ug/L
|	cd1	114	0	0.004	0	26.9	ug/L
|>	In	115	133791.2				ug/L
|	Pb	207	0	0.008	0.01	109.5	ug/L
|	Pb	206	0	0.008	0	30.1	ug/L
|	Pb	208	0	0.01	0.01	111	ug/L
|	pb1	208	0	0.012	0	38.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-SPK-2
Sample Da Wednesday, September 18, 2013 13:10:04
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-SPK-2.989
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1916	1.792	1890.53	4.601
|	Zn1	64	36970	3.638	3212.619	22.883
|	Zn2	66	22497	2.841	1417.117	30.351
|	Zn3	68	15953	1.977	988.39	27.675
|	Zn4	67	3657	3.208	341.673	29.263
|	Zn	64	79077	2.792	5959.799	25.687
|	As	75	23610	0.493	-66.107	59.429
|	Y	89	25	2.341	26.333	26.942
|	Cd	111	23523	1.843	0.408	734.366
|	Cd	114	55724	0.948	11.555	23.664
|	cd1	114	133040	1.575	33	28.907
|>	In	115	133418	2.773	135606.8	1.722
|	Pb	207	32347	0.49	31	3.226
|	Pb	206	40768	1.649	38	31.579
|	Pb	208	77052	1.107	81	8.903
|	pb1	208	226064	0.708	230.001	13.266
|-	Bi	209	4	13.323	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0	2.437	0.82	33.6	ug/L
|	Zn1	64	0.254	75.512	4.02	5.3	ug/L
|	Zn2	66	0.158	74.268	4.06	5.5	ug/L
|	Zn3	68	0.112	72.57	1.79	2.5	ug/L

|	Zn4	67	0.025	75.944	4.26	5.6 ug/L
|	Zn	64	0.549	74.553	3.5	4.7 ug/L
|	As	75	0.178	62.125	1.95	3.1 ug/L
|	Y	89	0			ug/L
|	Cd	111	0.176	59.712	1.49	2.5 ug/L
|	Cd	114	0.418	58.426	1.91	3.3 ug/L
|	cd1	114	0.997	59.201	1.99	3.4 ug/L
|>	In	115	133418.3			ug/L
|	Pb	207	0.242	53.868	1.55	2.9 ug/L
|	Pb	206	0.305	53.157	1.73	3.3 ug/L
|	Pb	208	0.577	52.068	1.99	3.8 ug/L
|	pb1	208	1.693	52.805	1.13	2.1 ug/L
|-	Bi	209	0			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: NIST-2711
Sample Da Wednesday, September 18, 2013 13:12:41
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\NIST-2711.990
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	6144	1.175	1890.53	4.601
|	Zn1	64	20836	4.948	3212.619	22.883
|	Zn2	66	12570	5.543	1417.117	30.351
|	Zn3	68	9179	2.928	988.39	27.675
|	Zn4	67	2167	4.8	341.673	29.263
|	Zn	64	44751	4.554	5959.799	25.687
|	As	75	4838	2.378	-66.107	59.429
|	Y	89	7991	3.383	26.333	26.942
|	Cd	111	3279	1.454	0.408	734.366
|	Cd	114	7811	2.062	11.555	23.664
|	cd1	114	18773	1.64	33	28.907
|>	In	115	133174	1.396	135606.8	1.722
|	Pb	207	128052	1.741	31	3.226
|	Pb	206	149989	0.95	38	31.579
|	Pb	208	300876	1.804	81	8.903
|	pb1	208	876243	0.789	230.001	13.266
|-	Bi	209	368	13.617	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.032	187.394	1.32	0.7	ug/L
|	Zn1	64	0.133	39.521	1.67	4.2	ug/L
|	Zn2	66	0.084	39.357	1.88	4.8	ug/L
|	Zn3	68	0.062	39.816	0.7	1.7	ug/L
|	Zn4	67	0.014	41.896	1.83	4.4	ug/L
|	Zn	64	0.292	39.641	1.45	3.7	ug/L
|	As	75	0.037	12.884	0.42	3.2	ug/L
|	Y	89	0.06				ug/L
|	Cd	111	0.025	8.338	0.24	2.8	ug/L
|	Cd	114	0.059	8.192	0.26	3.2	ug/L
|	cd1	114	0.141	8.354	0.23	2.8	ug/L
|>	In	115	133173.7				ug/L
|	Pb	207	0.961	213.711	5.25	2.5	ug/L
|	Pb	206	1.126	195.966	1.42	0.7	ug/L
|	Pb	208	2.259	203.758	6.19	3	ug/L
|	pb1	208	6.579	205.167	4.47	2.2	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 13:15:17
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.991
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	5800	0.613	1890.53	4.601
|	Zn1	64	80438	1.096	3212.619	22.883
|	Zn2	66	48933	3.373	1417.117	30.351
|	Zn3	68	36150	1.457	988.39	27.675
|	Zn4	67	8445	0.618	341.673	29.263
|	Zn	64	173966	1.209	5959.799	25.687
|	As	75	59715	1.85	-66.107	59.429
|	Y	89	41	17.073	26.333	26.942
|	Cd	111	62544	2.399	0.408	734.366
|	Cd	114	149457	1.05	11.555	23.664
|	cd1	114	367579	0.47	33	28.907
|>	In	115	134843	3.218	135606.8	1.722
|	Pb	207	91263	1.608	31	3.226
|	Pb	206	118969	2.604	38	31.579
|	Pb	208	222166	1.351	81	8.903
|	pb1	208	655261	0.229	230.001	13.266
|-	Bi	209	58	16.293	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.029	169.368	7.75	4.6	ug/L
|	Zn1	64	0.573	170.68	4.78	2.8	ug/L
|	Zn2	66	0.352	165.327	1.85	1.1	ug/L
|	Zn3	68	0.261	168.678	7.95	4.7	ug/L
|	Zn4	67	0.06	183.312	4.9	2.7	ug/L
|	Zn	64	1.247	169.273	4.18	2.5	ug/L
|	As	75	0.444	155.203	4.75	3.1	ug/L
|	Y	89	0				ug/L

|	Cd	111	0.464	157.072	2.55	1.6	ug/L
|	Cd	114	1.109	155.088	5.34	3.4	ug/L
|	cd1	114	2.727	161.872	4.51	2.8	ug/L
|>	In	115	134843.3				ug/L
|	Pb	207	0.677	150.444	2.89	1.9	ug/L
|	Pb	206	0.883	153.674	8.58	5.6	ug/L
|	Pb	208	1.648	148.646	5.48	3.7	ug/L
|	pb1	208	4.861	151.587	4.9	3.2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 13:17:51
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.992
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	1994	4.406	1890.53	4.601	
|	Zn1	64	3853	14.096	3212.619	22.883	
|	Zn2	66	2167	13.142	1417.117	30.351	
|	Zn3	68	1512	16.285	988.39	27.675	
|	Zn4	67	461	12.764	341.673	29.263	
|	Zn	64	7993	14.016	5959.799	25.687	
|	As	75	-109	65.505	-66.107	59.429	
|	Y	89	23	16.225	26.333	26.942	
|	Cd	111	4	133.225	0.408	734.366	
|	Cd	114	20	43.637	11.555	23.664	
|	cd1	114	83	3.889	33	28.907	
|>	In	115	132452	0.761	135606.8	1.722	
|	Pb	207	34	21.209	31	3.226	
|	Pb	206	44	13.824	38	31.579	
|	Pb	208	88	7.452	81	8.903	
|	pb1	208	246	4.793	230.001	13.266	
|-	Bi	209	6	76.376	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	6.511	4.53	69.5	ug/L
|	Zn1	64	0.005	1.602	1.16	72.4	ug/L
|	Zn2	66	0.006	2.768	0.95	34.5	ug/L
|	Zn3	68	0.004	2.661	1.15	43.2	ug/L
|	Zn4	67	0.001	2.916	1.29	44.1	ug/L
|	Zn	64	0.016	2.221	1.09	49.1	ug/L
|	As	75	0	-0.118	0.19	159	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.008	0.01	150.7	ug/L
|	Cd	114	0	0.009	0.01	104.1	ug/L
|	cd1	114	0	0.023	0	5.2	ug/L
|>	In	115	132452.4				ug/L
|	Pb	207	0	0.006	0.01	195	ug/L
|	Pb	206	0	0.009	0.01	84.2	ug/L
|	Pb	208	0	0.006	0	74.1	ug/L
|	pb1	208	0	0.005	0	50.4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX021
Sample Da Wednesday, September 18, 2013 13:20:26
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX021.993
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	14001	3.359	1890.53	4.601	
|	Zn1	64	2123063	1.99	3212.619	22.883	
|	Zn2	66	1454246	2.932	1417.117	30.351	
|	Zn3	68	1030255	2.81	988.39	27.675	
|	Zn4	67	221886	0.342	341.673	29.263	
|	Zn	64	4829449	1.329	5959.799	25.687	
|	As	75	158	18.252	-66.107	59.429	
|	Y	89	8708	1.448	26.333	26.942	
|	Cd	111	1657	4.678	0.408	734.366	
|	Cd	114	3953	2.323	11.555	23.664	
|	cd1	114	9373	1.095	33	28.907	
|>	In	115	132730	2.736	135606.8	1.722	
|	Pb	207	40558	2.061	31	3.226	
|	Pb	206	57860	3.501	38	31.579	
|	Pb	208	102640	0.61	81	8.903	
|	pb1	208	302674	0.971	230.001	13.266	
|-	Bi	209	18	34.694	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.092	532.822	13.15	2.5	ug/L
|	Zn1	64	15.978	4758.094	139.82	2.9	ug/L
|	Zn2	66	10.957	5139.86	290.6	5.7	ug/L
|	Zn3	68	7.76	5013.851	227.38	4.5	ug/L
|	Zn4	67	1.67	5090.468	146.21	2.9	ug/L
|	Zn	64	36.365	4937.13	184.39	3.7	ug/L
|	As	75	0.002	0.586	0.07	11.2	ug/L
|	Y	89	0.065				ug/L
|	Cd	111	0.012	4.23	0.29	7	ug/L
|	Cd	114	0.03	4.153	0.07	1.6	ug/L
|	cd1	114	0.07	4.178	0.08	1.8	ug/L
|>	In	115	132730.3				ug/L

|	Pb	207	0.306	67.922	3.09	4.5	ug/L
|	Pb	206	0.436	75.884	4.31	5.7	ug/L
|	Pb	208	0.773	69.724	2.04	2.9	ug/L
|	pb1	208	2.28	71.105	2.64	3.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX022
Sample Da Wednesday, September 18, 2013 13:23:01
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX022.994
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	3062	4.152	1890.53	4.601	
|	Zn1	64	484474	0.892	3212.619	22.883	
|	Zn2	66	300507	0.305	1417.117	30.351	
|	Zn3	68	212514	1.366	988.39	27.675	
|	Zn4	67	44972	0.827	341.673	29.263	
|	Zn	64	1042467	0.728	5959.799	25.687	
|	As	75	-30	157.024	-66.107	59.429	
|	Y	89	3453	3.684	26.333	26.942	
|	Cd	111	1623	4.305	0.408	734.366	
|	Cd	114	3812	3.428	11.555	23.664	
|	cd1	114	9173	2.804	33	28.907	
|>	In	115	133800	0.69	135606.8	1.722	
|	Pb	207	70932	0.878	31	3.226	
|	Pb	206	95580	1.41	38	31.579	
|	Pb	208	173142	1.62	81	8.903	
|	pb1	208	511527	0.999	230.001	13.266	
|-	Bi	209	35	15.887	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.009	52.065	6.13	11.8	ug/L
|	Zn1	64	3.597	1071.237	13.37	1.2	ug/L
|	Zn2	66	2.236	1048.666	4.16	0.4	ug/L
|	Zn3	68	1.581	1021.528	14.11	1.4	ug/L
|	Zn4	67	0.334	1016.837	8.46	0.8	ug/L
|	Zn	64	7.747	1051.836	10.02	1	ug/L
|	As	75	0	0.092	0.12	136.5	ug/L
|	Y	89	0.026				ug/L
|	Cd	111	0.012	4.107	0.19	4.6	ug/L
|	Cd	114	0.028	3.972	0.12	3	ug/L
|	cd1	114	0.068	4.054	0.09	2.3	ug/L
|>	In	115	133800.5				ug/L
|	Pb	207	0.53	117.79	1.59	1.4	ug/L
|	Pb	206	0.714	124.268	1.48	1.2	ug/L
|	Pb	208	1.293	116.647	1.23	1.1	ug/L
|	pb1	208	3.821	119.163	0.59	0.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX023
Sample Da Wednesday, September 18, 2013 13:25:36
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX023.995
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	7206	2.843	1890.53	4.601	
|	Zn1	64	226326	2.38	3212.619	22.883	
|	Zn2	66	138719	1.27	1417.117	30.351	
|	Zn3	68	99209	1.282	988.39	27.675	
|	Zn4	67	21583	1.456	341.673	29.263	
|	Zn	64	485837	1.349	5959.799	25.687	
|	As	75	305	19.595	-66.107	59.429	
|	Y	89	4919	1.425	26.333	26.942	
|	Cd	111	329	9.673	0.408	734.366	
|	Cd	114	804	5.453	11.555	23.664	
|	cd1	114	1918	4.133	33	28.907	
|>	In	115	136325	1.673	135606.8	1.722	
|	Pb	207	10293	2.858	31	3.226	
|	Pb	206	13411	0.781	38	31.579	
|	Pb	208	25384	2.493	81	8.903	
|	pb1	208	73441	1.286	230.001	13.266	
|-	Bi	209	27	9.437	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.039	226.481	4.94	2.2	ug/L
|	Zn1	64	1.637	487.452	15.98	3.3	ug/L
|	Zn2	66	1.007	472.574	13.56	2.9	ug/L
|	Zn3	68	0.721	465.628	12.65	2.7	ug/L
|	Zn4	67	0.156	475.036	14.2	3	ug/L
|	Zn	64	3.521	478.007	13.07	2.7	ug/L
|	As	75	0.003	0.953	0.14	15	ug/L
|	Y	89	0.036				ug/L
|	Cd	111	0.002	0.816	0.08	10.2	ug/L
|	Cd	114	0.006	0.813	0.05	6.2	ug/L
|	cd1	114	0.014	0.821	0.03	4.2	ug/L
|>	In	115	136325.2				ug/L
|	Pb	207	0.075	16.74	0.75	4.5	ug/L
|	Pb	206	0.098	17.075	0.33	1.9	ug/L
|	Pb	208	0.186	16.743	0.54	3.3	ug/L
|	pb1	208	0.537	16.751	0.42	2.5	ug/L

|- Bi 209 0 ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX024
Sample Da Wednesday, September 18, 2013 13:28:12
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX024.996
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	4230	1.283	1890.53	4.601	
|	Zn1	64	89609	0.765	3212.619	22.883	
|	Zn2	66	56279	1.341	1417.117	30.351	
|	Zn3	68	39702	3.799	988.39	27.675	
|	Zn4	67	8684	0.862	341.673	29.263	
|	Zn	64	194274	0.453	5959.799	25.687	
|	As	75	1729	1.077	-66.107	59.429	
|	Y	89	2673	1.695	26.333	26.942	
|	Cd	111	301	10.398	0.408	734.366	
|	Cd	114	682	2.919	11.555	23.664	
|	cd1	114	1643	2.587	33	28.907	
|>	In	115	135138	1.628	135606.8	1.722	
|	Pb	207	40141	1.098	31	3.226	
|	Pb	206	51623	2.451	38	31.579	
|	Pb	208	97178	2.108	81	8.903	
|	pb1	208	284552	0.331	230.001	13.266	
|-	Bi	209	18	20.651	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.017	101.03	1.46	1.4	ug/L
|	Zn1	64	0.639	190.434	3.04	1.6	ug/L
|	Zn2	66	0.406	190.469	2.46	1.3	ug/L
|	Zn3	68	0.287	185.214	10.07	5.4	ug/L
|	Zn4	67	0.062	188.223	2.41	1.3	ug/L
|	Zn	64	1.394	189.249	3.8	2	ug/L
|	As	75	0.013	4.647	0.03	0.6	ug/L
|	Y	89	0.02				ug/L
|	Cd	111	0.002	0.754	0.08	10.1	ug/L
|	Cd	114	0.005	0.694	0.03	3.9	ug/L
|	cd1	114	0.012	0.707	0.03	4	ug/L
|>	In	115	135138.5				ug/L
|	Pb	207	0.297	65.977	0.36	0.5	ug/L
|	Pb	206	0.382	66.445	2.14	3.2	ug/L
|	Pb	208	0.718	64.797	0.45	0.7	ug/L
|	pb1	208	2.104	65.618	0.86	1.3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX025
Sample Da Wednesday, September 18, 2013 13:30:47
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX025.997
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	10369	2.136	1890.53	4.601	
|	Zn1	64	1704009	2.137	3212.619	22.883	
|	Zn2	66	1058589	0.862	1417.117	30.351	
|	Zn3	68	765568	1.91	988.39	27.675	
|	Zn4	67	160774	1.735	341.673	29.263	
|	Zn	64	3688940	1.102	5959.799	25.687	
|	As	75	320	14.944	-66.107	59.429	
|	Y	89	5862	2.128	26.333	26.942	
|	Cd	111	2123	2.169	0.408	734.366	
|	Cd	114	4937	1.871	11.555	23.664	
|	cd1	114	11832	0.646	33	28.907	
|>	In	115	134423	1.487	135606.8	1.722	
|	Pb	207	320759	1.97	31	3.226	
|	Pb	206	435351	1.22	38	31.579	
|	Pb	208	804914	3.09	81	8.903	
|	pb1	208	2347705	1.677	230.001	13.266	
|-	Bi	209	180	20.578	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.063	367.957	16.2	4.4	ug/L
|	Zn1	64	12.653	3767.759	49.92	1.3	ug/L
|	Zn2	66	7.866	3689.988	80.11	2.2	ug/L
|	Zn3	68	5.688	3674.995	33.24	0.9	ug/L
|	Zn4	67	1.194	3639.018	113.91	3.1	ug/L
|	Zn	64	27.4	3720.024	32.99	0.9	ug/L
|	As	75	0.003	1.004	0.14	13.5	ug/L
|	Y	89	0.043				ug/L
|	Cd	111	0.016	5.347	0.19	3.5	ug/L
|	Cd	114	0.037	5.125	0.13	2.6	ug/L
|	cd1	114	0.088	5.21	0.08	1.6	ug/L
|>	In	115	134423				ug/L
|	Pb	207	2.386	530.337	6.32	1.2	ug/L
|	Pb	206	3.239	563.725	15.19	2.7	ug/L
|	Pb	208	5.989	540.156	22.24	4.1	ug/L
|	pb1	208	17.466	544.665	13.11	2.4	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX026
Sample Da Wednesday, September 18, 2013 13:33:23

Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX026.998
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5229	0.787	1890.53	4.601
|	Zn1	64	83068	2.691	3212.619	22.883
|	Zn2	66	51605	1.391	1417.117	30.351
|	Zn3	68	36915	1.959	988.39	27.675
|	Zn4	67	8015	2.592	341.673	29.263
|	Zn	64	179604	1.695	5959.799	25.687
|	As	75	-96	52.344	-66.107	59.429
|	Y	89	6753	0.868	26.333	26.942
|	Cd	111	318	11.907	0.408	734.366
|	Cd	114	794	1.276	11.555	23.664
|	cd1	114	1855	2.364	33	28.907
|>	In	115	131904	1.266	135606.8	1.722
|	Pb	207	13578	1.499	31	3.226
|	Pb	206	17786	0.719	38	31.579
|	Pb	208	33062	1.858	81	8.903
|	pb1	208	97143	0.693	230.001	13.266
|-	Bi	209	20	21.795	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.026	149.586	1.56	1	ug/L
|	Zn1	64	0.606	180.542	7.41	4.1	ug/L
|	Zn2	66	0.381	178.644	3.49	2	ug/L
|	Zn3	68	0.273	176.165	5.87	3.3	ug/L
|	Zn4	67	0.058	177.586	6.6	3.7	ug/L
|	Zn	64	1.318	178.941	5.51	3.1	ug/L
|	As	75	0	-0.084	0.13	158	ug/L
|	Y	89	0.051				ug/L
|	Cd	111	0.002	0.815	0.1	12.3	ug/L
|	Cd	114	0.006	0.829	0	0.3	ug/L
|	cd1	114	0.014	0.82	0.03	3.3	ug/L
|>	In	115	131903.8				ug/L
|	Pb	207	0.103	22.832	0.4	1.8	ug/L
|	Pb	206	0.135	23.422	0.46	1.9	ug/L
|	Pb	208	0.25	22.553	0.4	1.8	ug/L
|	pb1	208	0.735	22.916	0.41	1.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX027
Sample Da Wednesday, September 18, 2013 13:35:58
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX027.999
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	6571	0.634	1890.53	4.601
|	Zn1	64	63964	3.309	3212.619	22.883
|	Zn2	66	40012	0.508	1417.117	30.351
|	Zn3	68	28223	1.9	988.39	27.675
|	Zn4	67	6216	1.135	341.673	29.263
|	Zn	64	138416	1.767	5959.799	25.687
|	As	75	-55	66.852	-66.107	59.429
|	Y	89	4008	4.834	26.333	26.942
|	Cd	111	164	10.478	0.408	734.366
|	Cd	114	326	7.788	11.555	23.664
|	cd1	114	806	6.59	33	28.907
|>	In	115	132483	0.483	135606.8	1.722
|	Pb	207	5667	1.576	31	3.226
|	Pb	206	7341	3.651	38	31.579
|	Pb	208	13989	1.965	81	8.903
|	pb1	208	40524	1.129	230.001	13.266
|-	Bi	209	13	27.735	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.036	207.539	3.23	1.6	ug/L
|	Zn1	64	0.459	136.716	4.51	3.3	ug/L
|	Zn2	66	0.292	136.773	0.91	0.7	ug/L
|	Zn3	68	0.206	132.934	2.35	1.8	ug/L
|	Zn4	67	0.044	135.352	2.31	1.7	ug/L
|	Zn	64	1.001	135.877	2.28	1.7	ug/L
|	As	75	0	0.025	0.1	394.6	ug/L
|	Y	89	0.03				ug/L
|	Cd	111	0.001	0.417	0.05	11	ug/L
|	Cd	114	0.002	0.332	0.03	8.6	ug/L
|	cd1	114	0.006	0.347	0.03	7.4	ug/L
|>	In	115	132483.3				ug/L
|	Pb	207	0.043	9.458	0.13	1.4	ug/L
|	Pb	206	0.055	9.594	0.33	3.4	ug/L
|	Pb	208	0.105	9.47	0.22	2.3	ug/L
|	pb1	208	0.304	9.485	0.06	0.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX028
Sample Da Wednesday, September 18, 2013 13:38:34
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3

Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX028.1000
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5174	1.779	1890.53	4.601
|	Zn1	64	964527	2.646	3212.619	22.883
|	Zn2	66	607448	0.871	1417.117	30.351
|	Zn3	68	432306	0.963	988.39	27.675
|	Zn4	67	91550	1.063	341.673	29.263
|	Zn	64	2095831	1.291	5959.799	25.687
|	As	75	468	19.408	-66.107	59.429
|	Y	89	4850	5.291	26.333	26.942
|	Cd	111	1828	2.092	0.408	734.366
|	Cd	114	4239	2.642	11.555	23.664
|	cd1	114	10233	1.296	33	28.907
|>	In	115	131534	2.157	135606.8	1.722
|	Pb	207	94615	4.083	31	3.226
|	Pb	206	127151	4.089	38	31.579
|	Pb	208	233304	2.575	81	8.903
|	pb1	208	681199	2.573	230.001	13.266
|-	Bi	209	40	33.819	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.025	147.923	8.07	5.5	ug/L
|	Zn1	64	7.313	2177.852	96.64	4.4	ug/L
|	Zn2	66	4.609	2161.921	34.51	1.6	ug/L
|	Zn3	68	3.28	2119.347	37.76	1.8	ug/L
|	Zn4	67	0.694	2114.706	61.98	2.9	ug/L
|	Zn	64	15.896	2158.135	64.02	3	ug/L
|	As	75	0.004	1.418	0.25	17.8	ug/L
|	Y	89	0.037				ug/L
|	Cd	111	0.014	4.704	0.11	2.4	ug/L
|	Cd	114	0.032	4.497	0.2	4.5	ug/L
|	cd1	114	0.078	4.605	0.16	3.5	ug/L
|>	In	115	131533.8				ug/L
|	Pb	207	0.719	159.798	3.45	2.2	ug/L
|	Pb	206	0.966	168.144	3.94	2.3	ug/L
|	Pb	208	1.773	159.932	3.72	2.3	ug/L
|	pb1	208	5.177	161.435	1.05	0.7	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX029
Sample Da Wednesday, September 18, 2013 13:41:10
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX029.1001
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	4826	1.673	1890.53	4.601
|	Zn1	64	419543	0.988	3212.619	22.883
|	Zn2	66	259439	2.935	1417.117	30.351
|	Zn3	68	189398	2.264	988.39	27.675
|	Zn4	67	39812	1.26	341.673	29.263
|	Zn	64	908192	1.37	5959.799	25.687
|	As	75	195	26.855	-66.107	59.429
|	Y	89	3580	3.769	26.333	26.942
|	Cd	111	997	1.611	0.408	734.366
|	Cd	114	2344	0.103	11.555	23.664
|	cd1	114	5559	1.508	33	28.907
|>	In	115	134793	1.609	135606.8	1.722
|	Pb	207	69694	1.782	31	3.226
|	Pb	206	94071	3.328	38	31.579
|	Pb	208	171756	4.437	81	8.903
|	pb1	208	507345	3.172	230.001	13.266
|-	Bi	209	41	12.195	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.022	127.268	5.68	4.5	ug/L
|	Zn1	64	3.09	920.064	24.09	2.6	ug/L
|	Zn2	66	1.915	898.407	41.13	4.6	ug/L
|	Zn3	68	1.398	903.298	24.61	2.7	ug/L
|	Zn4	67	0.293	892.696	13.38	1.5	ug/L
|	Zn	64	6.696	909.054	26.63	2.9	ug/L
|	As	75	0.002	0.677	0.14	20.4	ug/L
|	Y	89	0.026				ug/L
|	Cd	111	0.007	2.503	0.05	2	ug/L
|	Cd	114	0.017	2.42	0.04	1.5	ug/L
|	cd1	114	0.041	2.433	0.04	1.7	ug/L
|>	In	115	134793.3				ug/L
|	Pb	207	0.517	114.911	3.61	3.1	ug/L
|	Pb	206	0.698	121.432	4.72	3.9	ug/L
|	Pb	208	1.274	114.904	5.98	5.2	ug/L
|	pb1	208	3.763	117.351	4.63	3.9	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: bottle blank 1
Sample Da Wednesday, September 18, 2013 13:43:46
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55

Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\bottle blank 1.1002
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1949	1.542	1890.53	4.601
|	Zn1	64	3694	19.148	3212.619	22.883
|	Zn2	66	2040	19.32	1417.117	30.351
|	Zn3	68	1477	15.682	988.39	27.675
|	Zn4	67	506	9.935	341.673	29.263
|	Zn	64	7717	17.907	5959.799	25.687
|	As	75	-99	75.995	-66.107	59.429
|	Y	89	18	16.34	26.333	26.942
|	Cd	111	2	276	0.408	734.366
|	Cd	114	12	11.725	11.555	23.664
|	cd1	114	30	8.483	33	28.907
|>	In	115	132356	2.967	135606.8	1.722
|	Pb	207	76	22.519	31	3.226
|	Pb	206	104	19.744	38	31.579
|	Pb	208	174	12.514	81	8.903
|	pb1	208	548	14.411	230.001	13.266
|-	Bi	209	2	34.641	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	4.644	3.68	79.2	ug/L
|	Zn1	64	0.004	1.265	1.66	131.5	ug/L
|	Zn2	66	0.005	2.333	1.44	61.8	ug/L
|	Zn3	68	0.004	2.508	1.19	47.4	ug/L
|	Zn4	67	0.001	3.978	1.19	30	ug/L
|	Zn	64	0.014	1.956	1.48	75.5	ug/L
|	As	75	0	-0.092	0.2	218.9	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.004	0.01	332	ug/L
|	Cd	114	0	0.001	0	290.4	ug/L
|	cd1	114	0	-0.001	0	94.4	ug/L
|>	In	115	132356.3				ug/L
|	Pb	207	0	0.076	0.03	37	ug/L
|	Pb	206	0.001	0.088	0.02	26.9	ug/L
|	Pb	208	0.001	0.065	0.02	25.8	ug/L
|	pb1	208	0.002	0.076	0.02	24.3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 13:46:22
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth

Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.1003
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5692	3.671	1890.53	4.601
|	Zn1	64	81444	3.182	3212.619	22.883
|	Zn2	66	49389	1.982	1417.117	30.351
|	Zn3	68	36701	3.395	988.39	27.675
|	Zn4	67	8445	1.1	341.673	29.263
|	Zn	64	175978	1.75	5959.799	25.687
|	As	75	58954	0.737	-66.107	59.429
|	Y	89	45	12.33	26.333	26.942
|	Cd	111	62363	0.608	0.408	734.366
|	Cd	114	146547	1.598	11.555	23.664
|	cd1	114	361040	0.93	33	28.907
|>	In	115	136439	1.841	135606.8	1.722
|	Pb	207	90839	0.493	31	3.226
|	Pb	206	116658	1.031	38	31.579
|	Pb	208	223682	3.922	81	8.903
|	pb1	208	650287	1.471	230.001	13.266
|-	Bi	209	38	18.647	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.028	161.795	12.79	7.9	ug/L
|	Zn1	64	0.573	170.699	4.53	2.7	ug/L
|	Zn2	66	0.352	164.934	4.23	2.6	ug/L
|	Zn3	68	0.262	169.103	5.52	3.3	ug/L
|	Zn4	67	0.059	181.042	5.5	3	ug/L
|	Zn	64	1.246	169.156	2.5	1.5	ug/L
|	As	75	0.433	151.376	1.66	1.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.457	154.795	3.71	2.4	ug/L
|	Cd	114	1.074	150.237	4.68	3.1	ug/L
|	cd1	114	2.647	157.089	4.17	2.7	ug/L
|>	In	115	136439				ug/L
|	Pb	207	0.666	147.969	2.74	1.8	ug/L
|	Pb	206	0.855	148.764	1.22	0.8	ug/L
|	Pb	208	1.639	147.821	5.96	4	ug/L
|	pb1	208	4.765	148.594	2.63	1.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 13:48:56
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.1004
Tuning File C:\Elandata\Tuning\default.tun

Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	2004	2.897	1890.53	4.601	
|	Zn1	64	3579	15.592	3212.619	22.883	
|	Zn2	66	2131	16.753	1417.117	30.351	
|	Zn3	68	1489	16.528	988.39	27.675	
|	Zn4	67	457	18.186	341.673	29.263	
|	Zn	64	7656	15.935	5959.799	25.687	
|	As	75	-84	53.881	-66.107	59.429	
|	Y	89	19	10.767	26.333	26.942	
|	Cd	111	9	116.931	0.408	734.366	
|	Cd	114	19	21.203	11.555	23.664	
|	cd1	114	90	1.924	33	28.907	
|>	In	115	134535	0.645	135606.8	1.722	
|	Pb	207	50	29.757	31	3.226	
|	Pb	206	63	10.383	38	31.579	
|	Pb	208	120	14.019	81	8.903	
|	pb1	208	348	13.431	230.001	13.266	
|-	Bi	209	3	0	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	5.555	2.69	48.4	ug/L
|	Zn1	64	0.003	0.867	1.23	141.6	ug/L
|	Zn2	66	0.005	2.525	1.22	48.5	ug/L
|	Zn3	68	0.004	2.443	1.19	48.5	ug/L
|	Zn4	67	0.001	2.669	1.83	68.7	ug/L
|	Zn	64	0.013	1.758	1.22	69.4	ug/L
|	As	75	0	-0.048	0.12	244.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.021	0.03	122.9	ug/L
|	Cd	114	0	0.008	0	55.2	ug/L
|	cd1	114	0	0.025	0	3.3	ug/L
|>	In	115	134534.6				ug/L
|	Pb	207	0	0.032	0.02	75.1	ug/L
|	Pb	206	0	0.032	0.01	25.4	ug/L
|	Pb	208	0	0.027	0.01	43.1	ug/L
|	pb1	208	0.001	0.028	0.01	39.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: bottle blank 2
Sample Da Wednesday, September 18, 2013 13:51:31
Sample De BIO
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\bottle blank 2.1005
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens.	RSD
|-	Fe	57	1998	5.619	1890.53	4.601	
|	Zn1	64	3496	17.372	3212.619	22.883	
|	Zn2	66	2031	21.286	1417.117	30.351	
|	Zn3	68	1399	23.095	988.39	27.675	
|	Zn4	67	460	7.108	341.673	29.263	
|	Zn	64	7386	18.875	5959.799	25.687	
|	As	75	-112	68.456	-66.107	59.429	
|	Y	89	11	27.273	26.333	26.942	
|	Cd	111	4	116.735	0.408	734.366	
|	Cd	114	12	24.54	11.555	23.664	
|	cd1	114	37	12.298	33	28.907	
|>	In	115	134969	2.577	135606.8	1.722	
|	Pb	207	12	42.282	31	3.226	
|	Pb	206	12	43.301	38	31.579	
|	Pb	208	21	26.654	81	8.903	
|	pb1	208	70	19.795	230.001	13.266	
|-	Bi	209	3	43.301	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.001	5.063	5.21	103	ug/L
|	Zn1	64	0.002	0.666	1.36	204.7	ug/L
|	Zn2	66	0.005	2.164	1.51	70	ug/L
|	Zn3	68	0.003	1.994	1.56	78.4	ug/L
|	Zn4	67	0.001	2.719	0.88	32.2	ug/L
|	Zn	64	0.011	1.47	1.42	96.8	ug/L
|	As	75	0	-0.123	0.21	170	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.01	0.01	129.4	ug/L
|	Cd	114	0	0.001	0	315.4	ug/L
|	cd1	114	0	0.002	0	99.9	ug/L
|>	In	115	134969.1				ug/L
|	Pb	207	0	-0.032	0.01	24.4	ug/L
|	Pb	206	0	-0.033	0.01	20.7	ug/L
|	Pb	208	0	-0.04	0	9.8	ug/L
|	pb1	208	-0.001	-0.037	0	8.2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX001 3050
Sample Da Wednesday, September 18, 2013 13:54:08
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX001 3050.1006
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary

Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	217772	0.735	1890.53	4.601
|	Zn1	64	588955	0.276	3212.619	22.883
|	Zn2	66	374392	3.928	1417.117	30.351
|	Zn3	68	263460	1.364	988.39	27.675
|	Zn4	67	57117	1.91	341.673	29.263
|	Zn	64	1283923	1.321	5959.799	25.687
|	As	75	2033	2.411	-66.107	59.429
|	Y	89	24490	0.813	26.333	26.942
|	Cd	111	3478	3.861	0.408	734.366
|	Cd	114	7885	1.777	11.555	23.664
|	cd1	114	19068	0.139	33	28.907
|>	In	115	133362	2.685	135606.8	1.722
|	Pb	207	160512	3.231	31	3.226
|	Pb	206	210628	1.103	38	31.579
|	Pb	208	393120	0.24	81	8.903
|	pb1	208	1152517	0.563	230.001	13.266
|-	Bi	209	1057	1.429	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.62	9426.044	195.55	2.1	ug/L
|	Zn1	64	4.395	1308.632	33.26	2.5	ug/L
|	Zn2	66	2.798	1312.393	55.31	4.2	ug/L
|	Zn3	68	1.97	1272.57	49.1	3.9	ug/L
|	Zn4	67	0.426	1298.706	54.55	4.2	ug/L
|	Zn	64	9.588	1301.701	38.21	2.9	ug/L
|	As	75	0.016	5.506	0.17	3.1	ug/L
|	Y	89	0.184				ug/L
|	Cd	111	0.026	8.831	0.36	4.1	ug/L
|	Cd	114	0.059	8.261	0.34	4.1	ug/L
|	cd1	114	0.143	8.475	0.23	2.7	ug/L
|>	In	115	133361.7				ug/L
|	Pb	207	1.203	267.48	4.96	1.9	ug/L
|	Pb	206	1.58	274.946	8.22	3	ug/L
|	Pb	208	2.948	265.914	6.54	2.5	ug/L
|	pb1	208	8.644	269.54	5.75	2.1	ug/L
|-	Bi	209	0.008				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX002
Sample Da Wednesday, September 18, 2013 13:56:45
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX002.1007
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	205860	1.991	1890.53	4.601
|	Zn1	64	339388	0.926	3212.619	22.883
|	Zn2	66	211645	2.409	1417.117	30.351
|	Zn3	68	148932	1.462	988.39	27.675
|	Zn4	67	32412	1.064	341.673	29.263
|	Zn	64	732376	1.187	5959.799	25.687
|	As	75	2000	0.534	-66.107	59.429
|	Y	89	20861	2.056	26.333	26.942
|	Cd	111	1639	4.056	0.408	734.366
|	Cd	114	3741	2.533	11.555	23.664
|	cd1	114	9127	1.92	33	28.907
|>	In	115	133970	2.395	135606.8	1.722
|	Pb	207	73264	3.706	31	3.226
|	Pb	206	95622	3.737	38	31.579
|	Pb	208	183590	1.175	81	8.903
|	pb1	208	532147	0.449	230.001	13.266
|-	Bi	209	733	2.379	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.523	8866.179	315.74	3.6	ug/L
|	Zn1	64	2.511	747.679	22.46	3	ug/L
|	Zn2	66	1.57	736.587	30.74	4.2	ug/L
|	Zn3	68	1.105	713.978	26.43	3.7	ug/L
|	Zn4	67	0.24	730.145	24.81	3.4	ug/L
|	Zn	64	5.426	736.606	24.8	3.4	ug/L
|	As	75	0.015	5.396	0.13	2.4	ug/L
|	Y	89	0.156				ug/L
|	Cd	111	0.012	4.145	0.23	5.6	ug/L
|	Cd	114	0.028	3.895	0.17	4.5	ug/L
|	cd1	114	0.068	4.032	0.17	4.3	ug/L
|>	In	115	133970.1				ug/L
|	Pb	207	0.547	121.494	2.84	2.3	ug/L
|	Pb	206	0.714	124.237	6.26	5	ug/L
|	Pb	208	1.37	123.568	2.22	1.8	ug/L
|	pb1	208	3.972	123.853	2.59	2.1	ug/L
|-	Bi	209	0.005				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX003
Sample Da Wednesday, September 18, 2013 13:59:21
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX003.1008
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	244782	0.408	1890.53	4.601
|	Zn1	64	1006363	2.05	3212.619	22.883

|	Zn2	66	621693	2.017	1417.117	30.351
|	Zn3	68	450961	2.385	988.39	27.675
|	Zn4	67	94299	1.355	341.673	29.263
|	Zn	64	2173316	0.823	5959.799	25.687
|	As	75	4194	3.157	-66.107	59.429
|	Y	89	22308	0.772	26.333	26.942
|	Cd	111	3854	1.188	0.408	734.366
|	Cd	114	8734	1.037	11.555	23.664
|	cd1	114	21216	2.486	33	28.907
|>	In	115	129445	1.926	135606.8	1.722
|	Pb	207	197672	1.405	31	3.226
|	Pb	206	278707	1.275	38	31.579
|	Pb	208	485763	1.062	81	8.903
|	pb1	208	1452045	0.732	230.001	13.266
|-	Bi	209	763	4.389	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.878	10927.38	220.15	2	ug/L
|	Zn1	64	7.751	2308.056	8.35	0.4	ug/L
|	Zn2	66	4.795	2249.167	87.92	3.9	ug/L
|	Zn3	68	3.476	2246.208	27.82	1.2	ug/L
|	Zn4	67	0.726	2213.45	57.31	2.6	ug/L
|	Zn	64	16.748	2273.802	26.59	1.2	ug/L
|	As	75	0.033	11.513	0.53	4.6	ug/L
|	Y	89	0.172				ug/L
|	Cd	111	0.03	10.081	0.09	0.9	ug/L
|	Cd	114	0.067	9.426	0.21	2.3	ug/L
|	cd1	114	0.164	9.712	0.06	0.6	ug/L
|>	In	115	129444.5				ug/L
|	Pb	207	1.527	339.424	4.79	1.4	ug/L
|	Pb	206	2.153	374.728	7.28	1.9	ug/L
|	Pb	208	3.754	338.518	10.08	3	ug/L
|	pb1	208	11.218	349.828	6.58	1.9	ug/L
|-	Bi	209	0.006				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX004
Sample Da Wednesday, September 18, 2013 14:01:56
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX004.1009
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	232044	0.485	1890.53	4.601
|	Zn1	64	415663	1.303	3212.619	22.883
|	Zn2	66	262811	1.654	1417.117	30.351
|	Zn3	68	184292	4.415	988.39	27.675
|	Zn4	67	40337	1.561	341.673	29.263
|	Zn	64	903103	2.025	5959.799	25.687
|	As	75	1844	4.659	-66.107	59.429
|	Y	89	23704	1.438	26.333	26.942
|	Cd	111	1631	4.509	0.408	734.366
|	Cd	114	3757	0.427	11.555	23.664
|	cd1	114	8936	0.381	33	28.907
|>	In	115	129991	0.679	135606.8	1.722
|	Pb	207	55021	2.125	31	3.226
|	Pb	206	74648	3.925	38	31.579
|	Pb	208	136223	1.292	81	8.903
|	pb1	208	400485	1.893	230.001	13.266
|-	Bi	209	337	9.357	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.771	10308.18	37.97	0.4	ug/L
|	Zn1	64	3.174	945.245	18.93	2	ug/L
|	Zn2	66	2.012	943.594	22.11	2.3	ug/L
|	Zn3	68	1.411	911.524	46.7	5.1	ug/L
|	Zn4	67	0.308	938.247	20.88	2.2	ug/L
|	Zn	64	6.904	937.37	25.58	2.7	ug/L
|	As	75	0.015	5.134	0.21	4.1	ug/L
|	Y	89	0.182				ug/L
|	Cd	111	0.013	4.247	0.16	3.8	ug/L
|	Cd	114	0.029	4.03	0.03	0.9	ug/L
|	cd1	114	0.069	4.066	0.04	1.1	ug/L
|>	In	115	129990.6				ug/L
|	Pb	207	0.423	94.044	2.63	2.8	ug/L
|	Pb	206	0.574	99.908	4.56	4.6	ug/L
|	Pb	208	1.047	94.464	1.73	1.8	ug/L
|	pb1	208	3.08	96.031	2.43	2.5	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX005
Sample Da Wednesday, September 18, 2013 14:04:32
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX005.1010
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	619345	0.856	1890.53	4.601
|	Zn1	64	26038337	3.214	3212.619	22.883
|	Zn2	66	16085310	2.225	1417.117	30.351
|	Zn3	68	11648950	1.418	988.39	27.675
|	Zn4	67	2473506	2.007	341.673	29.263
|	Zn	64	56246104	2.167	5959.799	25.687

|	As	75	81784	1.142	-66.107	59.429
|	Y	89	42662	0.439	26.333	26.942
|	Cd	111	44078	1.384	0.408	734.366
|	Cd	114	104480	2.348	11.555	23.664
|	cd1	114	250323	0.69	33	28.907
|>	In	115	129637	1.305	135606.8	1.722
|	Pb	207	4374291	2.748	31	3.226
|	Pb	206	6117161	0.608	38	31.579
|	Pb	208	11001563	1.596	81	8.903
|	pb1	208	32527915	0.842	230.001	13.266
|-	Bi	209	419	5.521	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	4.764	27725.46	201.42	0.7	ug/L
|	Zn1	64	200.883	59820.33	2411.65	4	ug/L
|	Zn2	66	124.076	58202.87	1294.21	2.2	ug/L
|	Zn3	68	89.87	58066.64	1504.21	2.6	ug/L
|	Zn4	67	19.077	58147	406.48	0.7	ug/L
|	Zn	64	433.905	58909.18	1693.61	2.9	ug/L
|	As	75	0.631	220.936	4.24	1.9	ug/L
|	Y	89	0.329				ug/L
|	Cd	111	0.34	115.117	1.11	1	ug/L
|	Cd	114	0.806	112.678	1.43	1.3	ug/L
|	cd1	114	1.931	114.596	0.71	0.6	ug/L
|>	In	115	129637.3				ug/L
|	Pb	207	33.745	7500.693	215.9	2.9	ug/L
|	Pb	206	47.194	8213.197	155.6	1.9	ug/L
|	Pb	208	84.862	7653.451	38.31	0.5	ug/L
|	pb1	208	250.941	7825.253	120.36	1.5	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX006
Sample Da Wednesday, September 18, 2013 14:07:08
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX006.1011
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	181507	1.453	1890.53	4.601
|	Zn1	64	546814	2.058	3212.619	22.883
|	Zn2	66	339966	1.136	1417.117	30.351
|	Zn3	68	249804	1.803	988.39	27.675
|	Zn4	67	53008	2.257	341.673	29.263
|	Zn	64	1189591	1.458	5959.799	25.687
|	As	75	1720	4.301	-66.107	59.429
|	Y	89	20567	0.792	26.333	26.942
|	Cd	111	2692	1.72	0.408	734.366
|	Cd	114	6268	3.216	11.555	23.664
|	cd1	114	15201	2.837	33	28.907
|>	In	115	130097	1.109	135606.8	1.722
|	Pb	207	189024	1.553	31	3.226
|	Pb	206	250650	1.283	38	31.579
|	Pb	208	471126	1.708	81	8.903
|	pb1	208	1367582	1.304	230.001	13.266
|-	Bi	209	946	3.226	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.381	8039.657	170.12	2.1	ug/L
|	Zn1	64	4.179	1244.51	14.84	1.2	ug/L
|	Zn2	66	2.603	1220.922	7.24	0.6	ug/L
|	Zn3	68	1.913	1235.901	15.43	1.2	ug/L
|	Zn4	67	0.405	1234.24	22.43	1.8	ug/L
|	Zn	64	9.1	1235.416	4.46	0.4	ug/L
|	As	75	0.014	4.799	0.25	5.1	ug/L
|	Y	89	0.158				ug/L
|	Cd	111	0.021	7.003	0.06	0.8	ug/L
|	Cd	114	0.048	6.726	0.26	3.8	ug/L
|	cd1	114	0.117	6.922	0.27	3.9	ug/L
|>	In	115	130097.5				ug/L
|	Pb	207	1.453	322.944	7.17	2.2	ug/L
|	Pb	206	1.927	335.298	7.82	2.3	ug/L
|	Pb	208	3.621	326.529	2.08	0.6	ug/L
|	pb1	208	10.51	327.746	1.69	0.5	ug/L
|-	Bi	209	0.007				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX007
Sample Da Wednesday, September 18, 2013 14:09:44
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX007.1012
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	418651	1.656	1890.53	4.601
|	Zn1	64	1293314	1.059	3212.619	22.883
|	Zn2	66	821775	1.098	1417.117	30.351
|	Zn3	68	593511	1.237	988.39	27.675
|	Zn4	67	125924	1.835	341.673	29.263
|	Zn	64	2834523	0.345	5959.799	25.687
|	As	75	13967	2.676	-66.107	59.429
|	Y	89	28713	1.975	26.333	26.942
|	Cd	111	2668	2.353	0.408	734.366
|	Cd	114	6083	0.802	11.555	23.664

|	cd1	114	14962	0.464	33	28.907
|>	In	115	134918	0.796	135606.8	1.722
|	Pb	207	275151	1.297	31	3.226
|	Pb	206	368250	3.039	38	31.579
|	Pb	208	686256	0.773	81	8.903
|	pb1	208	2003338	1.664	230.001	13.266
|-	Bi	209	1177	1.153	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	3.089	17980.64	440.43	2.4	ug/L
|	Zn1	64	9.563	2847.606	35.33	1.2	ug/L
|	Zn2	66	6.08	2852.253	9.96	0.3	ug/L
|	Zn3	68	4.392	2837.787	48.93	1.7	ug/L
|	Zn4	67	0.931	2837.609	74.96	2.6	ug/L
|	Zn	64	20.966	2846.443	19.11	0.7	ug/L
|	As	75	0.104	36.394	0.94	2.6	ug/L
|	Y	89	0.213				ug/L
|	Cd	111	0.02	6.695	0.11	1.6	ug/L
|	Cd	114	0.045	6.293	0.09	1.4	ug/L
|	cd1	114	0.111	6.567	0.03	0.5	ug/L
|>	In	115	134918.1				ug/L
|	Pb	207	2.039	453.246	2.39	0.5	ug/L
|	Pb	206	2.73	475.033	17.61	3.7	ug/L
|	Pb	208	5.086	458.711	6.63	1.4	ug/L
|	pb1	208	14.848	463.022	10.33	2.2	ug/L
|-	Bi	209	0.009				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX008
Sample Da Wednesday, September 18, 2013 14:12:20
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX008.1013
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	174265	0.904	1890.53	4.601
|	Zn1	64	480879	1.13	3212.619	22.883
|	Zn2	66	298355	1.761	1417.117	30.351
|	Zn3	68	219374	1.805	988.39	27.675
|	Zn4	67	46739	1.711	341.673	29.263
|	Zn	64	1045347	0.499	5959.799	25.687
|	As	75	1642	8.887	-66.107	59.429
|	Y	89	21196	1.167	26.333	26.942
|	Cd	111	2631	0.525	0.408	734.366
|	Cd	114	6237	1.577	11.555	23.664
|	cd1	114	14874	0.787	33	28.907
|>	In	115	132381	3.01	135606.8	1.722
|	Pb	207	127350	0.493	31	3.226
|	Pb	206	165948	4.035	38	31.579
|	Pb	208	305363	1.329	81	8.903
|	pb1	208	905747	1.731	230.001	13.266
|-	Bi	209	705	1.368	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.303	7586.113	292.35	3.9	ug/L
|	Zn1	64	3.612	1075.531	43.37	4	ug/L
|	Zn2	66	2.244	1052.581	13.6	1.3	ug/L
|	Zn3	68	1.651	1066.987	49.84	4.7	ug/L
|	Zn4	67	0.351	1069.301	43.67	4.1	ug/L
|	Zn	64	7.858	1066.816	35.84	3.4	ug/L
|	As	75	0.013	4.512	0.38	8.4	ug/L
|	Y	89	0.16				ug/L
|	Cd	111	0.02	6.731	0.2	3	ug/L
|	Cd	114	0.047	6.581	0.25	3.8	ug/L
|	cd1	114	0.112	6.658	0.17	2.6	ug/L
|>	In	115	132381.3				ug/L
|	Pb	207	0.962	213.925	7.37	3.4	ug/L
|	Pb	206	1.255	218.379	14.53	6.7	ug/L
|	Pb	208	2.308	208.157	8.84	4.2	ug/L
|	pb1	208	6.847	213.501	9.9	4.6	ug/L
|-	Bi	209	0.005				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX009
Sample Da Wednesday, September 18, 2013 14:14:55
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX009.1014
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	252538	1.198	1890.53	4.601
|	Zn1	64	481464	1.411	3212.619	22.883
|	Zn2	66	308570	2.198	1417.117	30.351
|	Zn3	68	216708	1.469	988.39	27.675
|	Zn4	67	47566	1.737	341.673	29.263
|	Zn	64	1054309	1.521	5959.799	25.687
|	As	75	2017	1.064	-66.107	59.429
|	Y	89	26702	2.317	26.333	26.942
|	Cd	111	2062	2.6	0.408	734.366
|	Cd	114	4715	0.518	11.555	23.664
|	cd1	114	11328	1.411	33	28.907
|>	In	115	132143	1.233	135606.8	1.722
|	Pb	207	94307	1.492	31	3.226
|	Pb	206	125807	1.637	38	31.579

|	Pb	208	235344	1.302	81	8.903
|	pb1	208	685871	1.192	230.001	13.266
|-	Bi	209	556	2.473	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.897	11041.57	49.64	0.4	ug/L
|	Zn1	64	3.621	1078.158	28.01	2.6	ug/L
|	Zn2	66	2.325	1090.786	37.14	3.4	ug/L
|	Zn3	68	1.633	1055.099	27.12	2.6	ug/L
|	Zn4	67	0.358	1089.763	31.34	2.9	ug/L
|	Zn	64	7.936	1077.484	29.74	2.8	ug/L
|	As	75	0.016	5.512	0.1	1.8	ug/L
|	Y	89	0.202				ug/L
|	Cd	111	0.016	5.283	0.07	1.4	ug/L
|	Cd	114	0.036	4.978	0.04	0.8	ug/L
|	cd1	114	0.086	5.075	0.13	2.6	ug/L
|>	In	115	132143				ug/L
|	Pb	207	0.713	158.592	2.62	1.7	ug/L
|	Pb	206	0.952	165.664	4.08	2.5	ug/L
|	Pb	208	1.78	160.57	1.34	0.8	ug/L
|	pb1	208	5.189	161.807	1.55	1	ug/L
|-	Bi	209	0.004				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 14:17:30
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.1015
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	6183	4.244	1890.53	4.601
|	Zn1	64	79829	1.484	3212.619	22.883
|	Zn2	66	48113	1.793	1417.117	30.351
|	Zn3	68	36161	2.269	988.39	27.675
|	Zn4	67	8466	3.786	341.673	29.263
|	Zn	64	172570	0.262	5959.799	25.687
|	As	75	59922	2.746	-66.107	59.429
|	Y	89	55	11.355	26.333	26.942
|	Cd	111	61332	1.431	0.408	734.366
|	Cd	114	145072	1.444	11.555	23.664
|	cd1	114	353490	0.857	33	28.907
|>	In	115	134045	2.661	135606.8	1.722
|	Pb	207	89231	1.327	31	3.226
|	Pb	206	113125	1.055	38	31.579
|	Pb	208	220457	2.857	81	8.903
|	pb1	208	640739	0.781	230.001	13.266
|-	Bi	209	73	7.118	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.032	187.64	18.81	10	ug/L
|	Zn1	64	0.572	170.395	6.46	3.8	ug/L
|	Zn2	66	0.349	163.537	4.72	2.9	ug/L
|	Zn3	68	0.263	169.616	2.26	1.3	ug/L
|	Zn4	67	0.061	185.036	11.92	6.4	ug/L
|	Zn	64	1.244	168.899	4.61	2.7	ug/L
|	As	75	0.448	156.595	2.59	1.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.458	154.944	2.05	1.3	ug/L
|	Cd	114	1.083	151.423	5.69	3.8	ug/L
|	cd1	114	2.638	156.566	3.88	2.5	ug/L
|>	In	115	134045.3				ug/L
|	Pb	207	0.666	147.954	2.5	1.7	ug/L
|	Pb	206	0.844	146.863	2.43	1.7	ug/L
|	Pb	208	1.646	148.419	8.3	5.6	ug/L
|	pb1	208	4.781	149.094	5.05	3.4	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 14:20:05
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.1016
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2315	4.5	1890.53	4.601
|	Zn1	64	3264	13.826	3212.619	22.883
|	Zn2	66	1917	16.892	1417.117	30.351
|	Zn3	68	1340	15.604	988.39	27.675
|	Zn4	67	409	10.161	341.673	29.263
|	Zn	64	6930	14.652	5959.799	25.687
|	As	75	-151	9.476	-66.107	59.429
|	Y	89	19	24.157	26.333	26.942
|	Cd	111	-3	205.454	0.408	734.366
|	Cd	114	23	41.936	11.555	23.664
|	cd1	114	63	15.142	33	28.907
|>	In	115	134394	2.444	135606.8	1.722
|	Pb	207	47	34.242	31	3.226
|	Pb	206	46	12.452	38	31.579
|	Pb	208	110	20.109	81	8.903
|	pb1	208	331	25.919	230.001	13.266
|-	Bi	209	3	17.321	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.003	19.095	2.15	11.3	ug/L
|	Zn1	64	0.001	0.196	1.15	588.1	ug/L
|	Zn2	66	0.004	1.809	1.27	70.1	ug/L
|	Zn3	68	0.003	1.752	1.15	65.5	ug/L
|	Zn4	67	0.001	1.605	1.12	69.7	ug/L
|	Zn	64	0.008	1.053	1.17	111.6	ug/L
|	As	75	-0.001	-0.224	0.04	20	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	-0.01	0.02	178	ug/L
|	Cd	114	0	0.012	0.01	84.5	ug/L
|	cd1	114	0	0.013	0	29.5	ug/L
|>	In	115	134393.8				ug/L
|	Pb	207	0	0.027	0.03	102.4	ug/L
|	Pb	206	0	0.01	0.01	81.3	ug/L
|	Pb	208	0	0.02	0.02	80.3	ug/L
|	pb1	208	0.001	0.024	0.02	87.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010
Sample Da Wednesday, September 18, 2013 14:22:40
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010.1017
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	204145	2.022	1890.53	4.601
|	Zn1	64	121277	0.561	3212.619	22.883
|	Zn2	66	75351	2.055	1417.117	30.351
|	Zn3	68	54934	1.915	988.39	27.675
|	Zn4	67	11945	2.476	341.673	29.263
|	Zn	64	263507	0.63	5959.799	25.687
|	As	75	5109	1.88	-66.107	59.429
|	Y	89	16356	1.839	26.333	26.942
|	Cd	111	413	9.712	0.408	734.366
|	Cd	114	803	5.239	11.555	23.664
|	cd1	114	1945	1.933	33	28.907
|>	In	115	130637	1.155	135606.8	1.722
|	Pb	207	15905	1.142	31	3.226
|	Pb	206	21082	0.985	38	31.579
|	Pb	208	39781	0.97	81	8.903
|	pb1	208	115727	0.641	230.001	13.266
|-	Bi	209	130	4.679	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.549	9015.944	286.33	3.2	ug/L
|	Zn1	64	0.905	269.431	4.53	1.7	ug/L
|	Zn2	66	0.566	265.654	2.74	1	ug/L
|	Zn3	68	0.413	266.978	2.65	1	ug/L
|	Zn4	67	0.089	271.094	10.1	3.7	ug/L
|	Zn	64	1.973	267.897	1.55	0.6	ug/L
|	As	75	0.04	13.857	0.36	2.6	ug/L
|	Y	89	0.125				ug/L
|	Cd	111	0.003	1.068	0.09	8.9	ug/L
|	Cd	114	0.006	0.848	0.05	5.9	ug/L
|	cd1	114	0.015	0.869	0.02	2.4	ug/L
|>	In	115	130636.6				ug/L
|	Pb	207	0.122	27.011	0.22	0.8	ug/L
|	Pb	206	0.161	28.039	0.54	1.9	ug/L
|	Pb	208	0.304	27.41	0.17	0.6	ug/L
|	pb1	208	0.884	27.573	0.16	0.6	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010-DUP
Sample Da Wednesday, September 18, 2013 14:25:16
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010-DUP.1018
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	208674	0.543	1890.53	4.601
|	Zn1	64	119504	1.191	3212.619	22.883
|	Zn2	66	74256	0.783	1417.117	30.351
|	Zn3	68	53456	0.752	988.39	27.675
|	Zn4	67	11435	1.787	341.673	29.263
|	Zn	64	258651	0.475	5959.799	25.687
|	As	75	5380	3.375	-66.107	59.429
|	Y	89	16790	2.629	26.333	26.942
|	Cd	111	396	11.13	0.408	734.366
|	Cd	114	796	5.277	11.555	23.664
|	cd1	114	1925	0.709	33	28.907
|>	In	115	130713	1.233	135606.8	1.722
|	Pb	207	15751	3.4	31	3.226
|	Pb	206	20829	2.599	38	31.579
|	Pb	208	38516	1.32	81	8.903
|	pb1	208	112784	1.101	230.001	13.266
|-	Bi	209	129	5.083	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.583	9211.372	155.44	1.7	ug/L
|	Zn1	64	0.891	265.228	5.01	1.9	ug/L
|	Zn2	66	0.558	261.596	1.9	0.7	ug/L

|	Zn3	68	0.402	259.548	3.42	1.3 ug/L
|	Zn4	67	0.085	258.986	4.34	1.7 ug/L
|	Zn	64	1.935	262.705	3.08	1.2 ug/L
|	As	75	0.042	14.571	0.47	3.2 ug/L
|	Y	89	0.128			ug/L
|	Cd	111	0.003	1.024	0.1	10 ug/L
|	Cd	114	0.006	0.84	0.05	6.5 ug/L
|	cd1	114	0.014	0.86	0.01	1.1 ug/L
|>	In	115	130712.5			ug/L
|	Pb	207	0.12	26.732	0.73	2.7 ug/L
|	Pb	206	0.159	27.69	1.01	3.7 ug/L
|	Pb	208	0.294	26.525	0.58	2.2 ug/L
|	pb1	208	0.861	26.859	0.62	2.3 ug/L
|-	Bi	209	0.001			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX010-SPK
Sample Da Wednesday, September 18, 2013 14:27:53
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX010-SPK.1019
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	206099	3.085	1890.53	4.601
|	Zn1	64	179566	2.57	3212.619	22.883
|	Zn2	66	113404	1.061	1417.117	30.351
|	Zn3	68	81113	1.083	988.39	27.675
|	Zn4	67	17098	1.458	341.673	29.263
|	Zn	64	391181	1.235	5959.799	25.687
|	As	75	52373	1.804	-66.107	59.429
|	Y	89	16810	0.833	26.333	26.942
|	Cd	111	47991	2.663	0.408	734.366
|	Cd	114	110249	1.966	11.555	23.664
|	cd1	114	265108	1.442	33	28.907
|>	In	115	132665	0.138	135606.8	1.722
|	Pb	207	79326	1.786	31	3.226
|	Pb	206	100205	2.179	38	31.579
|	Pb	208	191236	0.636	81	8.903
|	pb1	208	562893	0.632	230.001	13.266
|-	Bi	209	144	6.277	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.54	8960.644	290.4	3.2	ug/L
|	Zn1	64	1.33	396.001	9.86	2.5	ug/L
|	Zn2	66	0.844	396.083	3.81	1	ug/L
|	Zn3	68	0.604	390.337	4.63	1.2	ug/L
|	Zn4	67	0.126	385.158	6.04	1.6	ug/L
|	Zn	64	2.905	394.352	4.43	1.1	ug/L
|	As	75	0.395	138.299	2.42	1.8	ug/L
|	Y	89	0.127				ug/L
|	Cd	111	0.362	122.472	3.12	2.5	ug/L
|	Cd	114	0.831	116.197	2.35	2	ug/L
|	cd1	114	1.998	118.588	1.61	1.4	ug/L
|>	In	115	132665				ug/L
|	Pb	207	0.598	132.855	2.19	1.7	ug/L
|	Pb	206	0.755	131.401	2.95	2.2	ug/L
|	Pb	208	1.441	129.95	0.78	0.6	ug/L
|	pb1	208	4.241	132.258	0.69	0.5	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-1
Sample Da Wednesday, September 18, 2013 14:30:30
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-1.1020
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2364	1.333	1890.53	4.601
|	Zn1	64	3279	14.433	3212.619	22.883
|	Zn2	66	1871	14.628	1417.117	30.351
|	Zn3	68	1348	14.582	988.39	27.675
|	Zn4	67	362	10.361	341.673	29.263
|	Zn	64	6860	14.227	5959.799	25.687
|	As	75	-78	80.016	-66.107	59.429
|	Y	89	42	7.332	26.333	26.942
|	Cd	111	1	843.033	0.408	734.366
|	Cd	114	11	5.538	11.555	23.664
|	cd1	114	71	12.519	33	28.907
|>	In	115	130734	0.97	135606.8	1.722
|	Pb	207	157	8.849	31	3.226
|	Pb	206	222	12.279	38	31.579
|	Pb	208	396	5.019	81	8.903
|	pb1	208	1167	3.15	230.001	13.266
|-	Bi	209	10	33.986	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.004	24.117	2.4	9.9	ug/L
|	Zn1	64	0.001	0.413	1.07	258.3	ug/L
|	Zn2	66	0.004	1.81	0.96	53.1	ug/L
|	Zn3	68	0.003	1.95	0.95	48.9	ug/L
|	Zn4	67	0	0.768	0.88	113.9	ug/L
|	Zn	64	0.009	1.156	1	86.3	ug/L
|	As	75	0	-0.038	0.17	441	ug/L

|	Y	89	0			ug/L
|	Cd	111	0	0.002	0.03	1158.5 ug/L
|	Cd	114	0	0	0	210 ug/L
|	cd1	114	0	0.018	0	22.9 ug/L
|>	In	115	130733.8			ug/L
|	Pb	207	0.001	0.216	0.02	10.1 ug/L
|	Pb	206	0.001	0.247	0.04	14.4 ug/L
|	Pb	208	0.002	0.219	0.01	6.3 ug/L
|	pb1	208	0.007	0.225	0.01	3.6 ug/L
|-	Bi	209	0			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-SPK-1
Sample Da Wednesday, September 18, 2013 14:33:07
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-SPK-1.1021
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	2326	1.777	1890.53	4.601
|	Zn1	64	66100	4.226	3212.619	22.883
|	Zn2	66	41602	1.331	1417.117	30.351
|	Zn3	68	29510	2.548	988.39	27.675
|	Zn4	67	6559	2.563	341.673	29.263
|	Zn	64	143771	2.804	5959.799	25.687
|	As	75	48527	3.092	-66.107	59.429
|	Y	89	25	2.341	26.333	26.942
|	Cd	111	48494	3.036	0.408	734.366
|	Cd	114	113904	1.418	11.555	23.664
|	cd1	114	270750	2.08	33	28.907
|>	In	115	134875	1.155	135606.8	1.722
|	Pb	207	64062	2.716	31	3.226
|	Pb	206	77947	2.557	38	31.579
|	Pb	208	155538	2.259	81	8.903
|	pb1	208	449241	1.159	230.001	13.266
|-	Bi	209	7	39.365	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.003	19.261	2.6	13.5	ug/L
|	Zn1	64	0.466	138.914	6.88	5	ug/L
|	Zn2	66	0.298	139.798	2.27	1.6	ug/L
|	Zn3	68	0.212	136.689	4.78	3.5	ug/L
|	Zn4	67	0.046	140.585	5.52	3.9	ug/L
|	Zn	64	1.022	138.777	4.89	3.5	ug/L
|	As	75	0.36	126.094	5.11	4.1	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.36	121.733	3.67	3	ug/L
|	Cd	114	0.844	118.083	1.33	1.1	ug/L
|	cd1	114	2.007	119.127	1.99	1.7	ug/L
|>	In	115	134875				ug/L
|	Pb	207	0.475	105.535	3.13	3	ug/L
|	Pb	206	0.578	100.536	2.83	2.8	ug/L
|	Pb	208	1.153	103.978	3.55	3.4	ug/L
|	pb1	208	3.33	103.828	2.15	2.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX011
Sample Da Wednesday, September 18, 2013 14:35:43
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX011.1022
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	213965	0.791	1890.53	4.601
|	Zn1	64	951579	1.813	3212.619	22.883
|	Zn2	66	592462	1.071	1417.117	30.351
|	Zn3	68	431258	1.517	988.39	27.675
|	Zn4	67	89360	1.555	341.673	29.263
|	Zn	64	2064659	1.234	5959.799	25.687
|	As	75	5042	4.292	-66.107	59.429
|	Y	89	16189	2.312	26.333	26.942
|	Cd	111	2229	3.761	0.408	734.366
|	Cd	114	5081	1.111	11.555	23.664
|	cd1	114	12157	1.105	33	28.907
|>	In	115	132341	3.294	135606.8	1.722
|	Pb	207	121266	2.084	31	3.226
|	Pb	206	157918	0.847	38	31.579
|	Pb	208	294613	2.607	81	8.903
|	pb1	208	867241	1.959	230.001	13.266
|-	Bi	209	589	2.989	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.604	9335.917	344.08	3.7	ug/L
|	Zn1	64	7.173	2136.04	92.97	4.4	ug/L
|	Zn2	66	4.469	2096.559	68.59	3.3	ug/L
|	Zn3	68	3.253	2101.667	40.99	2	ug/L
|	Zn4	67	0.673	2052.394	90.89	4.4	ug/L
|	Zn	64	15.569	2113.665	74.8	3.5	ug/L
|	As	75	0.039	13.5	0.35	2.6	ug/L
|	Y	89	0.122				ug/L
|	Cd	111	0.017	5.7	0.11	1.9	ug/L
|	Cd	114	0.038	5.361	0.23	4.3	ug/L
|	cd1	114	0.092	5.442	0.22	4.1	ug/L

|>	In	115	132340.6			ug/L
|	Pb	207	0.917	203.776	8.04	3.9 ug/L
|	Pb	206	1.194	207.798	8.36	4 ug/L
|	Pb	208	2.228	200.975	11.83	5.9 ug/L
|	pb1	208	6.559	204.522	10.48	5.1 ug/L
|-	Bi	209	0.004			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX012
Sample Da Wednesday, September 18, 2013 14:38:19
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX012.1023
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	256669	0.322	1890.53	4.601
|	Zn1	64	655375	3.7	3212.619	22.883
|	Zn2	66	408408	2.202	1417.117	30.351
|	Zn3	68	291263	2.638	988.39	27.675
|	Zn4	67	61683	1.3	341.673	29.263
|	Zn	64	1416729	2.788	5959.799	25.687
|	As	75	2653	5.566	-66.107	59.429
|	Y	89	23151	2.739	26.333	26.942
|	Cd	111	3273	0.936	0.408	734.366
|	Cd	114	7574	1.354	11.555	23.664
|	cd1	114	18172	0.464	33	28.907
|>	In	115	133574	1.286	135606.8	1.722
|	Pb	207	122098	2.504	31	3.226
|	Pb	206	158098	0.522	38	31.579
|	Pb	208	296422	0.862	81	8.903
|	pb1	208	871664	0.733	230.001	13.266
|-	Bi	209	870	1.371	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.908	11103.68	167.69	1.5	ug/L
|	Zn1	64	4.883	1453.989	49.6	3.4	ug/L
|	Zn2	66	3.047	1429.323	21.83	1.5	ug/L
|	Zn3	68	2.173	1404.119	28.88	2.1	ug/L
|	Zn4	67	0.459	1400.153	33.3	2.4	ug/L
|	Zn	64	10.562	1433.973	34.17	2.4	ug/L
|	As	75	0.02	7.122	0.43	6	ug/L
|	Y	89	0.173				ug/L
|	Cd	111	0.024	8.295	0.14	1.7	ug/L
|	Cd	114	0.057	7.918	0.19	2.4	ug/L
|	cd1	114	0.136	8.061	0.1	1.3	ug/L
|>	In	115	133574.1				ug/L
|	Pb	207	0.914	203.18	7.11	3.5	ug/L
|	Pb	206	1.183	205.947	1.82	0.9	ug/L
|	Pb	208	2.219	200.112	3.46	1.7	ug/L
|	pb1	208	6.525	203.464	2.97	1.5	ug/L
|-	Bi	209	0.006				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX013
Sample Da Wednesday, September 18, 2013 14:40:55
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX013.1024
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	277568	1.551	1890.53	4.601
|	Zn1	64	1939989	2.969	3212.619	22.883
|	Zn2	66	1255034	1.396	1417.117	30.351
|	Zn3	68	903987	2.193	988.39	27.675
|	Zn4	67	192045	3.548	341.673	29.263
|	Zn	64	4291055	2.145	5959.799	25.687
|	As	75	10504	1.496	-66.107	59.429
|	Y	89	15786	1.825	26.333	26.942
|	Cd	111	3118	2.628	0.408	734.366
|	Cd	114	7159	0.381	11.555	23.664
|	cd1	114	17130	1.042	33	28.907
|>	In	115	130153	1.05	135606.8	1.722
|	Pb	207	152157	1.854	31	3.226
|	Pb	206	213419	0.441	38	31.579
|	Pb	208	387920	0.913	81	8.903
|	pb1	208	1140902	0.5	230.001	13.266
|-	Bi	209	165	11.464	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	2.119	12332.54	293.27	2.4	ug/L
|	Zn1	64	14.886	4432.825	176.89	4	ug/L
|	Zn2	66	9.633	4518.958	92.82	2.1	ug/L
|	Zn3	68	6.94	4483.953	144.62	3.2	ug/L
|	Zn4	67	1.473	4491.282	205.27	4.6	ug/L
|	Zn	64	32.933	4471.101	141.5	3.2	ug/L
|	As	75	0.081	28.41	0.53	1.9	ug/L
|	Y	89	0.121				ug/L
|	Cd	111	0.024	8.11	0.14	1.7	ug/L
|	Cd	114	0.055	7.68	0.1	1.3	ug/L
|	cd1	114	0.131	7.797	0.08	1	ug/L
|>	In	115	130152.8				ug/L
|	Pb	207	1.169	259.79	2.33	0.9	ug/L
|	Pb	206	1.64	285.343	3.79	1.3	ug/L
|	Pb	208	2.98	268.781	4.89	1.8	ug/L

|	pb1	208	8.765	273.32	3.39	1.2	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX014
Sample Da Wednesday, September 18, 2013 14:43:31
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX014.1025
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens.	RSD
|-	Fe	57	255049	1.292	1890.53	4.601	
|	Zn1	64	716637	0.758	3212.619	22.883	
|	Zn2	66	454321	1.642	1417.117	30.351	
|	Zn3	68	323427	1.778	988.39	27.675	
|	Zn4	67	69224	2.833	341.673	29.263	
|	Zn	64	1563610	0.154	5959.799	25.687	
|	As	75	3242	3.399	-66.107	59.429	
|	Y	89	24851	3.098	26.333	26.942	
|	Cd	111	3620	4.289	0.408	734.366	
|	Cd	114	8402	1.938	11.555	23.664	
|	cd1	114	20351	1.943	33	28.907	
|>	In	115	131858	2.908	135606.8	1.722	
|	Pb	207	153138	3.867	31	3.226	
|	Pb	206	196011	1.186	38	31.579	
|	Pb	208	370112	1.424	81	8.903	
|	pb1	208	1084949	1.415	230.001	13.266	
|-	Bi	209	1053	0.774	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.921	11181.2	278.78	2.5	ug/L
|	Zn1	64	5.414	1612.089	36.13	2.2	ug/L
|	Zn2	66	3.438	1612.63	68.28	4.2	ug/L
|	Zn3	68	2.447	1580.959	51.18	3.2	ug/L
|	Zn4	67	0.523	1592.81	33.99	2.1	ug/L
|	Zn	64	11.821	1604.846	44.89	2.8	ug/L
|	As	75	0.025	8.775	0.17	2	ug/L
|	Y	89	0.188				ug/L
|	Cd	111	0.027	9.292	0.16	1.7	ug/L
|	Cd	114	0.064	8.901	0.16	1.8	ug/L
|	cd1	114	0.154	9.148	0.1	1.1	ug/L
|>	In	115	131857.9				ug/L
|	Pb	207	1.161	258.158	9.36	3.6	ug/L
|	Pb	206	1.487	258.805	8.49	3.3	ug/L
|	Pb	208	2.807	253.166	3.8	1.5	ug/L
|	pb1	208	8.23	256.628	5.62	2.2	ug/L
|-	Bi	209	0.008				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX015
Sample Da Wednesday, September 18, 2013 14:46:07
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX015.1026
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens.	RSD
|-	Fe	57	220127	1.465	1890.53	4.601	
|	Zn1	64	358131	1.169	3212.619	22.883	
|	Zn2	66	226133	2.252	1417.117	30.351	
|	Zn3	68	164553	0.812	988.39	27.675	
|	Zn4	67	35756	0.647	341.673	29.263	
|	Zn	64	784572	1.247	5959.799	25.687	
|	As	75	1920	3.758	-66.107	59.429	
|	Y	89	20266	2.017	26.333	26.942	
|	Cd	111	1499	1.985	0.408	734.366	
|	Cd	114	3343	3.717	11.555	23.664	
|	cd1	114	8083	2.114	33	28.907	
|>	In	115	131764	3.23	135606.8	1.722	
|	Pb	207	104757	4.546	31	3.226	
|	Pb	206	134116	0.54	38	31.579	
|	Pb	208	252861	2.684	81	8.903	
|	pb1	208	746840	2.087	230.001	13.266	
|-	Bi	209	454	4.541	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.658	9649.665	388.43	4	ug/L
|	Zn1	64	2.695	802.683	16.83	2.1	ug/L
|	Zn2	66	1.706	800.382	14.58	1.8	ug/L
|	Zn3	68	1.242	802.719	25.26	3.1	ug/L
|	Zn4	67	0.269	820.132	31.63	3.9	ug/L
|	Zn	64	5.913	802.802	17.99	2.2	ug/L
|	As	75	0.015	5.268	0.05	0.9	ug/L
|	Y	89	0.154				ug/L
|	Cd	111	0.011	3.856	0.2	5.2	ug/L
|	Cd	114	0.025	3.536	0.11	3.1	ug/L
|	cd1	114	0.061	3.629	0.13	3.6	ug/L
|>	In	115	131764				ug/L
|	Pb	207	0.795	176.627	3.5	2	ug/L
|	Pb	206	1.018	177.211	5.8	3.3	ug/L
|	Pb	208	1.919	173.04	1.25	0.7	ug/L
|	pb1	208	5.668	176.739	2.02	1.1	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb

Sample Da Wednesday, September 18, 2013 14:48:42
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.1027
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	6091	2.816	1890.53	4.601
|	Zn1	64	78108	2.289	3212.619	22.883
|	Zn2	66	47233	2.474	1417.117	30.351
|	Zn3	68	34886	0.873	988.39	27.675
|	Zn4	67	8085	1.103	341.673	29.263
|	Zn	64	168312	1.355	5959.799	25.687
|	As	75	59663	1.865	-66.107	59.429
|	Y	89	45	5.634	26.333	26.942
|	Cd	111	60278	0.586	0.408	734.366
|	Cd	114	141771	0.96	11.555	23.664
|	cd1	114	350192	0.734	33	28.907
|>	In	115	131020	2.317	135606.8	1.722
|	Pb	207	86101	1.575	31	3.226
|	Pb	206	110541	1.169	38	31.579
|	Pb	208	214905	4.503	81	8.903
|	pb1	208	624405	1.586	230.001	13.266
|-	Bi	209	65	12.016	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.033	189.396	1.85	1	ug/L
|	Zn1	64	0.573	170.53	5.46	3.2	ug/L
|	Zn2	66	0.35	164.204	0.69	0.4	ug/L
|	Zn3	68	0.259	167.395	4.58	2.7	ug/L
|	Zn4	67	0.059	180.44	2.63	1.5	ug/L
|	Zn	64	1.241	168.482	3.26	1.9	ug/L
|	As	75	0.456	159.521	1.97	1.2	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.46	155.804	2.87	1.8	ug/L
|	Cd	114	1.082	151.349	3.66	2.4	ug/L
|	cd1	114	2.674	158.692	4.7	3	ug/L
|>	In	115	131020.4				ug/L
|	Pb	207	0.657	146.039	1.64	1.1	ug/L
|	Pb	206	0.844	146.815	2.74	1.9	ug/L
|	Pb	208	1.64	147.879	5.79	3.9	ug/L
|	pb1	208	4.765	148.581	1.85	1.2	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 14:51:17
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.1028
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2303	10.675	1890.53	4.601
|	Zn1	64	3047	16.288	3212.619	22.883
|	Zn2	66	1699	22.995	1417.117	30.351
|	Zn3	68	1249	20.237	988.39	27.675
|	Zn4	67	338	8.283	341.673	29.263
|	Zn	64	6334	18.403	5959.799	25.687
|	As	75	-91	28.699	-66.107	59.429
|	Y	89	17	46.69	26.333	26.942
|	Cd	111	2	165.06	0.408	734.366
|	Cd	114	13	13.878	11.555	23.664
|	cd1	114	63	15.336	33	28.907
|>	In	115	126958	2.249	135606.8	1.722
|	Pb	207	42	15.43	31	3.226
|	Pb	206	55	10.893	38	31.579
|	Pb	208	106	10.424	81	8.903
|	pb1	208	303	8.618	230.001	13.266
|-	Bi	209	4	35.251	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.004	24.591	13.22	53.7	ug/L
|	Zn1	64	0	0.091	1.15	1262.3	ug/L
|	Zn2	66	0.003	1.372	1.43	104.1	ug/L
|	Zn3	68	0.003	1.649	1.29	78.3	ug/L
|	Zn4	67	0	0.446	0.7	157.9	ug/L
|	Zn	64	0.006	0.805	1.24	153.7	ug/L
|	As	75	0	-0.081	0.08	93.4	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.005	0.01	195.6	ug/L
|	Cd	114	0	0.003	0	81	ug/L
|	cd1	114	0	0.015	0	25.6	ug/L
|>	In	115	126957.8				ug/L
|	Pb	207	0	0.022	0.01	43.4	ug/L
|	Pb	206	0	0.027	0.01	30.7	ug/L
|	Pb	208	0	0.021	0.01	33	ug/L
|	pb1	208	0.001	0.021	0.01	24.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX016
Sample Da Wednesday, September 18, 2013 14:53:52
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947

Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX016.1029
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	315291	1.248	1890.53	4.601
|	Zn1	64	270860	1.192	3212.619	22.883
|	Zn2	66	165890	1.47	1417.117	30.351
|	Zn3	68	121474	0.754	988.39	27.675
|	Zn4	67	26302	1.645	341.673	29.263
|	Zn	64	584526	0.332	5959.799	25.687
|	As	75	1860	1.03	-66.107	59.429
|	Y	89	26311	1.512	26.333	26.942
|	Cd	111	777	0.757	0.408	734.366
|	Cd	114	1688	4.107	11.555	23.664
|	cd1	114	4096	2.243	33	28.907
|>	In	115	127093	3.148	135606.8	1.722
|	Pb	207	65261	1.429	31	3.226
|	Pb	206	88293	0.145	38	31.579
|	Pb	208	161492	1.957	81	8.903
|	pb1	208	474557	1.161	230.001	13.266
|-	Bi	209	334	2.491	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	2.468	14362.91	277.84	1.9	ug/L
|	Zn1	64	2.109	627.972	19.59	3.1	ug/L
|	Zn2	66	1.295	607.648	13.63	2.2	ug/L
|	Zn3	68	0.949	613.355	24.35	4	ug/L
|	Zn4	67	0.205	623.648	26.38	4.2	ug/L
|	Zn	64	4.558	618.826	18.15	2.9	ug/L
|	As	75	0.015	5.293	0.11	2.1	ug/L
|	Y	89	0.207				ug/L
|	Cd	111	0.006	2.069	0.07	3.6	ug/L
|	Cd	114	0.013	1.848	0.12	6.4	ug/L
|	cd1	114	0.032	1.9	0.1	5.3	ug/L
|>	In	115	127092.8				ug/L
|	Pb	207	0.514	114.153	3.53	3.1	ug/L
|	Pb	206	0.695	120.931	3.78	3.1	ug/L
|	Pb	208	1.271	114.633	4.8	4.2	ug/L
|	pb1	208	3.734	116.448	3.26	2.8	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX017
Sample Da Wednesday, September 18, 2013 14:56:28
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX017.1030
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	238147	0.841	1890.53	4.601
|	Zn1	64	796432	0.344	3212.619	22.883
|	Zn2	66	491971	2.161	1417.117	30.351
|	Zn3	68	353450	1.162	988.39	27.675
|	Zn4	67	76801	1.864	341.673	29.263
|	Zn	64	1718655	0.973	5959.799	25.687
|	As	75	2943	2.737	-66.107	59.429
|	Y	89	19954	0.031	26.333	26.942
|	Cd	111	1762	1.75	0.408	734.366
|	Cd	114	4055	2.092	11.555	23.664
|	cd1	114	9885	1.714	33	28.907
|>	In	115	127822	2.218	135606.8	1.722
|	Pb	207	533998	3.378	31	3.226
|	Pb	206	690024	1.374	38	31.579
|	Pb	208	1320669	0.844	81	8.903
|	pb1	208	3856053	0.448	230.001	13.266
|-	Bi	209	948	2.904	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.85	10765.33	225.07	2.1	ug/L
|	Zn1	64	6.209	1849.036	43.41	2.3	ug/L
|	Zn2	66	3.841	1801.635	74.95	4.2	ug/L
|	Zn3	68	2.759	1782.824	60.87	3.4	ug/L
|	Zn4	67	0.599	1824.788	72.25	4	ug/L
|	Zn	64	13.408	1820.324	56.79	3.1	ug/L
|	As	75	0.024	8.228	0.29	3.5	ug/L
|	Y	89	0.156				ug/L
|	Cd	111	0.014	4.669	0.17	3.7	ug/L
|	Cd	114	0.032	4.427	0.18	4	ug/L
|	cd1	114	0.077	4.578	0.18	3.9	ug/L
|>	In	115	127821.6				ug/L
|	Pb	207	4.179	928.858	37.36	4	ug/L
|	Pb	206	5.399	939.556	10.25	1.1	ug/L
|	Pb	208	10.336	932.133	25.43	2.7	ug/L
|	pb1	208	30.176	941.003	22.34	2.4	ug/L
|-	Bi	209	0.007				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX018
Sample Da Wednesday, September 18, 2013 14:59:04
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual

Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX018.1031
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	210130	0.761	1890.53	4.601
|	Zn1	64	720984	1.652	3212.619	22.883
|	Zn2	66	451816	1.57	1417.117	30.351
|	Zn3	68	324394	0.209	988.39	27.675
|	Zn4	67	69275	1.611	341.673	29.263
|	Zn	64	1566469	1.137	5959.799	25.687
|	As	75	2863	4.729	-66.107	59.429
|	Y	89	24751	2.675	26.333	26.942
|	Cd	111	3861	0.449	0.408	734.366
|	Cd	114	9022	5.703	11.555	23.664
|	cd1	114	21771	2.013	33	28.907
|>	In	115	132785	1.162	135606.8	1.722
|	Pb	207	203213	0.658	31	3.226
|	Pb	206	265252	1.481	38	31.579
|	Pb	208	497406	2.604	81	8.903
|	pb1	208	1454674	1.962	230.001	13.266
|-	Bi	209	1311	3.578	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.569	9129.414	81.61	0.9	ug/L
|	Zn1	64	5.406	1609.834	16.91	1.1	ug/L
|	Zn2	66	3.392	1591.31	24.67	1.6	ug/L
|	Zn3	68	2.436	1573.911	19.63	1.2	ug/L
|	Zn4	67	0.519	1582.753	35.97	2.3	ug/L
|	Zn	64	11.754	1595.718	15.56	1	ug/L
|	As	75	0.022	7.719	0.43	5.6	ug/L
|	Y	89	0.186				ug/L
|	Cd	111	0.029	9.843	0.13	1.3	ug/L
|	Cd	114	0.068	9.492	0.59	6.2	ug/L
|	cd1	114	0.164	9.718	0.27	2.8	ug/L
|>	In	115	132784.5				ug/L
|	Pb	207	1.53	340.136	2.67	0.8	ug/L
|	Pb	206	1.998	347.652	8.3	2.4	ug/L
|	Pb	208	3.745	337.747	5.03	1.5	ug/L
|	pb1	208	10.953	341.553	3.67	1.1	ug/L
|-	Bi	209	0.01				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX019
Sample Da Wednesday, September 18, 2013 15:01:40
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX019.1032
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	203852	1.437	1890.53	4.601
|	Zn1	64	744997	1.09	3212.619	22.883
|	Zn2	66	463065	2.057	1417.117	30.351
|	Zn3	68	339844	2.13	988.39	27.675
|	Zn4	67	70746	2.482	341.673	29.263
|	Zn	64	1618652	0.291	5959.799	25.687
|	As	75	5335	1.101	-66.107	59.429
|	Y	89	14448	1.774	26.333	26.942
|	Cd	111	1507	2.747	0.408	734.366
|	Cd	114	3399	0.281	11.555	23.664
|	cd1	114	8228	1.31	33	28.907
|>	In	115	130505	1.652	135606.8	1.722
|	Pb	207	68255	1.591	31	3.226
|	Pb	206	93418	0.503	38	31.579
|	Pb	208	168384	1.025	81	8.903
|	pb1	208	498574	0.768	230.001	13.266
|-	Bi	209	359	9.381	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.548	9010.55	116.14	1.3	ug/L
|	Zn1	64	5.685	1693.03	16.9	1	ug/L
|	Zn2	66	3.539	1660.24	61.95	3.7	ug/L
|	Zn3	68	2.597	1677.741	8.3	0.5	ug/L
|	Zn4	67	0.54	1645.436	68.54	4.2	ug/L
|	Zn	64	12.361	1678.207	25.55	1.5	ug/L
|	As	75	0.041	14.475	0.14	1	ug/L
|	Y	89	0.111				ug/L
|	Cd	111	0.012	3.908	0.06	1.4	ug/L
|	Cd	114	0.026	3.631	0.05	1.4	ug/L
|	cd1	114	0.063	3.728	0.03	0.9	ug/L
|>	In	115	130504.7				ug/L
|	Pb	207	0.523	116.205	0.96	0.8	ug/L
|	Pb	206	0.716	124.54	1.44	1.2	ug/L
|	Pb	208	1.29	116.344	3.11	2.7	ug/L
|	pb1	208	3.82	119.109	2.73	2.3	ug/L
|-	Bi	209	0.003				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX020
Sample Da Wednesday, September 18, 2013 15:04:17
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX020.1033

Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	184175	1.895	1890.53	4.601
|	Zn1	64	232889	1.558	3212.619	22.883
|	Zn2	66	144295	3.447	1417.117	30.351
|	Zn3	68	104015	1.25	988.39	27.675
|	Zn4	67	22359	0.946	341.673	29.263
|	Zn	64	503558	0.638	5959.799	25.687
|	As	75	1351	8.094	-66.107	59.429
|	Y	89	19108	1.032	26.333	26.942
|	Cd	111	1011	6.688	0.408	734.366
|	Cd	114	2246	3.365	11.555	23.664
|	cd1	114	5427	0.628	33	28.907
|>	In	115	133161	1.42	135606.8	1.722
|	Pb	207	38157	1.36	31	3.226
|	Pb	206	49375	3.09	38	31.579
|	Pb	208	89812	1.659	81	8.903
|	pb1	208	267127	0.507	230.001	13.266
|-	Bi	209	266	3.759	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.369	7968.824	135.8	1.7	ug/L
|	Zn1	64	1.725	513.751	3.33	0.6	ug/L
|	Zn2	66	1.073	503.553	21.8	4.3	ug/L
|	Zn3	68	0.774	500.006	4.58	0.9	ug/L
|	Zn4	67	0.165	504.157	2.75	0.5	ug/L
|	Zn	64	3.738	507.484	5.43	1.1	ug/L
|	As	75	0.011	3.719	0.28	7.6	ug/L
|	Y	89	0.143				ug/L
|	Cd	111	0.008	2.57	0.21	8.1	ug/L
|	Cd	114	0.017	2.347	0.11	4.7	ug/L
|	cd1	114	0.041	2.405	0.05	2	ug/L
|>	In	115	133161.4				ug/L
|	Pb	207	0.286	63.652	1.37	2.2	ug/L
|	Pb	206	0.37	64.474	1.4	2.2	ug/L
|	Pb	208	0.674	60.788	1.73	2.9	ug/L
|	pb1	208	2.005	62.51	0.79	1.3	ug/L
|-	Bi	209	0.002				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX020-DUP
Sample Da Wednesday, September 18, 2013 15:06:54
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX020-DUP.1034
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	188398	1.541	1890.53	4.601
|	Zn1	64	230793	2.068	3212.619	22.883
|	Zn2	66	144251	3.547	1417.117	30.351
|	Zn3	68	101981	0.388	988.39	27.675
|	Zn4	67	22259	1.203	341.673	29.263
|	Zn	64	499283	1.159	5959.799	25.687
|	As	75	1371	8.411	-66.107	59.429
|	Y	89	18972	0.616	26.333	26.942
|	Cd	111	1009	5.23	0.408	734.366
|	Cd	114	2217	0.529	11.555	23.664
|	cd1	114	5386	1.387	33	28.907
|>	In	115	131851	0.953	135606.8	1.722
|	Pb	207	36983	1.973	31	3.226
|	Pb	206	48787	1.476	38	31.579
|	Pb	208	90449	2.635	81	8.903
|	pb1	208	267982	1.9	230.001	13.266
|-	Bi	209	279	3.045	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.415	8235.577	164.22	2	ug/L
|	Zn1	64	1.727	514.219	11.6	2.3	ug/L
|	Zn2	66	1.083	508.225	13.54	2.7	ug/L
|	Zn3	68	0.766	495.076	6.65	1.3	ug/L
|	Zn4	67	0.166	506.919	7.35	1.4	ug/L
|	Zn	64	3.743	508.137	3.16	0.6	ug/L
|	As	75	0.011	3.809	0.31	8.3	ug/L
|	Y	89	0.144				ug/L
|	Cd	111	0.008	2.59	0.11	4.3	ug/L
|	Cd	114	0.017	2.339	0.03	1.4	ug/L
|	cd1	114	0.041	2.41	0.05	2	ug/L
|>	In	115	131851.1				ug/L
|	Pb	207	0.28	62.296	1.14	1.8	ug/L
|	Pb	206	0.37	64.352	1.4	2.2	ug/L
|	Pb	208	0.685	61.819	1.83	3	ug/L
|	pb1	208	2.031	63.336	1.68	2.7	ug/L
|-	Bi	209	0.002				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX020-SPK
Sample Da Wednesday, September 18, 2013 15:09:31
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX020-SPK.1035
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration

Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	176600	1.292	1890.53	4.601
|	Zn1	64	282657	0.987	3212.619	22.883
|	Zn2	66	177020	2.314	1417.117	30.351
|	Zn3	68	128147	1.2	988.39	27.675
|	Zn4	67	27284	0.375	341.673	29.263
|	Zn	64	615109	0.948	5959.799	25.687
|	As	75	47825	0.699	-66.107	59.429
|	Y	89	18453	3.257	26.333	26.942
|	Cd	111	47104	2.754	0.408	734.366
|	Cd	114	113985	0.264	11.555	23.664
|	cd1	114	271077	0.504	33	28.907
|>	In	115	131906	0.806	135606.8	1.722
|	Pb	207	97294	1.243	31	3.226
|	Pb	206	126479	3.855	38	31.579
|	Pb	208	240447	1.431	81	8.903
|	pb1	208	703881	1.227	230.001	13.266
|-	Bi	209	264	8.946	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.325	7711.209	122.37	1.6	ug/L
|	Zn1	64	2.119	631.123	11.38	1.8	ug/L
|	Zn2	66	1.332	624.649	15.14	2.4	ug/L
|	Zn3	68	0.964	623.029	9.68	1.6	ug/L
|	Zn4	67	0.204	622.837	6.57	1.1	ug/L
|	Zn	64	4.62	627.179	9.52	1.5	ug/L
|	As	75	0.363	127.032	0.14	0.1	ug/L
|	Y	89	0.14				ug/L
|	Cd	111	0.357	120.902	3.31	2.7	ug/L
|	Cd	114	0.864	120.832	1.29	1.1	ug/L
|	cd1	114	2.055	121.965	1.58	1.3	ug/L
|>	In	115	131906.4				ug/L
|	Pb	207	0.737	163.904	2.11	1.3	ug/L
|	Pb	206	0.959	166.825	6.48	3.9	ug/L
|	Pb	208	1.822	164.339	1.1	0.7	ug/L
|	pb1	208	5.335	166.351	1.7	1	ug/L
|-	Bi	209	0.002				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-2
Sample Da Wednesday, September 18, 2013 15:12:07
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-2.1036
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2287	4.578	1890.53	4.601
|	Zn1	64	2678	14.236	3212.619	22.883
|	Zn2	66	1516	15.461	1417.117	30.351
|	Zn3	68	1080	14.76	988.39	27.675
|	Zn4	67	322	14.082	341.673	29.263
|	Zn	64	5597	14.517	5959.799	25.687
|	As	75	-84	5.686	-66.107	59.429
|	Y	89	32	15.894	26.333	26.942
|	Cd	111	1	118.461	0.408	734.366
|	Cd	114	11	51.97	11.555	23.664
|	cd1	114	65	9.352	33	28.907
|>	In	115	130376	2.4	135606.8	1.722
|	Pb	207	44	9.116	31	3.226
|	Pb	206	64	19.682	38	31.579
|	Pb	208	121	17.414	81	8.903
|	pb1	208	352	7.66	230.001	13.266
|-	Bi	209	6	66.811	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.004	21.075	6.95	33	ug/L
|	Zn1	64	-0.003	-0.924	0.99	107.5	ug/L
|	Zn2	66	0.001	0.569	0.96	168.2	ug/L
|	Zn3	68	0.001	0.658	0.91	137.7	ug/L
|	Zn4	67	0	-0.124	1.23	986.6	ug/L
|	Zn	64	-0.001	-0.124	0.97	779.9	ug/L
|	As	75	0	-0.055	0.02	27.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.002	0	174.6	ug/L
|	Cd	114	0	0	0.01	3864.4	ug/L
|	cd1	114	0	0.015	0	14	ug/L
|>	In	115	130375.6				ug/L
|	Pb	207	0	0.025	0.01	28.8	ug/L
|	Pb	206	0	0.037	0.02	44.3	ug/L
|	Pb	208	0	0.03	0.02	54.1	ug/L
|	pb1	208	0.001	0.031	0.01	26.6	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: BLANK-SPK-2
Sample Da Wednesday, September 18, 2013 15:14:44
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\BLANK-SPK-2.1037
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2170	1.465	1890.53	4.601

|	Zn1	64	65438	1.589	3212.619	22.883
|	Zn2	66	41449	0.995	1417.117	30.351
|	Zn3	68	29262	2.736	988.39	27.675
|	Zn4	67	6255	3.896	341.673	29.263
|	Zn	64	142405	1.25	5959.799	25.687
|	As	75	46924	1.877	-66.107	59.429
|	Y	89	26	19.487	26.333	26.942
|	Cd	111	47478	0.665	0.408	734.366
|	Cd	114	110022	0.928	11.555	23.664
|	cd1	114	264252	0.568	33	28.907
|>	In	115	129639	1.582	135606.8	1.722
|	Pb	207	62328	0.92	31	3.226
|	Pb	206	78776	1.261	38	31.579
|	Pb	208	150491	1.747	81	8.903
|	pb1	208	441699	0.86	230.001	13.266
|-	Bi	209	11	48.105	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.003	16.291	2.79	17.1	ug/L
|	Zn1	64	0.481	143.307	4.59	3.2	ug/L
|	Zn2	66	0.309	145.104	2.77	1.9	ug/L
|	Zn3	68	0.219	141.188	5.88	4.2	ug/L
|	Zn4	67	0.046	139.483	8	5.7	ug/L
|	Zn	64	1.055	143.211	4.18	2.9	ug/L
|	As	75	0.363	126.842	3.24	2.6	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.366	124.008	1.6	1.3	ug/L
|	Cd	114	0.849	118.695	2.94	2.5	ug/L
|	cd1	114	2.039	120.991	2.46	2	ug/L
|>	In	115	129639				ug/L
|	Pb	207	0.481	106.825	1.14	1.1	ug/L
|	Pb	206	0.608	105.733	2.98	2.8	ug/L
|	Pb	208	1.161	104.67	3.21	3.1	ug/L
|	pb1	208	3.406	106.219	2.43	2.3	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: NIST-2711
Sample Da Wednesday, September 18, 2013 15:17:20
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\NIST-2711.1038
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	224103	0.895	1890.53	4.601
|	Zn1	64	82014	1.566	3212.619	22.883
|	Zn2	66	49147	0.864	1417.117	30.351
|	Zn3	68	35754	1.201	988.39	27.675
|	Zn4	67	7952	3.442	341.673	29.263
|	Zn	64	174867	0.769	5959.799	25.687
|	As	75	17441	4.195	-66.107	59.429
|	Y	89	31976	0.481	26.333	26.942
|	Cd	111	7212	1.505	0.408	734.366
|	Cd	114	17004	0.621	11.555	23.664
|	cd1	114	40418	0.484	33	28.907
|>	In	115	129169	2.966	135606.8	1.722
|	Pb	207	282060	1.849	31	3.226
|	Pb	206	326323	0.542	38	31.579
|	Pb	208	652312	3.362	81	8.903
|	pb1	208	1903438	1.91	230.001	13.266
|-	Bi	209	1477	7.016	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.722	10020.54	214.15	2.1	ug/L
|	Zn1	64	0.612	182.176	8.18	4.5	ug/L
|	Zn2	66	0.37	173.657	3.78	2.2	ug/L
|	Zn3	68	0.27	174.28	7.35	4.2	ug/L
|	Zn4	67	0.059	180.195	11.85	6.6	ug/L
|	Zn	64	1.311	177.963	6.8	3.8	ug/L
|	As	75	0.135	47.406	0.83	1.8	ug/L
|	Y	89	0.248				ug/L
|	Cd	111	0.056	18.911	0.53	2.8	ug/L
|	Cd	114	0.132	18.409	0.64	3.5	ug/L
|	cd1	114	0.313	18.569	0.63	3.4	ug/L
|>	In	115	129169.2				ug/L
|	Pb	207	2.184	485.519	12.6	2.6	ug/L
|	Pb	206	2.528	439.912	15.47	3.5	ug/L
|	Pb	208	5.05	455.405	8.19	1.8	ug/L
|	pb1	208	14.74	459.636	10.94	2.4	ug/L
|-	Bi	209	0.011				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 15:19:56
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.1039
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	6096	1.806	1890.53	4.601
|	Zn1	64	79973	2.025	3212.619	22.883
|	Zn2	66	48660	1.881	1417.117	30.351
|	Zn3	68	34771	2.665	988.39	27.675
|	Zn4	67	8374	1.837	341.673	29.263

|	Zn	64	171778	0.957	5959.799	25.687
|	As	75	59931	0.993	-66.107	59.429
|	Y	89	42	7.593	26.333	26.942
|	Cd	111	61128	1.338	0.408	734.366
|	Cd	114	142750	1.045	11.555	23.664
|	cd1	114	347717	0.547	33	28.907
|>	In	115	131280	0.625	135606.8	1.722
|	Pb	207	87587	2.442	31	3.226
|	Pb	206	107407	3.839	38	31.579
|	Pb	208	210556	1.092	81	8.903
|	pb1	208	613295	1.477	230.001	13.266
|-	Bi	209	143	15.993	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.032	189.088	3.2	1.7	ug/L
|	Zn1	64	0.585	174.346	3.11	1.8	ug/L
|	Zn2	66	0.36	168.981	3.76	2.2	ug/L
|	Zn3	68	0.258	166.411	3.68	2.2	ug/L
|	Zn4	67	0.061	186.729	2.36	1.3	ug/L
|	Zn	64	1.265	171.677	0.59	0.3	ug/L
|	As	75	0.457	159.913	2.58	1.6	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.466	157.654	2.86	1.8	ug/L
|	Cd	114	1.087	152.051	2.52	1.7	ug/L
|	cd1	114	2.649	157.195	1.79	1.1	ug/L
|>	In	115	131279.9				ug/L
|	Pb	207	0.667	148.243	3.24	2.2	ug/L
|	Pb	206	0.818	142.316	4.58	3.2	ug/L
|	Pb	208	1.603	144.6	1.99	1.4	ug/L
|	pb1	208	4.67	145.621	1.28	0.9	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 15:22:30
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.1040
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2153	3.555	1890.53	4.601
|	Zn1	64	2550	15.344	3212.619	22.883
|	Zn2	66	1468	15.693	1417.117	30.351
|	Zn3	68	1078	15.831	988.39	27.675
|	Zn4	67	298	24.598	341.673	29.263
|	Zn	64	5395	15.92	5959.799	25.687
|	As	75	-66	86.457	-66.107	59.429
|	Y	89	14	34.415	26.333	26.942
|	Cd	111	1	527.342	0.408	734.366
|	Cd	114	13	38.619	11.555	23.664
|	cd1	114	55	18.983	33	28.907
|>	In	115	127753	1.974	135606.8	1.722
|	Pb	207	42	24.278	31	3.226
|	Pb	206	55	12.727	38	31.579
|	Pb	208	105	17.098	81	8.903
|	pb1	208	302	13.426	230.001	13.266
|-	Bi	209	8	21.651	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.003	17.003	5.1	30	ug/L
|	Zn1	64	-0.004	-1.112	0.89	79.8	ug/L
|	Zn2	66	0.001	0.491	0.85	173	ug/L
|	Zn3	68	0.001	0.744	0.84	113.6	ug/L
|	Zn4	67	0	-0.564	1.78	316.2	ug/L
|	Zn	64	-0.002	-0.234	0.9	385.6	ug/L
|	As	75	0	-0.009	0.15	1794.8	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.001	0.01	955.9	ug/L
|	Cd	114	0	0.002	0.01	281.5	ug/L
|	cd1	114	0	0.011	0	39	ug/L
|>	In	115	127753.1				ug/L
|	Pb	207	0	0.022	0.02	81.3	ug/L
|	Pb	206	0	0.026	0.01	41.4	ug/L
|	Pb	208	0	0.02	0.01	56.3	ug/L
|	pb1	208	0.001	0.021	0.01	46.1	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX021
Sample Da Wednesday, September 18, 2013 15:25:05
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX021.1041
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	350617	2.67	1890.53	4.601
|	Zn1	64	4721678	2.674	3212.619	22.883
|	Zn2	66	2973355	0.945	1417.117	30.351
|	Zn3	68	2136702	0.766	988.39	27.675
|	Zn4	67	487924	0.938	341.673	29.263
|	Zn	64	10319659	1.624	5959.799	25.687
|	As	75	3738	4.381	-66.107	59.429
|	Y	89	24104	0.731	26.333	26.942
|	Cd	111	4914	1.99	0.408	734.366

|	Cd	114	10916.	1.136	11.555	23.664
|	cd1	114	26436	0.655	33	28.907
|>	In	115	131405	1.715	135606.8	1.722
|	Pb	207	118632	0.981	31	3.226
|	Pb	206	173697	1.065	38	31.579
|	Pb	208	297973	0.15	81	8.903
|	pb1	208	885198	0.346	230.001	13.266
|-	Bi	209	139	14.503	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	2.655	15449.46	410.51	2.7	ug/L
|	Zn1	64	35.923	10697.44	432.98	4	ug/L
|	Zn2	66	22.622	10611.93	235.54	2.2	ug/L
|	Zn3	68	16.258	10504.48	262.69	2.5	ug/L
|	Zn4	67	3.711	11312.4	209.72	1.9	ug/L
|	Zn	64	78.515	10659.54	325.3	3.1	ug/L
|	As	75	0.029	10.124	0.4	4	ug/L
|	Y	89	0.183				ug/L
|	Cd	111	0.037	12.664	0.43	3.4	ug/L
|	Cd	114	0.083	11.606	0.16	1.4	ug/L
|	cd1	114	0.201	11.928	0.13	1.1	ug/L
|>	In	115	131404.6				ug/L
|	Pb	207	0.903	200.643	2.52	1.3	ug/L
|	Pb	206	1.322	230.056	5.8	2.5	ug/L
|	Pb	208	2.267	204.499	3.85	1.9	ug/L
|	pb1	208	6.736	210.063	4.37	2.1	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX022
Sample Da Wednesday, September 18, 2013 15:27:42
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX022.1042
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	180144	1.269	1890.53	4.601
|	Zn1	64	1118711	2.322	3212.619	22.883
|	Zn2	66	695649	3.636	1417.117	30.351
|	Zn3	68	504297	1.653	988.39	27.675
|	Zn4	67	106266	3.007	341.673	29.263
|	Zn	64	2424922	1.848	5959.799	25.687
|	As	75	2600	1.425	-66.107	59.429
|	Y	89	15723	1.26	26.333	26.942
|	Cd	111	3586	5.391	0.408	734.366
|	Cd	114	8383	0.954	11.555	23.664
|	cd1	114	20104	1.627	33	28.907
|>	In	115	128717	1.96	135606.8	1.722
|	Pb	207	183499	1.634	31	3.226
|	Pb	206	244711	3.37	38	31.579
|	Pb	208	461886	1.691	81	8.903
|	pb1	208	1339586	0.567	230.001	13.266
|-	Bi	209	1011	3.479	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.386	8067.037	236.31	2.9	ug/L
|	Zn1	64	8.668	2581.154	40.93	1.6	ug/L
|	Zn2	66	5.394	2530.079	66.66	2.6	ug/L
|	Zn3	68	3.912	2527.87	90.54	3.6	ug/L
|	Zn4	67	0.824	2510.277	121.7	4.8	ug/L
|	Zn	64	18.797	2552.019	44.77	1.8	ug/L
|	As	75	0.021	7.239	0.16	2.2	ug/L
|	Y	89	0.122				ug/L
|	Cd	111	0.028	9.427	0.32	3.4	ug/L
|	Cd	114	0.065	9.098	0.19	2.1	ug/L
|	cd1	114	0.156	9.257	0.15	1.7	ug/L
|>	In	115	128717.4				ug/L
|	Pb	207	1.425	316.851	3.61	1.1	ug/L
|	Pb	206	1.901	330.774	7.04	2.1	ug/L
|	Pb	208	3.589	323.723	11.69	3.6	ug/L
|	pb1	208	10.409	324.584	7.97	2.5	ug/L
|-	Bi	209	0.008				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX023
Sample Da Wednesday, September 18, 2013 15:30:18
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX023.1043
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	203131	0.745	1890.53	4.601
|	Zn1	64	651545	1.199	3212.619	22.883
|	Zn2	66	404440	4.053	1417.117	30.351
|	Zn3	68	285257	1.202	988.39	27.675
|	Zn4	67	59994	1.447	341.673	29.263
|	Zn	64	1401236	1.559	5959.799	25.687
|	As	75	4883	0.564	-66.107	59.429
|	Y	89	16454	2.708	26.333	26.942
|	Cd	111	845	3.276	0.408	734.366
|	Cd	114	1909	2.432	11.555	23.664
|	cd1	114	4545	2.485	33	28.907
|>	In	115	130523	0.507	135606.8	1.722
|	Pb	207	31417	0.477	31	3.226

|	Pb	206	40215	0.922	38	31.579
|	Pb	208	75740	1.292	81	8.903
|	pb1	208	222763	0.366	230.001	13.266
|-	Bi	209	241	9.722	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.542	8976.525	62.38	0.7	ug/L
|	Zn1	64	4.968	1479.47	19.53	1.3	ug/L
|	Zn2	66	3.088	1448.71	61.29	4.2	ug/L
|	Zn3	68	2.178	1407.424	20.24	1.4	ug/L
|	Zn4	67	0.457	1393.375	19.91	1.4	ug/L
|	Zn	64	10.692	1451.594	25.53	1.8	ug/L
|	As	75	0.038	13.261	0.01	0.1	ug/L
|	Y	89	0.126				ug/L
|	Cd	111	0.006	2.192	0.07	3.2	ug/L
|	Cd	114	0.015	2.033	0.05	2.4	ug/L
|	cd1	114	0.035	2.052	0.05	2.4	ug/L
|>	In	115	130522.5				ug/L
|	Pb	207	0.24	53.451	0.08	0.1	ug/L
|	Pb	206	0.308	53.572	0.61	1.1	ug/L
|	Pb	208	0.58	52.282	0.82	1.6	ug/L
|	pb1	208	1.705	53.169	0.35	0.7	ug/L
|-	Bi	209	0.002				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX024
Sample Da Wednesday, September 18, 2013 15:32:55
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX024.1044
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	366909	2.238	1890.53	4.601
|	Zn1	64	478517	2.005	3212.619	22.883
|	Zn2	66	301786	1.883	1417.117	30.351
|	Zn3	68	211797	3.142	988.39	27.675
|	Zn4	67	46188	0.553	341.673	29.263
|	Zn	64	1038288	1.201	5959.799	25.687
|	As	75	29113	1.559	-66.107	59.429
|	Y	89	12362	1.36	26.333	26.942
|	Cd	111	743	4.274	0.408	734.366
|	Cd	114	1600	0.691	11.555	23.664
|	cd1	114	4278	1.269	33	28.907
|>	In	115	129254	0.489	135606.8	1.722
|	Pb	207	143822	0.967	31	3.226
|	Pb	206	184676	1.045	38	31.579
|	Pb	208	356028	1.777	81	8.903
|	pb1	208	1032590	0.38	230.001	13.266
|-	Bi	209	474	4.322	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	2.825	16441.25	440.08	2.7	ug/L
|	Zn1	64	3.678	1095.373	19.41	1.8	ug/L
|	Zn2	66	2.324	1090.359	20.61	1.9	ug/L
|	Zn3	68	1.631	1053.994	30.99	2.9	ug/L
|	Zn4	67	0.355	1081.544	5.58	0.5	ug/L
|	Zn	64	7.989	1084.611	9.47	0.9	ug/L
|	As	75	0.226	78.978	1.01	1.3	ug/L
|	Y	89	0.095				ug/L
|	Cd	111	0.006	1.946	0.08	4.1	ug/L
|	Cd	114	0.012	1.72	0.01	0.8	ug/L
|	cd1	114	0.033	1.95	0.02	0.9	ug/L
|>	In	115	129253.7				ug/L
|	Pb	207	1.112	247.274	1.26	0.5	ug/L
|	Pb	206	1.428	248.6	1.75	0.7	ug/L
|	Pb	208	2.754	248.375	5.01	2	ug/L
|	pb1	208	7.987	249.071	1.2	0.5	ug/L
|-	Bi	209	0.004				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX025
Sample Da Wednesday, September 18, 2013 15:35:31
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX025.1045
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	508028	1.073	1890.53	4.601
|	Zn1	64	3689015	0.605	3212.619	22.883
|	Zn2	66	2281564	1.929	1417.117	30.351
|	Zn3	68	1720665	0.785	988.39	27.675
|	Zn4	67	371987	1.508	341.673	29.263
|	Zn	64	8063231	0.263	5959.799	25.687
|	As	75	6748	3.047	-66.107	59.429
|	Y	89	19223	2.577	26.333	26.942
|	Cd	111	5309	0.227	0.408	734.366
|	Cd	114	12347	1.113	11.555	23.664
|	cd1	114	30693	1.202	33	28.907
|>	In	115	127289	1.675	135606.8	1.722
|	Pb	207	876630	2.635	31	3.226
|	Pb	206	1215910	0.996	38	31.579
|	Pb	208	3047385	3.257	81	8.903
|	pb1	208	8199009	1.689	230.001	13.266
|-	Bi	209	1515	2.473	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	3.978	23153.34	568.19	2.5	ug/L
|	Zn1	64	28.965	8625.362	189.95	2.2	ug/L
|	Zn2	66	17.914	8403.425	101.02	1.2	ug/L
|	Zn3	68	13.514	8731.537	198.96	2.3	ug/L
|	Zn4	67	2.921	8902.767	261.76	2.9	ug/L
|	Zn	64	63.314	8595.794	142.89	1.7	ug/L
|	As	75	0.054	18.72	0.42	2.3	ug/L
|	Y	89	0.151				ug/L
|	Cd	111	0.042	14.123	0.26	1.8	ug/L
|	Cd	114	0.097	13.556	0.35	2.6	ug/L
|	cd1	114	0.241	14.3	0.35	2.4	ug/L
|>	In	115	127288.5				ug/L
|	Pb	207	6.886	1530.601	16.23	1.1	ug/L
|	Pb	206	9.553	1662.54	20.94	1.3	ug/L
|	Pb	208	23.948	2159.791	90.76	4.2	ug/L
|	pb1	208	64.427	2009.059	54.68	2.7	ug/L
|-	Bi	209	0.012				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX026
Sample Da Wednesday, September 18, 2013 15:38:08
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX026.1046
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	205183	1.623	1890.53	4.601
|	Zn1	64	228014	1.646	3212.619	22.883
|	Zn2	66	142570	1.384	1417.117	30.351
|	Zn3	68	102955	0.624	988.39	27.675
|	Zn4	67	22501	1.514	341.673	29.263
|	Zn	64	496041	0.324	5959.799	25.687
|	As	75	1265	4.277	-66.107	59.429
|	Y	89	20611	1.086	26.333	26.942
|	Cd	111	788	6.169	0.408	734.366
|	Cd	114	1620	4.305	11.555	23.664
|	cd1	114	3949	3.04	33	28.907
|>	In	115	130407	1.855	135606.8	1.722
|	Pb	207	35573	1.809	31	3.226
|	Pb	206	49024	3.196	38	31.579
|	Pb	208	89477	1.28	81	8.903
|	pb1	208	263386	0.676	230.001	13.266
|-	Bi	209	192	4.968	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.56	9079.943	316.08	3.5	ug/L
|	Zn1	64	1.725	513.741	13.15	2.6	ug/L
|	Zn2	66	1.083	508.03	9.78	1.9	ug/L
|	Zn3	68	0.782	505.476	6.79	1.3	ug/L
|	Zn4	67	0.17	518.439	15.69	3	ug/L
|	Zn	64	3.761	510.561	8.74	1.7	ug/L
|	As	75	0.01	3.567	0.17	4.8	ug/L
|	Y	89	0.158				ug/L
|	Cd	111	0.006	2.047	0.16	7.8	ug/L
|	Cd	114	0.012	1.726	0.07	4.2	ug/L
|	cd1	114	0.03	1.783	0.06	3.3	ug/L
|>	In	115	130407.2				ug/L
|	Pb	207	0.273	60.587	0.74	1.2	ug/L
|	Pb	206	0.376	65.367	1.18	1.8	ug/L
|	Pb	208	0.686	61.835	0.95	1.5	ug/L
|	pb1	208	2.018	62.942	1.1	1.7	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX027
Sample Da Wednesday, September 18, 2013 15:40:44
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX027.1047
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	211426	0.652	1890.53	4.601
|	Zn1	64	217553	3.952	3212.619	22.883
|	Zn2	66	132501	0.924	1417.117	30.351
|	Zn3	68	98003	1.485	988.39	27.675
|	Zn4	67	21147	0.456	341.673	29.263
|	Zn	64	469203	1.965	5959.799	25.687
|	As	75	2965	0.979	-66.107	59.429
|	Y	89	14899	3.584	26.333	26.942
|	Cd	111	441	1.629	0.408	734.366
|	Cd	114	847	4.319	11.555	23.664
|	cd1	114	2149	2.077	33	28.907
|>	In	115	127280	1.596	135606.8	1.722
|	Pb	207	19619	0.376	31	3.226
|	Pb	206	26491	0.842	38	31.579
|	Pb	208	48771	1.477	81	8.903
|	pb1	208	143509	1.212	230.001	13.266
|-	Bi	209	145	7.68	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.647	9588.062	159.15	1.7	ug/L
|	Zn1	64	1.686	502.128	25.33	5	ug/L

|	Zn2	66	1.031	483.524	9.82	2 ug/L
|	Zn3	68	0.763	492.893	12.34	2.5 ug/L
|	Zn4	67	0.164	498.825	8.72	1.7 ug/L
|	Zn	64	3.643	494.656	15.75	3.2 ug/L
|	As	75	0.024	8.324	0.14	1.6 ug/L
|	Y	89	0.117			ug/L
|	Cd	111	0.003	1.172	0.02	1.7 ug/L
|	Cd	114	0.007	0.919	0.03	2.8 ug/L
|	cd1	114	0.017	0.988	0.01	1.3 ug/L
|>	In	115	127280.2			ug/L
|	Pb	207	0.154	34.215	0.42	1.2 ug/L
|	Pb	206	0.208	36.179	0.69	1.9 ug/L
|	Pb	208	0.383	34.515	1.04	3 ug/L
|	pb1	208	1.126	35.117	0.96	2.7 ug/L
|-	Bi	209	0.001			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX028
Sample Da Wednesday, September 18, 2013 15:43:21
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX028.1048
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	261303	1.396	1890.53	4.601
|	Zn1	64	2073690	1.332	3212.619	22.883
|	Zn2	66	1324762	2.703	1417.117	30.351
|	Zn3	68	974055	2.469	988.39	27.675
|	Zn4	67	207672	1.296	341.673	29.263
|	Zn	64	4580178	0.349	5959.799	25.687
|	As	75	5779	2.232	-66.107	59.429
|	Y	89	19914	2.235	26.333	26.942
|	Cd	111	4160	3.643	0.408	734.366
|	Cd	114	9535	1.018	11.555	23.664
|	cd1	114	23030	0.363	33	28.907
|>	In	115	128798	0.594	135606.8	1.722
|	Pb	207	241887	1.981	31	3.226
|	Pb	206	332910	1.983	38	31.579
|	Pb	208	597580	0.978	81	8.903
|	pb1	208	1770686	0.636	230.001	13.266
|-	Bi	209	957	2.741	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	2.015	11726.89	202.06	1.7	ug/L
|	Zn1	64	16.077	4787.583	75.87	1.6	ug/L
|	Zn2	66	10.275	4819.833	118.42	2.5	ug/L
|	Zn3	68	7.556	4882.125	143.58	2.9	ug/L
|	Zn4	67	1.61	4907.14	71.71	1.5	ug/L
|	Zn	64	35.518	4822.108	39.41	0.8	ug/L
|	As	75	0.045	15.871	0.37	2.3	ug/L
|	Y	89	0.154				ug/L
|	Cd	111	0.032	10.934	0.39	3.6	ug/L
|	Cd	114	0.074	10.34	0.08	0.8	ug/L
|	cd1	114	0.179	10.598	0.1	0.9	ug/L
|>	In	115	128798.1				ug/L
|	Pb	207	1.878	417.385	7.47	1.8	ug/L
|	Pb	206	2.585	449.8	10.39	2.3	ug/L
|	Pb	208	4.639	418.409	6.52	1.6	ug/L
|	pb1	208	13.746	428.665	4.22	1	ug/L
|-	Bi	209	0.007				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: EX029
Sample Da Wednesday, September 18, 2013 15:45:58
Sample De 3050
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\EX029.1049
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens. RSD
|-	Fe	57	199186	2.151	1890.53	4.601
|	Zn1	64	947884	1.671	3212.619	22.883
|	Zn2	66	582920	3.757	1417.117	30.351
|	Zn3	68	420726	0.97	988.39	27.675
|	Zn4	67	89910	0.536	341.673	29.263
|	Zn	64	2041441	2.02	5959.799	25.687
|	As	75	2530	3.337	-66.107	59.429
|	Y	89	15815	0.379	26.333	26.942
|	Cd	111	2064	2.471	0.408	734.366
|	Cd	114	4907	2.278	11.555	23.664
|	cd1	114	11832	1.649	33	28.907
|>	In	115	128747	2.871	135606.8	1.722
|	Pb	207	185168	0.068	31	3.226
|	Pb	206	255690	4.174	38	31.579
|	Pb	208	468979	2.508	81	8.903
|	pb1	208	1374284	2.768	230.001	13.266
|-	Bi	209	723	1.595	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.534	8930.319	407.95	4.6	ug/L
|	Zn1	64	7.34	2185.869	26.41	1.2	ug/L
|	Zn2	66	4.516	2118.649	21.88	1	ug/L
|	Zn3	68	3.262	2107.471	39.64	1.9	ug/L
|	Zn4	67	0.696	2122.326	71.53	3.4	ug/L
|	Zn	64	15.815	2147.11	19.19	0.9	ug/L

|	As	75	0.02	7.048	0.14	1.9 ug/L
|	Y	89	0.123			ug/L
|	Cd	111	0.016	5.43	0.24	4.4 ug/L
|	Cd	114	0.038	5.323	0.27	5.1 ug/L
|	cd1	114	0.092	5.445	0.24	4.4 ug/L
|>	In	115	128746.8			ug/L
|	Pb	207	1.439	319.807	9.03	2.8 ug/L
|	Pb	206	1.988	345.89	20.86	6 ug/L
|	Pb	208	3.645	328.69	14.1	4.3 ug/L
|	pb1	208	10.681	333.061	15.54	4.7 ug/L
|-	Bi	209	0.006			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 1000
Sample Da Wednesday, September 18, 2013 15:48:35
Sample Description:
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\1000.1050
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	20670	0.233	1890.53	4.601
|	Zn1	64	568066	3.47	3212.619	22.883
|	Zn2	66	353797	2.393	1417.117	30.351
|	Zn3	68	254784	3.979	988.39	27.675
|	Zn4	67	54084	2.546	341.673	29.263
|	Zn	64	1230731	2.078	5959.799	25.687
|	As	75	453356	0.766	-66.107	59.429
|	Y	89	26	28.719	26.333	26.942
|	Cd	111	449322	0.602	0.408	734.366
|	Cd	114	1052843	1.435	11.555	23.664
|	cd1	114	2537188	1.02	33	28.907
|>	In	115	127811	2.434	135606.8	1.722
|	Pb	207	567490	2.92	31	3.226
|	Pb	206	722892	2.557	38	31.579
|	Pb	208	1374564	1.392	81	8.903
|	pb1	208	4026936	2.263	230.001	13.266
|-	Bi	209	59	18.333	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.148	860.425	21.13	2.5	ug/L
|	Zn1	64	4.424	1317.385	67.63	5.1	ug/L
|	Zn2	66	2.758	1293.617	4.96	0.4	ug/L
|	Zn3	68	1.988	1284.339	74.77	5.8	ug/L
|	Zn4	67	0.421	1283.142	62.7	4.9	ug/L
|	Zn	64	9.59	1302.037	48.61	3.7	ug/L
|	As	75	3.549	1241.605	20.75	1.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	3.517	1190.706	30.22	2.5	ug/L
|	Cd	114	8.241	1152.382	34.77	3	ug/L
|	cd1	114	19.861	1178.801	39.06	3.3	ug/L
|>	In	115	127811.1				ug/L
|	Pb	207	4.442	987.249	36.94	3.7	ug/L
|	Pb	206	5.66	984.983	46.75	4.7	ug/L
|	Pb	208	10.759	970.31	29.55	3	ug/L
|	pb1	208	31.519	982.888	34.69	3.5	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 15:51:11
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.1051
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	6121	0.78	1890.53	4.601
|	Zn1	64	76704	2.428	3212.619	22.883
|	Zn2	66	46088	1.824	1417.117	30.351
|	Zn3	68	34451	2.986	988.39	27.675
|	Zn4	67	7984	3.289	341.673	29.263
|	Zn	64	165227	2.299	5959.799	25.687
|	As	75	59024	2.128	-66.107	59.429
|	Y	89	31	22.581	26.333	26.942
|	Cd	111	58979	1.478	0.408	734.366
|	Cd	114	140354	0.623	11.555	23.664
|	cd1	114	343324	1.53	33	28.907
|>	In	115	136354	0.932	135606.8	1.722
|	Pb	207	84333	1.64	31	3.226
|	Pb	206	106884	4.607	38	31.579
|	Pb	208	207372	1.486	81	8.903
|	pb1	208	603264	1.592	230.001	13.266
|-	Bi	209	42	21.822	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.031	180.133	3.81	2.1	ug/L
|	Zn1	64	0.539	160.463	3.89	2.4	ug/L
|	Zn2	66	0.328	153.664	3.39	2.2	ug/L
|	Zn3	68	0.245	158.535	4.48	2.8	ug/L
|	Zn4	67	0.056	170.821	7.16	4.2	ug/L
|	Zn	64	1.168	158.551	3.81	2.4	ug/L
|	As	75	0.433	151.643	3.83	2.5	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.433	146.464	3.43	2.3	ug/L
|	Cd	114	1.029	143.938	2.17	1.5	ug/L

|	cd1	114	2.518	149.428	2.15	1.4 ug/L
|>	In	115	136354.2			ug/L
|	Pb	207	0.618	137.422	1.63	1.2 ug/L
|	Pb	206	0.783	136.34	5.12	3.8 ug/L
|	Pb	208	1.52	137.102	0.95	0.7 ug/L
|	pb1	208	4.422	137.907	1.15	0.8 ug/L
|-	Bi	209	0			ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 15:53:45
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.1052
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2309	2.636	1890.53	4.601
|	Zn1	64	2412	16.122	3212.619	22.883
|	Zn2	66	1295	18.234	1417.117	30.351
|	Zn3	68	973	14.929	988.39	27.675
|	Zn4	67	275	7.518	341.673	29.263
|	Zn	64	4955	15.775	5959.799	25.687
|	As	75	-6	706.265	-66.107	59.429
|	Y	89	17	25.641	26.333	26.942
|	Cd	111	1	2235.533	0.408	734.366
|	Cd	114	25	22.757	11.555	23.664
|	cd1	114	75	2.046	33	28.907
|>	In	115	126333	0.777	135606.8	1.722
|	Pb	207	44	13.217	31	3.226
|	Pb	206	66	4.846	38	31.579
|	Pb	208	137	21.735	81	8.903
|	pb1	208	373	15.444	230.001	13.266
|-	Bi	209	4	41.66	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.004	25.265	3.56	14.1	ug/L
|	Zn1	64	-0.005	-1.364	0.95	69.7	ug/L
|	Zn2	66	0	-0.089	0.91	1017.3	ug/L
|	Zn3	68	0	0.27	0.77	283.8	ug/L
|	Zn4	67	0	-1.05	0.54	51.8	ug/L
|	Zn	64	-0.005	-0.638	0.87	136.6	ug/L
|	As	75	0	0.153	0.12	78.8	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.001	0.03	5182.5	ug/L
|	Cd	114	0	0.016	0.01	40.7	ug/L
|	cd1	114	0	0.021	0	4.8	ug/L
|>	In	115	126333.2				ug/L
|	Pb	207	0	0.027	0.01	35.6	ug/L
|	Pb	206	0	0.043	0	10.7	ug/L
|	Pb	208	0	0.044	0.02	48.8	ug/L
|	pb1	208	0.001	0.039	0.01	36.8	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 2000
Sample Da Wednesday, September 18, 2013 15:56:20
Sample Description:
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\2000.1053
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	49850	2.969	1890.53	4.601
|	Zn1	64	1127623	2.102	3212.619	22.883
|	Zn2	66	702145	0.53	1417.117	30.351
|	Zn3	68	497912	0.118	988.39	27.675
|	Zn4	67	105238	2.886	341.673	29.263
|	Zn	64	2432918	1.046	5959.799	25.687
|	As	75	894458	0.713	-66.107	59.429
|	Y	89	19	57.209	26.333	26.942
|	Cd	111	878311	2.632	0.408	734.366
|	Cd	114	2026187	3.243	11.555	23.664
|	cd1	114	4827232	1.52	33	28.907
|>	In	115	126945	1.751	135606.8	1.722
|	Pb	207	1128818	0.731	31	3.226
|	Pb	206	1451116	1.272	38	31.579
|	Pb	208	3783919	2.606	81	8.903
|	pb1	208	10147798	0.918	230.001	13.266
|-	Bi	209	105	11.318	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.379	2205.221	95.28	4.3	ug/L
|	Zn1	64	8.862	2638.981	88.71	3.4	ug/L
|	Zn2	66	5.522	2590.341	56.75	2.2	ug/L
|	Zn3	68	3.916	2530.029	42.15	1.7	ug/L
|	Zn4	67	0.827	2520.022	96.94	3.8	ug/L
|	Zn	64	19.127	2596.711	65.84	2.5	ug/L
|	As	75	7.049	2466.222	60.03	2.4	ug/L
|	Y	89	0				ug/L
|	Cd	111	6.922	2343.653	102.2	4.4	ug/L
|	Cd	114	15.966	2232.585	89.7	4	ug/L
|	cd1	114	38.035	2257.41	55.66	2.5	ug/L
|>	In	115	126945				ug/L
|	Pb	207	8.893	1976.81	32.03	1.6	ug/L
|	Pb	206	11.431	1989.413	11.15	0.6	ug/L

|	Pb	208	29.815	2688.922	91.53	3.4	ug/L
|	pb1	208	79.951	2493.166	43.98	1.8	ug/L
|-	Bi	209	0.001				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 5000
Sample Da Wednesday, September 18, 2013 15:58:57
Sample Description:
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\5000.1054
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens.	RSD
|-	Fe	57	120151	3.617	1890.53	4.601	
|	Zn1	64	2729907	0.673	3212.619	22.883	
|	Zn2	66	1794446	2.468	1417.117	30.351	
|	Zn3	68	1269139	2.837	988.39	27.675	
|	Zn4	67	268298	2.299	341.673	29.263	
|	Zn	64	6061789	0.689	5959.799	25.687	
|	As	75	2271857	0.77	-66.107	59.429	
|	Y	89	32	32.78	26.333	26.942	
|	Cd	111	2228051	1.878	0.408	734.366	
|	Cd	114	5247306	1.179	11.555	23.664	
|	cd1	114	12529610	0.28	33	28.907	
|>	In	115	130252	3.667	135606.8	1.722	
|	Pb	207	3892635	1.18	31	3.226	
|	Pb	206	4912446	3.059	38	31.579	
|	Pb	208	9606021	1.651	81	8.903	
|	pb1	208	28065432	1.982	230.001	13.266	
|-	Bi	209	294	10.909	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.91	5296.947	383.64	7.2	ug/L
|	Zn1	64	20.954	6239.976	240.75	3.9	ug/L
|	Zn2	66	13.78	6463.909	300.89	4.7	ug/L
|	Zn3	68	9.75	6299.359	371.77	5.9	ug/L
|	Zn4	67	2.06	6279.285	353.22	5.6	ug/L
|	Zn	64	46.544	6319.016	269.92	4.3	ug/L
|	As	75	17.456	6107.746	196.9	3.2	ug/L
|	Y	89	0				ug/L
|	Cd	111	17.113	5793.934	105.01	1.8	ug/L
|	Cd	114	40.316	5637.561	180.57	3.2	ug/L
|	cd1	114	96.276	5714.108	196.4	3.4	ug/L
|>	In	115	130251.5				ug/L
|	Pb	207	29.903	6646.759	162.8	2.4	ug/L
|	Pb	206	37.749	6569.507	320.94	4.9	ug/L
|	Pb	208	73.801	6655.914	217.06	3.3	ug/L
|	pb1	208	215.661	6725.081	280.15	4.2	ug/L
|-	Bi	209	0.002				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: 10000
Sample Da Wednesday, September 18, 2013 16:01:34
Sample Description:
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proc Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\10000.1055
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inte	Meas. Inte	Blank Inter	Blank Intens.	RSD
|-	Fe	57	222426	2.656	1890.53	4.601	
|	Zn1	64	5271434	1.579	3212.619	22.883	
|	Zn2	66	3284628	1.302	1417.117	30.351	
|	Zn3	68	2356990	1.689	988.39	27.675	
|	Zn4	67	512863	1.417	341.673	29.263	
|	Zn	64	11425915	1.293	5959.799	25.687	
|	As	75	4407758	1.059	-66.107	59.429	
|	Y	89	45	13.118	26.333	26.942	
|	Cd	111	4286650	2.343	0.408	734.366	
|	Cd	114	10136094	0.923	11.555	23.664	
|	cd1	114	24172474	1.321	33	28.907	
|>	In	115	128026	0.802	135606.8	1.722	
|	Pb	207	7661747	2.837	31	3.226	
|	Pb	206	9857076	1.951	38	31.579	
|	Pb	208	18760916	0.424	81	8.903	
|	pb1	208	55066311	0.575	230.001	13.266	
|-	Bi	209	634	5.606	2.667	43.301	

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	1.724	10030.99	294.82	2.9	ug/L
|	Zn1	64	41.153	12254.93	226.83	1.9	ug/L
|	Zn2	66	25.648	12031.37	244.1	2	ug/L
|	Zn3	68	18.404	11891.39	249.21	2.1	ug/L
|	Zn4	67	4.004	12203.44	210.13	1.7	ug/L
|	Zn	64	89.21	12111.54	215.09	1.8	ug/L
|	As	75	34.43	12046.92	142.73	1.2	ug/L
|	Y	89	0				ug/L
|	Cd	111	33.488	11337.96	353.98	3.1	ug/L
|	Cd	114	79.179	11072.02	183.17	1.7	ug/L
|	cd1	114	188.821	11206.79	192.35	1.7	ug/L
|>	In	115	128025.5				ug/L
|	Pb	207	59.84	13300.98	291.09	2.2	ug/L
|	Pb	206	76.993	13399.1	245.07	1.8	ug/L
|	Pb	208	146.545	13216.47	103.37	0.8	ug/L
|	pb1	208	430.123	13412.8	30.39	0.2	ug/L
|-	Bi	209	0.005				ug/L

LEGS Quantitative Analysis - Summary Report

Sample ID: blank
Sample Da Wednesday, September 18, 2013 16:04:09
Sample Description:
Solution Ty Sample
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\blank.1056
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2198	6.487	1890.53	4.601
|	Zn1	64	2658	14.976	3212.619	22.883
|	Zn2	66	1555	18.901	1417.117	30.351
|	Zn3	68	1104	20.633	988.39	27.675
|	Zn4	67	320	16.586	341.673	29.263
|	Zn	64	5638	17.104	5959.799	25.687
|	As	75	1340	6.204	-66.107	59.429
|	Y	89	17	13.323	26.333	26.942
|	Cd	111	183	59.883	0.408	734.366
|	Cd	114	432	39.654	11.555	23.664
|	cd1	114	1062	42.65	33	28.907
|>	In	115	127645	0.839	135606.8	1.722
|	Pb	207	528	20.243	31	3.226
|	Pb	206	672	11.796	38	31.579
|	Pb	208	1324	12.893	81	8.903
|	pb1	208	3859	15.424	230.001	13.266
|-	Bi	209	28	9.096	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.003	19.069	5.89	30.9	ug/L
|	Zn1	64	-0.003	-0.848	0.98	115.1	ug/L
|	Zn2	66	0.002	0.82	1.12	136.6	ug/L
|	Zn3	68	0.001	0.885	1.19	134.7	ug/L
|	Zn4	67	0	-0.031	1.32	4229.9	ug/L
|	Zn	64	0	0.035	1.07	3021.7	ug/L
|	As	75	0.011	3.844	0.2	5.3	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.001	0.486	0.29	60.5	ug/L
|	Cd	114	0.003	0.462	0.19	41.2	ug/L
|	cd1	114	0.008	0.48	0.21	44.5	ug/L
|>	In	115	127644.8				ug/L
|	Pb	207	0.004	0.869	0.19	22	ug/L
|	Pb	206	0.005	0.868	0.11	13.1	ug/L
|	Pb	208	0.01	0.882	0.13	14.3	ug/L
|	pb1	208	0.029	0.89	0.15	17	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Standard Check 150 ppb
Sample Da Wednesday, September 18, 2013 16:06:43
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Standard Check 150 ppb.1057
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	5648	4.478	1890.53	4.601
|	Zn1	64	75450	2.536	3212.619	22.883
|	Zn2	66	46166	2.151	1417.117	30.351
|	Zn3	68	34670	1.649	988.39	27.675
|	Zn4	67	7836	2.465	341.673	29.263
|	Zn	64	164121	1.63	5959.799	25.687
|	As	75	59947	2.639	-66.107	59.429
|	Y	89	31	36.353	26.333	26.942
|	Cd	111	59680	1.036	0.408	734.366
|	Cd	114	138476	2.312	11.555	23.664
|	cd1	114	343593	1.193	33	28.907
|>	In	115	129531	2.04	135606.8	1.722
|	Pb	207	83739	2.846	31	3.226
|	Pb	206	106018	1.608	38	31.579
|	Pb	208	201890	3.07	81	8.903
|	pb1	208	592599	0.628	230.001	13.266
|-	Bi	209	43	24.612	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.03	172.579	8.32	4.8	ug/L
|	Zn1	64	0.559	166.477	6.82	4.1	ug/L
|	Zn2	66	0.346	162.381	7.08	4.4	ug/L
|	Zn3	68	0.26	168.308	6.16	3.7	ug/L
|	Zn4	67	0.058	176.779	6.07	3.4	ug/L
|	Zn	64	1.224	166.135	6.19	3.7	ug/L
|	As	75	0.464	162.19	7.12	4.4	ug/L
|	Y	89	0				ug/L
|	Cd	111	0.461	156.025	3.07	2	ug/L
|	Cd	114	1.069	149.487	2.44	1.6	ug/L
|	cd1	114	2.653	157.438	1.36	0.9	ug/L
|>	In	115	129531.4				ug/L
|	Pb	207	0.647	143.715	6.14	4.3	ug/L
|	Pb	206	0.818	142.414	2.63	1.8	ug/L
|	Pb	208	1.558	140.496	1.82	1.3	ug/L
|	pb1	208	4.574	142.638	2.04	1.4	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Blank
Sample Da Wednesday, September 18, 2013 16:09:18
Sample Description:
Solution Ty QC Std

Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Blank.1058
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	2088	5.004	1890.53	4.601
|	Zn1	64	2343	13.37	3212.619	22.883
|	Zn2	66	1343	16.409	1417.117	30.351
|	Zn3	68	1020	18.837	988.39	27.675
|	Zn4	67	291	19.31	341.673	29.263
|	Zn	64	4997	15.424	5959.799	25.687
|	As	75	160	16.052	-66.107	59.429
|	Y	89	16	16.536	26.333	26.942
|	Cd	111	46	22.757	0.408	734.366
|	Cd	114	101	37.925	11.555	23.664
|	cd1	114	269	19.823	33	28.907
|>	In	115	127258	3.239	135606.8	1.722
|	Pb	207	123	10.551	31	3.226
|	Pb	206	179	17.649	38	31.579
|	Pb	208	316	10.998	81	8.903
|	pb1	208	945	11.313	230.001	13.266
|-	Bi	209	4	50	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	0.002	14.511	7.63	52.6	ug/L
|	Zn1	64	-0.005	-1.571	0.72	45.8	ug/L
|	Zn2	66	0	0.047	0.79	1689.9	ug/L
|	Zn3	68	0.001	0.473	1.01	212.6	ug/L
|	Zn4	67	0	-0.731	1.22	167.3	ug/L
|	Zn	64	-0.005	-0.636	0.81	127.7	ug/L
|	As	75	0.002	0.611	0.07	11.7	ug/L
|	Y	89	0				ug/L
|	Cd	111	0	0.122	0.03	24.3	ug/L
|	Cd	114	0.001	0.1	0.04	44.9	ug/L
|	cd1	114	0.002	0.111	0.03	25.4	ug/L
|>	In	115	127257.6				ug/L
|	Pb	207	0.001	0.165	0.03	17.4	ug/L
|	Pb	206	0.001	0.197	0.05	25.2	ug/L
|	Pb	208	0.002	0.171	0.03	17.5	ug/L
|	pb1	208	0.006	0.179	0.03	18	ug/L
|-	Bi	209	0				ug/L

LEGS Quantitative Analysis - Summary Report
Sample ID: Interference Check
Sample Da Wednesday, September 18, 2013 16:11:52
Sample Description:
Solution Ty QC Std
Blank File: C:\Elandata\Dataset\Default\Blank.947
Number of 3
Peak Proce Maximum
Signal Prof Maximum
Dual Detec Dual
Dead Time 55
Sample Fil C:\Elandata\Sample\Exponent As Pb Zn Cd bio 9-18-13.sam
Method Fil C:\Elandata\Method\epa\invitro with zn 12-20-10.mth
Dataset Fil C:\Elandata\Dataset\Default\Interference Check.1059
Tuning File C:\Elandata\Tuning\default.tun
Optimizatic C:\Elandata\Optimize\default.dac
Calibration File:
Calibration External Calibration
Summary
Intensities

	Analyte	Mass	Meas. Inter	Meas. Inter	Blank Inter	Blank Intens. RSD
|-	Fe	57	1096318	1.486	1890.53	4.601
|	Zn1	64	185556	1.498	3212.619	22.883
|	Zn2	66	110844	2.214	1417.117	30.351
|	Zn3	68	77130	2.138	988.39	27.675
|	Zn4	67	21482	0.638	341.673	29.263
|	Zn	64	395012	1.35	5959.799	25.687
|	As	75	76261	0.363	-66.107	59.429
|	Y	89	184	5.516	26.333	26.942
|	Cd	111	38360	1.915	0.408	734.366
|	Cd	114	91130	1.831	11.555	23.664
|	cd1	114	217739	0.702	33	28.907
|>	In	115	122501	1.279	135606.8	1.722
|	Pb	207	37483	2.7	31	3.226
|	Pb	206	45883	1.968	38	31.579
|	Pb	208	89812	2.983	81	8.903
|	pb1	208	259933	2.107	230.001	13.266
|-	Bi	209	341	2.373	2.667	43.301

Concentration Results

	Analyte	Mass	Net Intens.	Conc. Mea	Conc. SD	Conc. RSD	Sample Unit
|-	Fe	57	8.936	52007.21	723.72	1.4	ug/L
|	Zn1	64	1.491	444.012	3.47	0.8	ug/L
|	Zn2	66	0.894	419.521	4.55	1.1	ug/L
|	Zn3	68	0.622	402.151	10.35	2.6	ug/L
|	Zn4	67	0.173	526.878	3.56	0.7	ug/L
|	Zn	64	3.181	431.819	2.62	0.6	ug/L
|	As	75	0.623	218.017	3.15	1.4	ug/L
|	Y	89	0.001				ug/L
|	Cd	111	0.313	106.018	1.68	1.6	ug/L
|	Cd	114	0.744	104.025	2.36	2.3	ug/L
|	cd1	114	1.777	105.485	0.76	0.7	ug/L
|>	In	115	122500.8				ug/L
|	Pb	207	0.306	67.974	2.28	3.3	ug/L
|	Pb	206	0.374	65.146	1.84	2.8	ug/L
|	Pb	208	0.733	66.089	2.71	4.1	ug/L
|	pb1	208	2.121	66.133	2.17	3.3	ug/L
|-	Bi	209	0.003				ug/L

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CHAIN-OF-CUSTODY / Analytical Request Document

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Page: 1 of 3

1373072

Section A Required Client Information

Company: Exponent
Address: Boulder, CO
Email To: Lowneyy@exponent.com
Phone: 303-588-9950 Fax:
Requested Due Date/TAT: Standard

Section B Required Project Information

Report To: Yvette Lowney
Copy To:
Purchase Order No.:
Project Name: National Zinc
Project Number:

Section C Invoice Information

Attention: See Client
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY: NPDES, GROUND WATER, DRINKING WATER, UST, RCRA, OTHER

Site Location STATE:

Section D Required Client Information

Matrix Codes (MATRIX / CODE): Drinking Water DW; Water WT; Waste Water WW; Product P; Soil/Solid SL; Oil OL; Wipe WP; Air AR; Tissue TS; Other OT

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED Composite Start Date	Composite Start Time	Composite End/Grab Date	Composite End/Grab Time	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test Y/N	Requested Analysis Filtered (Y/N): See Comments	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	334 Front #1	SL	C			8/5/13			1										X		
2	334 Front #2	SL	C			8/5/13			1										X		
3	312 Front #1	SL	C			8/5/13			1										X		
4	312 Front - Sidewalk	SL	C			8/5/13			1										X		
5	335 Front - Sidewalk	SL	C			8/5/13			1										X		
6	Thayer School #1	SL	C			8/6/13			1										X		
7	Ballfield #1	SL	C			8/6/13			1										X		
8	Ballfield #2	SL	C			8/6/13			1										X		
9	Logan Park #1	SL	C			8/6/13			1										X		
10	Logan Park #2	SL	C			8/6/13			1										X		
11	Walnut + Park - Ditch	SL	C			8/6/13			1										X		
12	Walnut + 2nd - Ditch	SL	C			8/6/13			1										X		

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS
See Yvette for instructions	Philip Jon	8/8/13	8:00	[signature]	8/9/13	14:39	

ORIGINAL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Philip Jon

SIGNATURE of SAMPLER: [signature] DATE Signed (MM/DD/YY): 8/8/13

Temp in °C | Received on Ice (Y/N) | Custody Sealed Cooler (Y/N) | Samples Intact (Y/N)

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CHAIN-OF-CUSTODY / Analytical Request Document

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1373073

Section A Required Client Information

Company: Exponent
Address: Boulder, CO
Email To: Lowney@exponent.com
Phone: 303-589-9955 Fax:
Requested Due Date/TAT: Standard

Section B Required Project Information

Report To: Yvette Lowney
Copy To:
Purchase Order No:
Project Name: National Zinc
Project Number:

Section C Invoice Information

Attention: See Client
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY: NPDES, GROUND WATER, DRINKING WATER, UST, RCRA, OTHER

Site Location STATE:

Section D Required Client Information

Matrix Codes (MATRIX / CODE): Drinking Water DW, Water WT, Waste Water WW, Product P, Soil/Solid SL, Oil OL, Wipe WP, Air AR, Tissue TS, Other OT

SAMPLE ID (A-Z, 0-9 / -) Sample IDs MUST BE UNIQUE

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED Composite Start Date	Composite Start Time	Composite End/Grab Date	Composite End/Grab Time	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test Y/N	See Comments	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	212 W. 3rd #1	SL	C			8/6/13			1										X		
2	216 W. 3rd #1	SL	C			↓			1										X		
3	326 W. 4th #1	SL	C			↓			1										X		
4	326 W. 4th #2	SL	C			↓			1										X		
5	S. Carson - Ditch #1	SL	C			↓			1										X		
6	MCFD - A	SL	C			↓			1										X		
7	MCFD - B	SL	C			↓			1										X		
8	508 W. 2nd - A	SL	C			8/7/13			1										X		
9	508 W. 2nd - B	SL	C			↓			1										X		
10	524 W. 2nd - A	SL	C			↓			1										X		
11	524 W. 2nd - B	SL	C			↓			1										X		
12	630 W. 2nd - A	SL	C			↓			1										X		

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS
Contact Yvette for instructions	Philip Jon	8/8/13	8:00	[signature]	8/9/13	14:32	

ORIGINAL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Philip Jon

SIGNATURE of SAMPLER: [signature] DATE Signed (MM/DD/YY): 8/8/13

Temp in °C | Received on Ice (Y/N) | Custody Sealed Cooler (Y/N) | Samples Intact (Y/N)

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

CHAIN-OF-CUSTODY / Analytical Request Document

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Pace Analytical

Page: 3 of 3

1553623

Section A Required Client Information

Company: Exponent
Address: Boulder, CO
Email To: Lowney@exponent.com
Phone: 303-589-9959 Fax:
Requested Due Date/TAT: Standard

Section B Required Project Information

Report To: Yvette Lowney
Copy To:
Purchase Order No.:
Project Name: National Zinc
Project Number:

Section C Invoice Information

Attention: See Client
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY: ☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER ☐ UST ☐ RCRA ☐ OTHER _____

Site Location STATE: _____

Requested Analysis Filtered (Y/N)

Section D Required Client Information

Matrix Codes MATRIX / CODE: Drinking Water DW, Water WT, Waste Water WW, Product P, Soil/Solid SL, Oil OL, Wipe WP, Air AR, Tissue TS, Other OT

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

ITEM #	SAMPLE ID	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED Composite Start Date	Composite Start Time	Composite End/Grab Date	Composite End/Grab Time	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test ↓ (Y/N)	See Comments	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	630 W. 2nd - B	SL	C			8/7/13			1										X		Ex
2	529 W. 1st - A	SL	C			↓			1										X		
3	529 W. 1st - B	SL	C						1										X		
4	709 W. 2nd - A	SL	C						1										X		
5	600 E. Main - Sidewalk	SL	C						1										X		
6																					
7																					
8																					
9																					
10																					
11																					
12																					

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS
Contact Yvette for instructions	Philip Jan	8/8/13	8:00	[signature]	8/9/13	14:35	

ORIGINAL

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER: Philip Jan

SIGNATURE of SAMPLER: [signature] DATE Signed (MM/DD/YY): 8/8/13

Temp in °C | Received on Ice (Y/N) | Custody Sealed Cooler (Y/N) | Samples Intact (Y/N)

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

Exponent

303-245-7082 Yvette Wieder Lowney

Client: Exponent

Project Manager: Yvette Lowney

CHAIN of CUSTODY

Project: 1208309.000

Telephone No:

Fax No:

Method of Shipment:

Special Detection Limit/Reporting:

Sample I.D	Lab Sample No.	No. of Containers	Matrix: Soil	Matrix: Water	Matrix: Air	Matrix: Other	Prsv.: Yes	Prsv.: No	Sampling Date	Sampling Time	6020 / 3050	in vitro Pb/As	Turn Around Time (working days)
EX 001			X								X	X	
EX 002													
EX 003													
EX 004													
EX 005													
EX 006													
EX 007													
EX 008													
EX 009													
EX 010													
EX 011													
EX 012													
EX 013													
EX 014													

MARKS: reagent blank, bottle blank, blank spike, matrix spike, triplicate extraction of #025

Sample Received Intact: Yes No

Temperature received: Ice No ice

Relinq. by sampler (Sign & Print Name)	Date	Time	Received by (Sign & Print Name)	Date	Time
Yvette Lowney	9/4/2013		[illegible]	9/5/13	800
Relinquished by	Date	Time	Received by		
Relinquished by	Date	Time	Received by		
Relinquished by	Date	Time	Received by laboratory	Date	Time

Lab Work No:

Exponent

303-248-7082 Yvette Meder Lowney

Client: Exponent

Project Manager: Lowney

CHAIN of CUSTODY

Project: 1208309.000

Telephone No

Fax No

Method of Shipment

Special Detection Limit/Reporting

Sample I D	Lab Sample No.	No of Containers	Matrix: Soil	Matrix: Water	Matrix: Air	Matrix: Other	Prsv.: Yes	Prsv.: No	Sampling Date	Sampling Time	3050 / 6020 Kp	in vitro Pb/As	in vitro duplicate	in vitro triplicate										Turn Around Time (working days)
EX015			X								X	X												
EX016																								
EX017																								
EX018																								
EX019																								
EX020																								
EX021																								
EX022																								
EX023																								
EX024																								
EX025													X	X										
EX026																								
EX027																								
EX028																								

MARKS

Sample Received Intact: Yes No

Temperature received: Ice No ice

Relinq by sampler (Sign & Print Name)	Date	Time	Received by (Sign & Print Name)	
			8/8/13	8:00
Relinquished by	Date	Time	Received by	
Relinquished by	Date	Time	Received by	
Relinquished by	Date	Time	Received by laboratory	Date Time

Lab Work No.

Exponent

303-245-7082 Yvette Wieder Lowney

CHAIN of CUSTODY

Client: Exponent

Project Manager: Lowney

Project: 120 8309.000

Telephone No:

Fax No:

Method of Shipment:

Special Detection Limit/Reporting:

Sample I.D.	Lab Sample No.	No. of Containers	Matrix: Soil	Matrix: Water	Matrix: Air	Matrix: Other	Prsv.: Yes	Prsv.: No	Sampling Date	Sampling Time	3050/6020 KP	In Vitro Pb/As	Turn Around Time (working days)
EX029			X								X	X	
SRM 2711			X								X	X	

MARKS

Sample Received Intact: Yes No

Temperature received: Ice No ice

Relinq. by sampler (Sign & Print Name)	Date	Time	Received by (Sign & Print Name)
Relinquished by	Date	Time	Received by
Relinquished by	Date	Time	Received by
Relinquished by	Date	Time	Received by laboratory — Date — Time

8-9-13

Lab Work No

Attachment B

Copy of Letter to KDHE Regarding Deviations from RSE Phase I Work Plan

Exponent

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August 22, 2013

Chris Carey
Holly Burke
Kansas Department of Health and the Environment

Subject: Updated Analytical Approach for Bioaccessibility Testing of Soils Collected from the "Aerial Deposition" area of Cherryvale, Kansas
Exponent Project No. 1208309.000

Dear Chris and Holly:

This memorandum describes a proposed addition to the RSE Work Plan for Phase I testing: In vitro bioaccessibility study for metals in soil at Cherryvale, Kansas. As described in the RSE Work Plan provided to KDHE on June 3, 2013, the soil samples specified in this scope of work included samples from the surface horizon of the top 2 cm of soil. For the residential area affected by possible historical aerial deposition from the smelter, the RSE Work Plan specifies:

> "...four composite surface soil samples from residences near EPA's residential removal action area. Samples will be generated from a three-point composite from areas of the residential yard that are away from the drip line of the house, and specifically not target areas impacted by what might appear to be smelter waste. These yard composites will be generated from six distinct residences (subject to access agreement), screened in the field for lead concentration by XRF, and the four composite samples with the highest lead concentrations of the six residences will be selected for bioaccessibility testing."

To be responsive to the RSE Work Plan, the field crew collected surface soils from each location. Based on these samples, characterization (concentration, bioaccessibility) can be completed consistent with the Work Plan.

However, in the area targeted for assessing possible historical aerial deposition in residential areas, the first location sampled showed low concentrations of lead in the surface horizon; none exceeded 400 ppm. Based on preliminary XRF data collected in the field, soil samples for some residences had to be collected from 2–8 cm below the ground surface in order to include soils with lead concentrations greater than 400 ppm. Therefore, in addition to surface soils from each identified location, a soil sample from a deeper horizon was collected from five properties

within this area. From visual evaluation, it appears that a thin layer deeper in the soil horizon may represent the zone that possibly received aerial deposition of fallout from smelter operations, and that since the facility operations ceased, material has been placed or otherwise accumulated on top of the soil surface.

For understanding the concentrations of metals in soils to which area residents might be exposed regularly, the surface soil horizon provides the most appropriate information, because this is the material that individuals may contact on a regular basis. Therefore, as defined in the Work Plan, four surface soil samples will be included in the evaluation of bioaccessibility.

Further, in order to characterize the thin layer of soil that may represent possible historical aerial deposition from smelter operations, we propose to also include three soil samples from deeper horizons: specifically, these are three locations for which targeted sampling to capture a deeper, higher-lead soil layer resulted in samples with XRF lead concentrations greater than 400 ppm (based on initial evaluation with field XRF instrumentation). These samples would be handled in the same manner as other soil samples collected during the field effort, and would be sieved to <250 μm. Metals concentrations would be determined by EPA Method 6020, and lead and arsenic bioaccessibility would be evaluated per the methods outlined in the RSE Work Plan.

If you have require additional information, please contact me at 303.245.7082 or lowneyy@exponent.com.

Sincerely,

Yvette Lowney

Yvette Lowney, MPH
Managing Scientist

cc: William Anderson — Doerner, Saunders, Daniel & Anderson, LLP
Andrew Thiros — US Steel Corporation

Attachment C

Standard Operating Procedure for an *In Vitro* Bioaccessibility Assay for Lead in Soil

EPA 9200.1-86
May 2008

Standard Operating Procedure for an *In Vitro* Bioaccessibility Assay for Lead in Soil

1.0 Scope and Application

The purpose of this standard operating procedure (SOP) is to define the proper analytical procedure for the validated *in vitro* bioaccessibility assay for lead in soil (U.S. EPA, 2007b), to describe the typical working range and limits of the assay, and to indicate potential interferences. At this time, the method described herein has only been validated for lead in soil (U.S. EPA, 2007b).

The SOP described herein is typically applicable for the characterization of lead bioaccessibility in soil. The assay may be varied or changed as required and dependent upon site conditions, equipment limitations, or limitations imposed by the procedure. Users are cautioned that deviations in the method from the assay described herein may impact the results (and the validity of the method). Users are strongly encouraged to document any deviations as well as the comparison and associated Quality Assurance (QA) in any report.

This document is intended to be used as reference for developing site-specific Quality Assurance Project Plans (QAPPs) and Sampling and Analysis Plans (SAPs), but not intended to be used as a substitute for a site-specific QAPP or a detailed SAP.

Mention of trade names or commercial products does not constitute endorsement or recommended use by U.S. EPA.

2.0 Method Summary

Reliable analysis of the potential hazard to children from ingestion of lead in the environment depends on accurate information on a number of key parameters, including (1) lead concentration in environmental media (soil, dust, water, food, air, paint, etc.), (2) childhood intake rates of each medium, and (3) the rate and extent of lead absorption from each medium ("bioavailability"). Knowledge of lead bioavailability is important because the amount of lead that actually enters the body from an ingested medium depends on the physical-chemical properties of the lead and of the medium. For example, lead in soil may exist, at least in part, as poorly water-soluble minerals, and may also exist inside particles of inert matrix such as rock or slag of variable size, shape, and association. These chemical and physical properties may tend to influence (usually decrease) the absorption (bioavailability) of lead when ingested. Thus, equal ingested doses of different forms of lead in different media may not be of equal health concern.

The bioavailability of lead in a particular medium may be expressed either in absolute terms (absolute bioavailability) or in relative terms (relative bioavailability).

- Absolute Bioavailability (ABA) is the ratio of the amount of lead absorbed compared to the amount ingested:

  ABA = (Absorbed Dose) / (Ingested Dose)

  This ratio is also referred to as the oral absorption fraction (AFo).

- Relative Bioavailability (RBA) is the ratio of the absolute bioavailability of lead present in some test material compared to the absolute bioavailability of lead in some appropriate reference material:

  RBA = ABA(test) / ABA(reference)

For example, if 100 µg of lead contained in soil were ingested and 30 µg entered the body, the ABA for soil would be:

30 (Absorbed Dose) /100 (Ingested Dose), or 0.30 (30%).

Likewise, if 100 micrograms (µg) of lead dissolved in drinking water were ingested and a total of 50 µg entered the body, the ABA would be:

50 (Absorbed Dose) /100 (Ingested Dose), or 0.50 (50%).

If the lead dissolved in water was used as the frame of reference for describing the relative amount of lead absorbed from soil, the RBA would be:

0.30 (test) / 0.50 (reference), or 0.60 (60%).

Usually the form of lead used as reference material is a soluble compound such as lead acetate that is expected to completely dissolve when ingested.

The *in vitro* bioaccessibility assay described in this SOP provides a rapid and relatively inexpensive alternative to *in vivo* assays for predicting RBA of lead in soils and soil-like materials. The method is based on the concept that lead solubilization in gastrointestinal fluid is likely to be an important determinant of lead bioavailability *in vivo*. The method measures the extent of lead solubilization in an extraction solvent that resembles gastric fluid. The fraction of lead which solubilizes in an *in vitro* system is referred to as *in vitro* bioaccessibility (IVBA), which may then be used as an indicator of *in vivo* RBA. Measurements of IVBA using this assay have been shown to be a reliable predictor of *in vivo* RBA of lead in a wide range of soil types and lead phases from a variety of different sites (U.S. EPA, 2007b).

3.0 Sample Preparation, Preservation, Containers, Handling, and Storage

All test soils should be prepared by drying (<40°C) and sieving to <250 μm. The <250 μm size fraction was used because this particle size is representative of that which adheres to children's hands (U.S. EPA, 2000). Stainless steel sieves are recommended. Samples should be thoroughly mixed prior to use to ensure homogenization. Mixing and aliquoting of samples using a riffle splitter is recommended. Clean plastic bags or storage bottles are recommended. All samples should be archived after analysis and retained for further analysis for a period of six (6) months. No preservatives or special storage conditions are required.

4.0 Interferences and Potential Problems

At present, it appears that the relationship between IVBA and RBA is widely applicable, having been found to hold true for a wide range of different soil types and lead phases from a variety of different sites. However, the majority of the samples tested have been collected from mining and milling sites, and it is plausible that some forms of lead that do not occur at this type of site might not follow the observed correlation. Thus, whenever a sample containing an unusual and/or untested lead phase is evaluated by the IVBA protocol, this sample should be identified as a potential source of uncertainty. In the future, as additional samples with a variety of new and different lead forms are tested by both *in vivo* and *in vitro* methods, the applicability of the method will be more clearly defined. In addition, excess phosphate in the sample medium may result in interference (i.e., the assay is not suited to phosphate-amended soils). Interferences and potential problems are discussed under Procedures (Section 7).

5.0 Apparatus

The main piece of equipment used for this procedure is the extraction device shown in Figure 1. An electric motor (the same motor as is used in the Toxicity Characteristic Leaching Procedure, or TCLP) drives a flywheel, which in turn drives a Plexiglass block situated inside a temperature-controlled water bath. The Plexiglass block contains ten 5-centimeter holes with stainless steel screw clamps, each of which is designed to hold a 125-mL wide-mouth high density polyethylene (HDPE) bottle. The water bath should be filled such that the extraction bottles are completely immersed. Temperature in the water bath should be maintained at 37±2 °C using an immersion circulator heater. The 125-mL HDPE bottles should have air-tight screw-cap seals, and care should be taken to ensure that the bottles do not leak during the extraction procedure. All equipment should be properly cleaned, acid washed, and rinsed with deionized water prior to use.

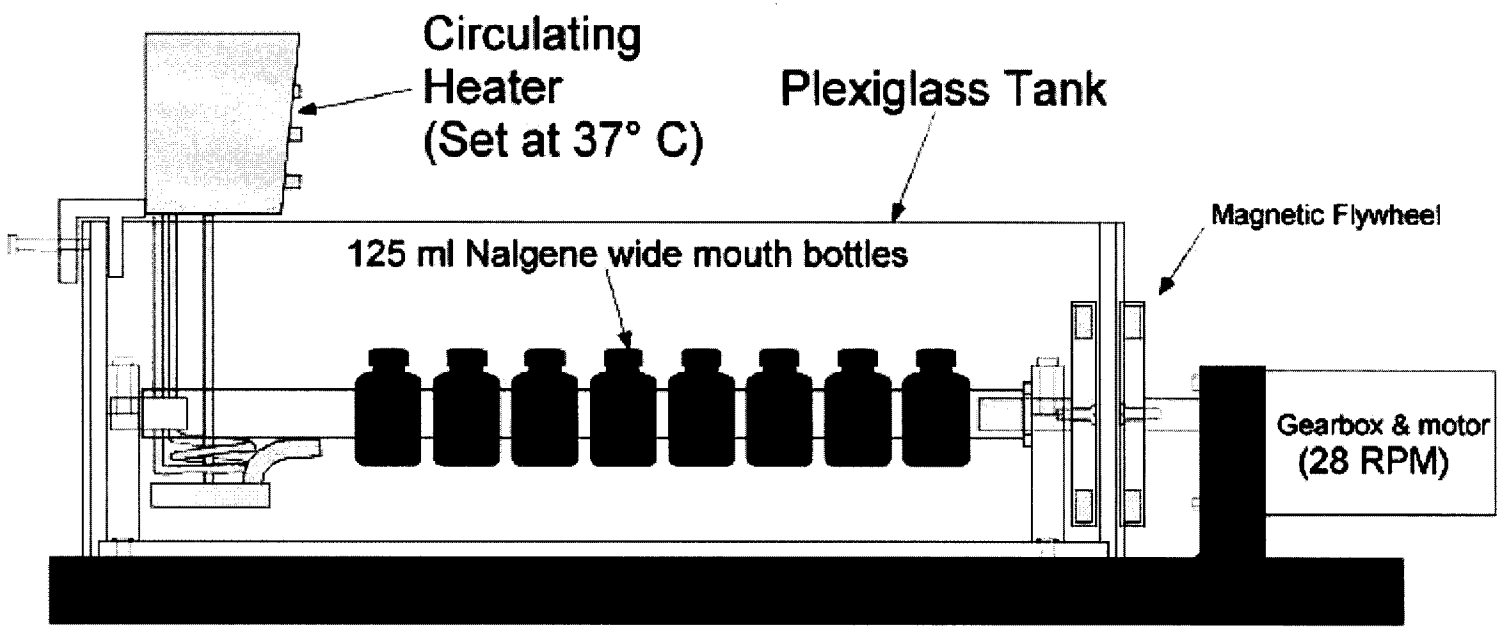

Figure 1. In Vitro Bioaccessibility Extraction Apparatus.

6.0 Reagents

All reagents should be free of lead and the final fluid should be tested to confirm that lead concentrations are <¼ (<one-fourth) the project required detection limit (PRDL) of 10 µg/L (i.e., <2 µg/L lead in the final fluid). Cleanliness of all materials used to prepare and/or store the extraction fluid and buffer is essential; all glassware and equipment used to prepare standards and reagents should be properly cleaned, acid washed, and triple-rinsed with deionized water prior to use.

7.0 Procedures

The dissolution of lead from a test material into the extraction fluid depends on a number of variables including extraction fluid composition, temperature, time, agitation, solid/fluid ratio, and pH. Any alterations in these parameters should be evaluated to determine the optimum values for maximizing sensitivity, stability, and the correlation between *in vitro* and *in vivo* values. Additional discussion of these procedures is available in U.S. EPA (2007b) and Drexler and Brattin (2007).

7.1 Extraction Fluid

The extraction fluid for this procedure is 0.4 M glycine (free base, reagent grade glycine in deionized water), adjusted to a pH of 1.50±0.05 at 37°C using trace metal grade concentrated hydrochloric acid (HCl).[1]

7.2 Temperature

A temperature of 37°C should be used because this is approximately the temperature of gastric fluid *in vivo*.

7.3 Extraction Time

The time that ingested material is present in the stomach (i.e., stomach-emptying time) is about 1 hour for a child, particularly when a fasted state is assumed (see U.S. EPA 2007a, Appendix A). Thus, an extraction time of 1 hour should be used. It was found that allowing the bottles to stand at room temperature for up to 4 hours after rotation at 37°C caused no significant variation (<10%) in lead concentration.

7.4 pH

Human gastric pH values tend to range from about 1 to 4 during fasting (see U.S. EPA 2007b, Appendix A). For the IVBA, a pH of 1.5 should be used.

---

[1] Most previous *in vitro* test systems have employed a more complex fluid intended to simulate gastric fluid. For example, Medlin (1997) used a fluid that contained pepsin and a mixture of citric, malic, lactic, acetic, and hydrochloric acids. When the bioaccessibility of a series of test substances were compared using 0.4 M glycine buffer (pH 1.5) with and without the inclusion of these enzymes and metabolic acids, no significant difference was observed (p=0.196). This indicates that the simplified buffer employed in the procedure is appropriate, even though it lacks some constituents known to be present in gastric fluid.

7.5 Agitation

If the test material is allowed to accumulate at the bottom of the extraction apparatus, the effective surface area of contact between the extraction fluid and the test material may be reduced, and this may influence the extent of lead solubilization. Depending on which theory of dissolution is relevant (Nernst and Brunner, 1904, or Dankwerts, 1951), agitation will greatly affect either the diffusion layer thickness or the rate of production of fresh surface. Previous workers have noted problems associated with both stirring and argon bubbling methods (Medlin and Drexler, 1995; Drexler, 1997). Although no systematic comparison of agitation methods was performed, an end-over-end method of agitation is recommended.

7.6 Solid/Fluid Ratio and Mass of Test Material

A solid-to-fluid ratio of 1/100 (mass per unit volume) should be used to reduce the effects of metal dissolution as noted by Sorenson *et al.* (1971) when lower ratios (1/5 and 1/25) were used. Tests using Standard Reference Materials (SRM 2710a) showed no significant variation (within ±1% of control means) in the fraction of lead extracted with soil masses as low as 0.2 gram (g) per 100 mL. However, use of low masses of test material could introduce variability due to small scale heterogeneity in the sample and/or to weighing errors. Therefore, the final method employs 1.0 g of test material in 100 mL of extraction fluid.

In special cases, the mass of test material may need to be <1.0 g to avoid the potential for saturation of the extraction solution. Tests performed using lead acetate, lead oxide, and lead carbonate indicate that if the bulk concentration of a test material containing these relatively soluble forms of lead exceed approximately 50,000 ppm, the extraction fluid becomes saturated at 37°C and, upon cooling to room temperature and below, lead chloride crystals will precipitate. To prevent this from occurring, the concentration of lead in the test material should not exceed 50,000 ppm, or the mass of the test material should be reduced to 0.50±0.01 g.

7.7 Summary of Final Leaching Protocol

The extraction procedure is begun by placing 1.00±0.05 g of sieved test material (<250 μm) and 100±0.5 mL of the buffered extraction fluid (0.4 M glycine, pH 1.5) into a 125-mL wide-mouth HDPE bottle. Care should be taken to ensure that static electricity does not cause soil particles to adhere to the lip or outside threads of the bottle; if necessary, an antistatic brush can be used to eliminate static electricity prior to adding the test substrate. The bottle should be tightly sealed and then shaken or inverted to ensure that there is no leakage and that no soil is caked on the bottom of the bottle.

Each bottle should be placed into the modified TCLP extractor (water temperature 37±2°C). Samples are extracted by rotating the samples end-over-end at 30±2 rpm for 1 hour. After 1 hour, the bottles should be removed, dried, and placed upright on the bench top to allow the soil to settle to the bottom. A 15-mL sample of supernatant fluid is removed directly from the extraction bottle into a disposable 20-cc syringe. After withdrawal of the sample into the syringe, a Luer-Lok attachment fitted with a 0.45-μm cellulose acetate disk filter (25 mm diameter) is attached, and the 15 mL aliquot of fluid is filtered through the attachment to remove any particulate matter. This filtered sample of extraction fluid is then analyzed for lead, as

described below. If the total time elapsed for the extraction process exceeds 90 minutes, the test must be repeated.

As noted above, in some cases (mainly slag soils), the test material can increase the pH of the extraction buffer, and this could influence the results of the bioaccessibility measurement. To guard against this, the pH of the fluid should be measured at the end of the extraction step (just after a sample was withdrawn for filtration and analysis). If the pH is not within 0.5 pH units of the starting pH (1.5), the sample should be re-analyzed. If the second test also resulted in an increase in pH of >0.5 units, it is reasonable to conclude that the test material is buffering the solution. In these cases, the test should be repeated using manual pH adjustment during the extraction process, stopping the extraction at 5, 10, 15, and 30 minutes and manually adjusting the pH down to pH 1.5 at each interval by drop-wise addition of HCl.

7.8 Analysis of Extraction Fluid for Lead

The filtered samples of extraction fluid should be stored in a refrigerator at 4°C until they are analyzed (within 1 week of extraction). Once received by the laboratory, all media should be maintained under standard chain-of-custody. The samples should be analyzed for lead by ICP-AES or ICP-MS (U.S. EPA Method 6010 or 6020, U.S. EPA, 1986). The method detection limit (MDL) in extraction fluid should be approximately 20 µg/L for Method 6010 and 0.1-0.3 µg/L for Method 6020.

8.0 Calculations

In order for an *in vitro* bioaccessibility test system to be useful in predicting the *in vivo* RBA of a test material, it is necessary to establish empirically that a strong correlation exists between the *in vivo* and the *in vitro* results across many different samples. Because there is measurement error not only in RBA but also in IVBA, linear fitting was also performed taking the error in both RBA and IVBA into account. There was nearly no difference in fit, so the results of the weighted linear regression were selected for simplicity (U.S. EPA, 2007b). This decision may be revisited as more data become available. Based on this decision, the currently preferred model is:

$$RBA = 0.878 \cdot IVBA - 0.028$$

It is important to recognize that use of this equation to calculate RBA from a given IVBA measurement will yield the "typical" RBA value expected for a test material with that IVBA, and the true RBA may be somewhat different (either higher or lower).

9.0 Quality Control/Quality Assurance

Recommended quality assurance for the extraction procedure are as follows:

- Reagent Blank — extraction fluid analyzed once per batch.
- Bottle Blank — extraction fluid only (no test soil) run through the complete procedure at a frequency of 1 in 20 samples (minimum of 1 per batch).

- Blank Spike — extraction fluid spiked at 10 mg/L lead, and run through the complete procedure at a frequency of 1 in 20 samples (minimum of 1 per batch).

- Matrix Spikes — subsample of each material used for duplicate analyses used as a matrix spike. The matrix spike should be prepared at 10 mg/L lead and run through the extraction procedure at a frequency of 1 in 10 samples (minimum of 1 per batch).

- Duplicate Sample — duplicate sample extractions performed on 1 in 10 samples (minimum of 1 per batch).

- Control Soil — National Institute of Standards and Testing (NIST) Standard Reference Material (SRM) 2711 (Montana Soil) used as a control soil. The SRM should be analyzed at a frequency of 1 in 20 samples (minimum 1 per batch).

Recommended control limits for these quality control samples:

Analysis	Frequency	Control Limits
Reagent blank	once per batch	<25 µg/L lead
Bottle blank	5%*	<50 µg/L lead
Blank spike (10 mg/L)	5%*	85-115% recovery
Matrix spike (10 mg/L)	10%*	75-125% recovery
Duplicate sample	10%*	±20% RPD
Control soil (NIST 2711)	5%*	±10% RPD

RPD = Relative percent difference
*Minimum of once per batch

10.0 Data Validation

NIST SRM 2711 should be used as a control soil. To evaluate the precision of the *in vitro* bioaccessibility extraction protocol, replicate analyses of standard reference materials (NIST SRM 2710 or 2711) should be used. The SRM will be analyzed at a frequency of 1 in 20 samples (minimum 1 per batch).

11.0 Health and Safety

When working with potentially hazardous materials, follow U.S. EPA, OSHA, or corporate health and safety procedures.

12.0 References

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Relative Bioavailability and Bioaccessibility and Speciation of Arsenic in Contaminated Soils

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NIEHS
National Institute of Environmental Health Sciences

National Institutes of Health
U.S. Department of Health and Human Services

Relative Bioavailability and Bioaccessibility and Speciation of Arsenic in Contaminated Soils

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Running Title: Relative Bioavailability of As Contaminated Soils

Key Words: Arsenic, bioaccessibility, bioavailability, gastrointestinal, human health, human health risk assessment, metalloid, soil physicochemical properties, speciation.

Acknowledgements: We thank Karen Herbin-Davis and Brenda Edwards for excellent technical assistance. Materials Research Collaborative Access Team operations at Argonne National Laboratory are supported by the U.S. Department of Energy and institutional members.

Disclaimer: The United States Environmental Protection Agency through its Office of Research and Development partially funded and collaborated in the research described here. It has been subjected to Agency review and approved for publication.

Competing interest declaration: The authors declare no competing financial interests.

Abbreviations: ABA: Absolute Bioavailability; Al: aluminum; As^{V}: arsenate; As: arsenic;; As^{III}: arsenite; Fe: iron; HCl: hydrochloric acid; ICP-OES: Inductively Coupled Plasma-Optical Emission Spectroscopy; IVBA: In vitro bioaccessibility; mg kg^{-1}: milligrams per kilogram; Mn: manganese; NIST: National Institute of Standards and Technology; RBA: Relative Bioavailability; SD: Standard Deviation; SRM: Standard Reference Material; US EPA: United States Environmental Protection Agency; XAS: X-Ray Absorption Spectroscopy.

ABSTRACT

Background: Assessment of soil arsenic bioavailability may profoundly affect the extent of remediation required at contaminated sites by improving human exposure estimates. Because small adjustments in soil arsenic bioavailability estimates can significantly alter risk assessments and remediation goals, convenient, rapid, reliable, and inexpensive tools are needed to determine soil arsenic bioavailability.

Objectives: This study evaluated inexpensive methods for assessing arsenic bioavailability in soil as a means to improve human exposure estimates and potentially reduce remediation costs.

Methods: Nine soils from residential sites affected by mining or smelting activity and two NIST standard reference materials were evaluated for arsenic bioavailability, bioaccessibility, and speciation. Arsenic bioavailability was determined using an in vivo mouse model while arsenic bioaccessibility was determined using the Solubility/Bioavailability Research Consortium in vitro assay. Arsenic speciation in soil and selected soil physicochemical properties were also evaluated in order to determine whether these parameters could be used as predictors of arsenic bioavailability and bioaccessibility.

Conclusion: In the mouse assay, bioavailabilities of arsenic in soils were compared to that for sodium arsenate. Relative bioavailabilities of soil arsenic ranged from 11-53% (mean = 33%). In vitro soil arsenic bioaccessibility values were strongly correlated with soil arsenic relative bioavailability values ($R^2 = 0.92$). Among physicochemical properties, combined concentrations of iron and aluminum accounted for 80 and 62% of the variability in estimates of relative bioavailability and bioaccessibility, respectively. The multifaceted approach described here yielded congruent estimates of arsenic bioavailability and evidence of interrelations among physicochemical properties and bioavailability estimates.

INTRODUCTION

The metalloid arsenic (As), a group 1 human carcinogen (IARC 2004), is the second most common inorganic contaminant at Superfund sites (U.S. EPA 2001). Hence, cancer risk associated with ingestion of As-contaminated soils (Calabrese et al. 1996; Davis et al. 1991; Dudka and Miller 1999) often drives risk assessments for human exposure to metal contaminants at Superfund sites (U.S. EPA 2007c). With increasing urbanization, exposure to As-contaminated soils grows more likely as residential areas extend into the vicinity or, in some cases, intrude onto Superfund sites (Scheckel et al. 2009). Reliable analysis of human health risks from ingestion of As-contaminated soil depends on estimating the bioavailability of As in the soil (U.S. EPA 1989). Current exposure estimates from ingestion of As-contaminated soils often do not consider differences between the bioavailability of As in water and soil (Ehlers and Luthy 2003). The use of default values that assume equivalent bioavailabilities for As in the two matrices can overestimate risk associated with ingestion of As-contaminated soil (Bradham and Wentsel 2010; U.S. EPA 2007b, 2007c). Speciation of As in soil, concentrations of other metals or metalloids, and other soil properties (e.g., pH and mineralogy) can affect the bioavailability of soil As and the amount available for systemic disposition (Kelly et al. 2002; NRC 2003; U.S. EPA 2007b). Because even small adjustments in soil As bioavailability estimates can significantly affect estimated risk and cleanup goals (U.S. EPA 2007c), methods are needed that quickly and inexpensively provide accurate and reliable data that can be applied to cleanups of As-contaminated sites worldwide.

Studies of soil As bioavailability have used species as diverse as rodents, swine, and monkeys (Casteel et al. 1997; Freeman et al. 1995; Lorenzana et al. 1996; Nagar et al. 2009; Ng et al. 1998; Pascoe et al. 1994; Rees et al. 2009; Roberts et al. 2002). Time and cost

considerations may limit use of some species in bioavailability assays (U.S. EPA 2007b). In the present study, the mouse was the test species of choice because of low purchase and husbandry costs, ease of handling, improved predictive value of data due to the feasibility of an increased sample size in assays, and the potential for widespread use of a mouse-based assay in many laboratories. Mice are well characterized physiologically and can be manipulated experimentally (e.g., altered dietary components, altered genotype) to determine the effects of biological variation on the gastrointestinal absorption of metals and metalloids. Extant data on gastrointestinal absorption of ingested arsenicals facilitate use of the mouse as a test species in assays of soil As bioavailability (Hughes et al. 2003, 2005, 2008). Although there are differences between mice and humans in metabolism and disposition of arsenicals (Vahter 1999), similarities are sufficient to permit use of mouse data to create physiologically based pharmacokinetic models which can be scaled for humans (El-Masri and Kenyon 2008; Evans et al. 2008; Gentry et al. 2004a, 2004b; Hughes et al. 1999).

Use of complementary experimental approaches to assess bioavailability has been advocated as a strategy to develop models that reduce uncertainty in risk assessment (NRC 2003). Here, animal-based and in vitro assays have been linked with physicochemical characterization of soils in a unified approach to develop accurate and reliable methods for risk assessment of As-contaminated soils. Results for test soils and standard reference materials (SRMs) suggest that concerted use of in vivo and in vitro methods combined with physicochemical characterization of soils provides a stronger scientific basis for the refinement of risk assessments for As-contaminated soils. In addition, correlations between physicochemical properties of soils and estimates of As bioavailability and bioaccessibility

indicated that use of physicochemical properties could profitably inform the refinement of both animal-based and in vitro assays.

METHODS

Soil origin, processing, and physicochemical characterization - Please see Supplemental Material for full description of soil origin, processing, and physicochemical characterization. Soils used in this study were collected from sites affected by mining and smelter activities. Physicochemical properties were determined in duplicate samples of each soil.

Arsenic speciation in soils was examined using the Materials Research Collaborative Access Team's (MRCAT) beamline 10-ID, Sector 10 at the Advanced Photon Source (APS), Argonne National Laboratory (ANL), Argonne, IL. A principal component analysis coupled with linear combination fitting (LCF) was used to identify the major As species in the samples. Linear combination fits (LCF) were performed using XAS k^2 space spectra from reference standards to As phases in the soil samples.

Arsenic concentrations in all soil and biological samples were determined by Instrumental Neutron Activation Analysis (INAA) at the Department of Nuclear Engineering, North Carolina State University, Raleigh (mean As mass detection limit of 0.035 μg). All bioavailability and bioaccessibility calculations were based on INAA values.

Mouse Bioavailability Assay – The Institutional Animal Care and Use Committee of the U.S. EPA National Health and Environmental Effects Research Laboratory approved a protocol for mouse use that assured humane treatment and alleviation of suffering. Four to six week-old female C57BL/6 mice (Charles River Laboratory, Raleigh, NC) were acclimated in groups of

three in a 12 hour light–12 hour dark photocycle at 20-22°C. Mice had free access to rodent diet (TestDiet, Richmond, IN) and tap water that contained less than 11 μg of As per liter (Kenyon et al. 2008). Composition of AIN-93G purified rodent diet (Reeves et al., 1993) obtained from Dyets (Bethlehem, PA) is given in Supplemental Material, Table 1. Soil-amended diets were prepared by thorough mixing of test soil with powdered AIN-93G purified rodent diet to a 1% (w/w) soil:diet ratio. Arsenate-amended diet prepared by addition of sodium arsenate heptahydrate (Sigma, St. Louis, MO) to powdered AIN-93G purified rodent diet was used to determine the bioavailability of a freely soluble As salt. Diets were stored at 4° C until used.

At an assay's beginning, three mice housed together during acclimation were transferred *en group* to a metabolic cage that separated urine and feces (Nalgene, Rochester, NY). Twelve mice in four metabolic cages constituted an experimental run. Metabolic cages were maintained for 10 days under environmental conditions given above with unlimited access to test diet and drinking water. For sample collection and data analysis, the unit of observation was the cage and the standard assay for a soil had a sample size of four (except soil 9 where sample size was three). To examine assay variability and reproducibility, bioavailability of As in soils 4 and 10 were assayed two and three times, respectively, over a two-year period.

Daily food consumption for each cage was calculated as the difference between the weight of the food hopper immediately after each morning's filling and before replenishment the following morning. Cumulative food consumption for each cage was the sum of daily food consumption. Urine and feces were collected each morning from each metabolic cage. Combined body weights of the three mice in each metabolic cage were determined immediately before initial transfer into the metabolic cage and at termination. Mice were euthanized by CO_2 anesthesia on day 10.

Daily urine or feces collections for each cage were stored at -20°C until processed to produce a single cumulative urine sample and single cumulative feces sample. After thorough mixing, multiple aliquots of the cumulative urine sample for each cage were taken for determination of As concentration by INAA. Cumulative urinary excretion of As was calculated as the product of As concentration in the cumulative urine sample and the volume of the cumulative urine sample. Cumulative feces samples were homogenized with a Spex CertiPrep 6850 Freezer/Mill (Metuchen, NJ). Multiple aliquots of cumulative feces sample were taken for determination of As concentration by INAA. Cumulative fecal excretion of As was calculated as the product of As concentration in the cumulative feces sample and the mass of the cumulative feces sample.

Absolute bioavailability (ABA) of As from ingestion of a soil or arsenate-amended diet was calculated as the ratio of cumulative excretion of As in urine and cumulative dietary intake of As (NRC 2003, U.S. EPA 2007c). ABA is commonly calculated and expressed on a percentage basis:

% ABA = [Cumulative μg As excreted in urine/Cumulative μg As consumed]*100 [1]

Relative bioavailability (RBA) was calculated as the ratio of the ABA for As in a specific soil-amended diet to the ABA for As in a diet containing sodium arsenate (NRC 2003, U.S. EPA 2007c). RBA is commonly expressed on a percentage basis:

% RBA = [ABA for As in a specific diet/ABA of As in sodium arsenate]*100 [2]

Bioaccessibility assays - Please see Supplemental Material for a full description of bioaccessibility assays. Bioaccessible As was determined using an in vitro method developed by the Solubility/Bioavailability Research Consortium (SBRC assay) (Kelly et al. 2002). In vitro

assays were performed in triplicate for each soil and included addition of one gram test soil to 100 mL of 0.4 M glycine, pH 1.5 gastric fluid in 125 mL HDPE bottle, rotating end-over-end in a water bath at 37°C for one hour. All soils tested in the bioaccessibility protocol were identical to those administered to mice in the in vivo and mineralogy studies described above. All in vitro extraction solutions were refrigerated at 4 °C for preservation and subsequent analysis by ICP-OES (U.S. EPA 2007d).

In vitro bioaccessibility (IVBA) was calculated and expressed on a percentage basis using the following equation:

$$\text{IVBA (\%)} = [\text{in vitro extractable (mg kg}^{-1}\text{)/total contaminant (mg kg}^{-1}\text{)}]*100 \quad [3]$$

Statistical analysis - Simple linear regression was used to evaluate the relationship between in vivo As RBA data and in vitro bioaccessibility data and to examine the role of selected soil physicochemical properties on As RBA and bioaccessibility. All analyses were performed using R version 2.9.1 (R Development Core Team, Vienna, Austria), and figures were created using GraphPad Prism version 5.0 (GraphPad, San Diego, CA).

RESULTS

Soil Characterization -Table 1 summarizes selected characteristics of test soils. Total As concentration in test soils ranged from 173 to 6899 mg kg^{-1}. As speciation by oxidation state varied among soils (See Supplemental Material, Figure 1). Soils 1, 3, 4, 7 and 11 had varying ratios of arsenite (As^{III}) to arsenate (As^{V}) species; soils 2, 5, 6, 8, 9, and 10 contained only arsenate. Realgar was identified in soils 1, 3, 4, and 11 and arsenopyrite was identified in soils 4 and 7. Sorbed arsenate and scorodite are common As species in soil environments and often result from the oxidation of As ore materials such as realgar or arsenopyrite. Concentrations of

Fe, Mn, and Al in soils ranged from 18.9 to 294.4 g kg^{-1}, 0 to 8.5 g kg^{-1}, and 3.9 to 21.7 g kg^{-1} respectively. Soil pH ranged from 2.1 to 7.3.

Mouse Bioavailability Assay - The gross clinical condition of mice was unaffected by ingestion of any of the amended diets; amendment of diet with soil or sodium arsenate did not significantly affect cumulative diet consumption (data not shown). Thus, amendment of AIN-93G rodent diet with 1% (w/w) soil or arsenate did not affect diet palatability for mice. Mean cumulative consumption of As strongly correlated with the concentration of As in the diet (See Supplemental Material, Figure 2). Mouse assay performance was evaluated by determining the percentage of cumulative As intake recovered in cumulative urine and feces collections. Arsenic recoveries in excreta averaged 83.7% (range 67 to 96%) for sodium arsenate- or soil-amended diets. For all dietary additives, percentage recovery and dietary As concentration were not correlated ($R^2 = 0.227$, $P = 0.398$ by Pearson Product Moment Correlation).

Increasing cumulative ingestion of As from amended diets was associated with increasing cumulative urinary excretion of As (Figure 1). Figure 2a shows As ABA estimates from diets amended with arsenate, test soils, or SRMs. Duplicate assays with arsenate-amended diet yielded an As ABA of ~60%. As ABA estimates for test soils ranged widely from ~7 to ~33%. Duplicate assays with diets amended with soil 4 (4a, 4b) yielded As ABA estimates of 6.7 and 7.1%. Triplicate assays with diets amended with NIST-2710 Montana Soil SRM (10a, 10b, 10c) yielded As ABA estimates ranging from 25.9 to 27.2%. For comparison, NIST-2710a SRM-amended diets dosed at multiple levels yielded an As ABA of ~ 26% for each dosage level (Supplemental Material, Figure 2). Figure 2b shows As RBA estimates for test soils and SRMs. Relative to arsenate bioavailability, As RBA estimates for test soils ranged from 11 to 53%. As

RBA estimates for NIST-2710 Montana soil-amended diet and NIST2710a soil-amended diet were ~44%. Supplemental Material, Table 2 summarizes data from mouse assays.

Correlations among Estimates of Bioaccessibility and Bioavailability and Physicochemical Properties- IVBA values ranged from 6.8 to 67% (SD 0 – 3%). NIST SRMs (Soils 10 and 11) were extracted multiple times over the course of the study in accordance with the SBRC assay (SDs were 4.1 and 1.7, respectively). Predictability of As RBA estimates from the mouse assay by the estimates of bioaccessibility from the SBRC assay was assessed by linear regression analysis. The derived regression model accounted for 92% of the variability in As bioavailability observed in the mouse assay ($R^2 = 0.92$, Pearson correlation = 0.96) (Figure 3).

Predictability of As bioavailability or bioaccessibility from the physicochemical properties and speciation of As in soils was examined by simple linear regression analysis (Table 2). Physicochemical properties of soil that were significant predictors ($P < 0.10$) of As RBA estimates were also significant predictors of IVBA estimates, with the exception of the percent arsenopyrite term. Among predictors, FeAl (Fe+Al concentration) accounted for the largest amount of variation in RBA and IVBA estimate ($R^2 = 0.58$ and 0.40, respectively). Log (FeAl) improved the predictive value of this term ($R^2 = 0.80$ and 0.62 for RBA and IVBA respectively). Although multivariable linear regression analysis has been used to estimate As bioavailability (Yang et al. 2002), application of this method in the present study did not materially improve predictions of As RBA or IVBA.

DISCUSSION

The concordance of RBA and bioaccessibility estimates obtained in mouse and in vitro assays with common physicochemical characteristics of soils suggested that these approaches could be used in a complementary manner to reduce uncertainty in assessment of risk associated with exposure to As-contaminated soils.

The mouse assay proved adaptable for use with soils with a wide range of As concentrations and physicochemical properties. Amended diets were palatable and, as anticipated from earlier studies (Xie et al., 2004), mice remained in apparent good health throughout the experimental period. In this study, calculation of the absolute bioavailability of arsenic used results from the mouse assay for a diet amended with 7 ppm of arsenic as sodium arsenate. This amendment produced arsenic dosage levels of 8.9 and 9.2 mg kg^{-1} in duplicate studies (Supplemental Material Tables 1 and 2). The dosage level for arsenate-amended diets exceeded those for contaminated soils 3, 5, 6, 8, 10b, approximately equaled (i.e., with overlapping standard deviations) those for soils 4a, 4b, 10a,10c, and was lower than those for soils 1, 2, 7, 9, 11. Hence, for most soils tested, the concentration of arsenate added to the diet equaled or exceeded that present in diet after soil amendment. Although additional studies with arsenate-amended diets are needed to confirm that estimates of bioavailability of arsenate or As in soil are unaffected by arsenic concentration in amended diets, studies in arsenate-treated laboratory mice suggest that dosage level does not affect the rate of urinary clearance of arsenic (Hughes et al., 1994; Hughes and Thompson, 1996; Kenyon et al., 2008). Similarities in the pattern and extent of urinary clearance of arsenic in mice which have received sodium arsenate over a wide range of dosage levels suggests that dosage level does not influence uptake of arsenate across the gastrointestinal barrier or its clearance into urine. In the absence of a change

in the rate of urinary clearance of arsenic over a wide dosage range, it is likely that mice ingesting diets amended with arsenate or arsenic-containing soils will reach whole body steady state body burden during the experimental period used in this study (Hughes et al., 2003).

Similar estimates of As bioavailability obtained for soils 4 and 10 in assays over a two-year period indicated that assay performance was stable (Figure 2a and b). In adult female mice receiving repeated daily oral doses of sodium arsenate, the body burden of As reaches steady state after eight or nine days of dosing (Hughes et al. 2003, 2010). Under steady state condition, concentrations of As in tissues and outputs of As in urine and feces will reach plateau values that will remain unchanged throughout the dosing interval. Although concentrations of As in urine and feces are both good indicators of current exposure, the predominance of urine as the route for As clearance after oral administration of inorganic As (Hughes et al. 2003) makes it ideal for estimating the extent of absorption of dietary As. Summing amounts of As excreted in urine and feces during the experimental period can be used to approximate recovery of As in the mouse assay. For the materials evaluated in the mouse assay, recoveries of ingested As in excreta ranged from 67 to 96%. However, these values should be regarded as minimal estimates as they do not include As that is retained in tissues of mice.

The mouse assay can be further refined by examining the role of dietary composition on the estimates of soil As bioavailability obtained with this model. Compared with AIN-93 purified diets, the human diet commonly consumed in developed countries derives more calories from fat, contains less fiber, and may not be optimal in terms of mineral and vitamin composition. These differences in dietary composition could affect the bioavailability of arsenic in two ways. First, the elemental composition of the diet can affect As uptake across the gastrointestinal barrier. For example, an increasing concentration of phosphate reduces in vitro

uptake of arsenate by Caco-2 intestinal cells derived from human colonic adenocarcinoma cells (Calatayud et al. 2010) and gastrointestinal uptake of As in rats dosed orally with arsenate (Gonzalez et al. 1995). Second, in humanized gnotobiotic mice the microbiota of the gastrointestinal tract is quickly altered by consumption of a diet with a high fat and high sugar content (Turnbaugh et al. 2009). Alteration of the microbiota of the gastrointestinal tract produced by changes in dietary composition could alter gastrointestinal uptake of ingested arsenate. Recent studies show that the anaerobic microbiota from the mouse cecum extensively metabolize arsenate to produce inorganic thioarsenicals and methylated oxy- and thioarsenicals (Pinyayev et al. 2011). The mouse model can readily be adapted to examine effects of dietary composition of diets on the bioavailability of As in soils.

Soil As RBA estimates obtained in juvenile swine and monkeys have ranged from 0 to 52% (Casteel et al. 1997; Freeman et al. 1995; Lorenzana et al. 1996; Rees et al. 2009; Roberts et al. 2002; Rodriguez et al. 1999). Comparisons of As RBA data obtained in mice and juvenile swine are problematic due to differences in experimental design and dosing levels. However, there are four soils that have been evaluated in both species. For three soils (soils 9, 10, 11 in this study), As RBA estimates from mouse and juvenile swine differed by 4, 0, and 1%, respectively (U.S. EPA 2009). For the fourth soil (soil 8 in this study) As RBA estimates differed for mouse (40.9%) and juvenile swine (60%). Differences in As RBAs for mouse and juvenile swine may reflect physiological differences between species. Additional soils should be evaluated in both species to identify possible sources of variability and permit a detailed comparison of the assays.

A recent NRC report has recommended development and validation of in vitro assays that can replace in vivo assays and can provide reliable and accurate data that reduces

uncertainty in risk assessment (NRC 2007). This recommendation prompted development of bioaccessibility assays that reflect processes that control As bioavailability in the human gastrointestinal tract (Basta et al. 2007, Juhasz et al. 2007, Kelly et al. 2002, Rodriguez et al. 1999, Ruby et al. 1999). High correlation ($R^2 = 0.92$, Pearson correlation = 0.96) between the As bioaccessibility data from the SBRC assay and As RBA estimates from the mouse assay is consistent with the high correlation of estimates of As RBA from juvenile swine with As bioaccessibility estimates from the SBRC assay ($R^2 = 0.75$, Pearson correlation = 0.87) (Juhasz 2009). The correlation of findings from the SBRC assay and the mouse assay suggests that the bioaccessibility assay provides useful information about the characteristics of As-containing soils that influence As RBA as measured in the mouse assay. In addition, strong agreement of estimates from the SBRC in vitro assay and the mouse assay suggest that the mouse assay can be used to validate performance of bioaccessibility assays.

Metal speciation and the concentrations of Fe, Al, and Mn are known to affect solubilities and bioavailabilities of metals in soils (Bradham et al. 2006; Kelly et al. 2002; NRC 2003; Scheckel et al. 2009). Here, the effects of As speciation and metal concentrations on estimates of soil As RBA and bioaccessibility obtained in the mouse assay and SBRC assay were evaluated by linear regression analyses. Significant inverse correlations ($P < 0.10$) were found between concentrations of extractable Fe or Al in soils and between sums of concentrations of extractable soil Fe and Al (Fe+Al) and estimates of soil As RBA and bioaccessibility. For example, the log-transformed sum of extractable Fe and Al concentrations accounted for 80% and 62% of the variability in estimates of As RBA and bioaccessibility, respectively. The high predictive value of log (Fe+Al) suggested that sorption of As to Fe and Al oxides reduced As solubilization and thereby reduced As RBA and bioaccessibility. Similar results were found by

Beak et al. (2006a, 2006b) for As bioaccessibility using a modified Rodriguez et al (1999) in vitro method which investigated As sorption on ferrihydrite ($Fe^{3+}{}_5O_3(OH)_9$) and corundum (Al_2O_3). Thus, determination of the concentrations and forms of Fe and Al in soils may be useful in assessing As bioavailability. There are several clay minerals that contain ferrous and ferric iron which, upon release via weathering, will form iron oxides and hydroxides in soil environments (Bowell 1994). Similar processes are also identified for aluminum and manganese oxides in soils (Jenne 1968; McKeague et al. 1971). Lower As RBA estimates for soils containing sulfide forms of As (realgar or arsenopyrite) may reflect slow dissolution kinetics of these mineral species. Although arsenopyrite was only present in two of the test soils, its presence significantly reduced As bioavailability estimates ($P < 0.10$). This finding is consistent with reports showing that As in arsenopyrite is bound tightly; therefore, As bioavailability is likely to be low (Roberts et al. 2007). Additional studies would be useful to identify other metals and metalloids in soils that are potential modifiers of As bioavailability and bioaccessibility and to determine concentration dependencies of these interactions.

CONCLUSION

A multifaceted approach combining in vivo assays, in vitro assays, and physicochemical characterization of soils yielded comparable estimates of As bioavailability and provided evidence of interrelations among physicochemical properties and estimates of As bioavailability. The range of As RBA estimates in this study (11 to 53%) implies that use of a default value of 100% for As bioavailability in human health risk assessments may overestimate risk associated with exposure to As-contaminated soils. Further studies with the mouse assay and the in vitro

assay coordinated with physiochemical characterization of test soils can confirm and extend the results obtained in this study and identify refinements in experimental design and data analysis that can improve the accuracy and reliability of estimates of bioaccessibility and bioavailability.

SUPPLEMENT MATERIAL AVAILABLE

Figures and tables showing the XANES spectra for the soils, the composition of basal purified rodent diet, summary data on As consumption, dosage level, excretion, and bioavailability for materials evaluated in mouse assays, and the relationship between concentrations of As in mouse diet and mean cumulative consumption of As over the experimental period can be found in the Supplement Material.

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Table 1. Description, elemental composition and arsenic speciation in test soils[a]

		Soil Properties					Arsenic Speciation*				
							Arsenate (As^V)		Arsenite (As^{III})		
Soil ID	Description[b]	As[c] (mg/kg)	Fe[d,e] (g/kg)	Mn[d,e] (g/kg)	Al[d,e] (g/kg)	pH[e]	Sorbed As^V (%)	Scorodite (%)	Realgar (%)	Arsenopyrite (%)	χ^2 red[f]
1	urban residential	990	20.9	0.5	11.8	6.1	52.0	21.2	26.8	-	0.004
2	urban residential	829	20.5	0.7	9.4	6.3	96.7	3.3	-	-	0.004
3	urban residential	379	18.9	0.2	9.0	5.0	53.1	15.2	31.7	-	0.003
4	smelter slag	837	294.4	2.7	13.2	7.2	18.7	1.6	47.7	32.1	0.001
5	residential	244	46.0	0.8	21.7	7.3	96.2	3.8	-	-	0.002
6	residential	173	63.4	0.7	20.9	6.6	66.8	33.2	-	-	0.002
7	smelter slag	6899	144.5	0.9	15.0	5.2	18.3	47.1	-	34.6	0.001
8	residential	280	72.3	0.0	3.9	2.1	79.5	20.5	-	-	0.007
9	smelter slag	4495	120.1	0.4	12.3	2.6	67.6	32.4	-	-	0.011
10	NIST 2710	601	29.2	8.5	17.2	5.0	95.0	5.0	-	-	0.007
11	NIST 2710a	1513	34.0	1.7	10.0	4.0	66.8	23.2	9.9	-	0.01

[a] < 250 μm particle size fraction used for all analyses
[b] Source of arsenic contaminated soil
[c] Determined by Instrumental Neuron Activation Analysis
[d] Extracted using EPA Method 3051A and analyzed by ICP-OES 6010C
[e] Data represents the mean of duplicate analyses
[f] Reduced chi-squared values = $[(\text{data-fit})^2] / [\text{data}^2]$
* Determined by linear combination of As XAS

Table 2 - Results of linear regression analyses to explore the influence of select soil properties on arsenic relative bioavailability (RBA) and in vitro bioaccessibility (IVBA).

predictor	RBA			IVBA		
	equation	R^2	P value	equation	R^2	P value
sorbed As(V) (%)	RBA = 0.2x + 17.1	0.14	0.26	IVBA = 0.3x + 18.4	0.11	0.31
scorodite (%)	RBA = -0.4x + 38.9	0.10	0.35	IVBA = -0.7x + 50.9	0.16	0.22
realgar (%)	RBA = 0.1x + 31.1	0.01	0.80	IVBA = 0.2x + 36.1	0.01	0.73
arsenopyrite (%)	RBA = -0.7x + 36.2	0.28	0.09*	IVBA = -0.7x + 42.5	0.16	0.23
AsV (%)	RBA = 0.2x + 19.0	0.05	0.50	IVBA = 0.1x + 26.9	0.02	0.70
AsIII (%)	RBA = -0.2x + 34.7	0.05	0.50	IVBA = -0.1x + 40.2	0.02	0.70
As (mg/kg)	RBA = x + 37.3	0.17	0.21	IVBA = x + 45.2	0.15	0.23
Fe (g/kg)	RBA = -0.1x + 43.5	0.48	0.02**	IVBA = -0.2x + 51.4	0.32	0.07*
Al (g/kg)	RBA = -1.9x + 57.3	0.34	0.06*	IVBA = -2.7x + 73.3	0.32	0.07*
Mn (g/kg)	RBA = 0.7x + 31.0	0.01	0.77	IVBA = 1.1x + 36.3	0.01	0.76
pH	RBA = -2.2x + 43.3	0.05	0.52	IVBA = -1.2x + 44.0	0.01	0.82
FeAl (mol/kg)	RBA = -8.8x + 48.7	0.58	0.01***	IVBA = -10.5x + 57.9	0.40	0.04**
log(FeAl) (mol/kg)	RBA = -53.1x + 41.6	0.80	0.00***	IVBA = -67.5x + 50.1	0.62	0.00***

* $P \leq 0.10$, ** $P \leq 0.05$, *** $P \leq 0.01$

FIGURE LEGENDS

Figure 1. Relationship between cumulative arsenic intake and cumulative urinary arsenic excretion. Soils identified in Table 1. Replicate assays shown for soil 4 (4a, 4b) and soil 10 (10a, 10b, 10c); NaAs is sodium arsenate-amended diet. (Mean and standard deviation shown)

Figure 2. Absolute (a) and relative (b) bioavailabilities of arsenic from amended diets. Results expressed as function of cumulative arsenic intake. Soils identified in Table 1. Replicate assays shown for soil 4 (4a, 4b) and soil 10 (10a, 10b, 10c); NaAs is sodium arsenate-amended diet. (Mean and standard deviation shown)

Figure 3. Correlation between estimates of arsenic bioaccessibility and bioavailability. Linear regression analysis of correlation between estimates of bioaccessibility (% IVBA) and estimates of relative bioavailability (% RBA). Soils identified in Table 1. (Mean and standard deviation shown)

Figure 1

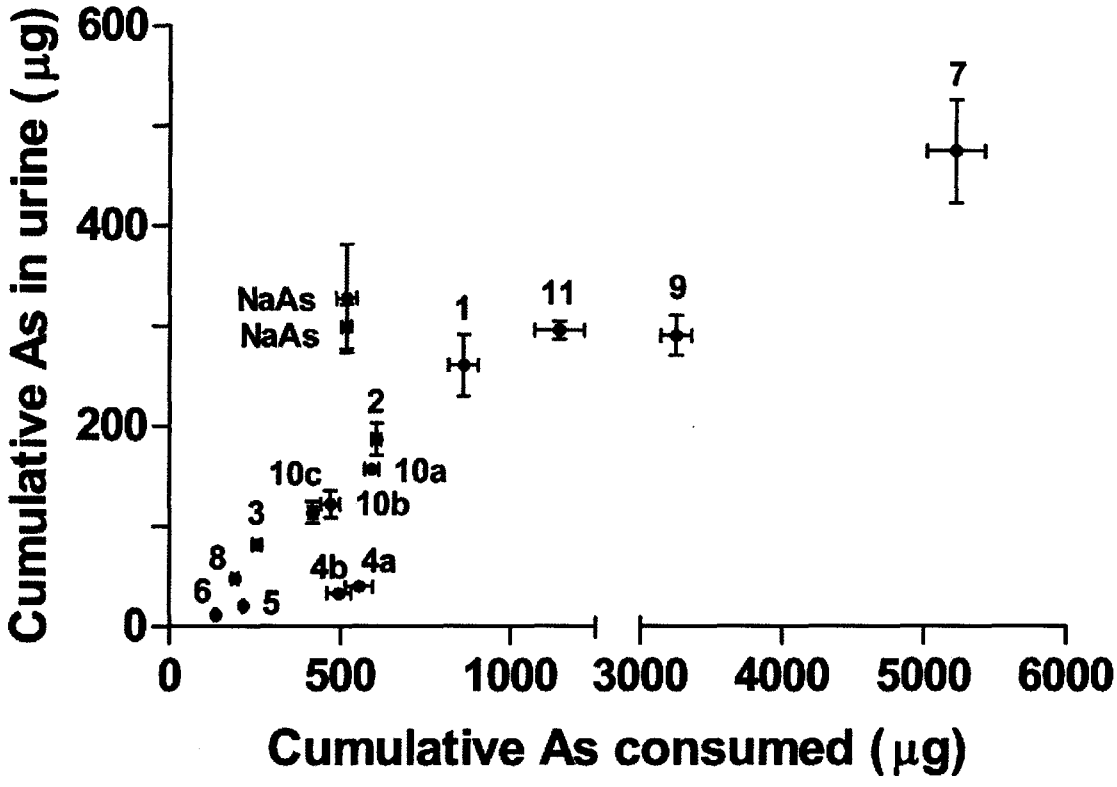

Cumulative As in urine (μg)
600
400
200
0
NaAs
NaAs
1
11
9
7
2
10c
10a
10b
3
8
4b
4a
6
5
0
500
1000
3000
4000
5000
6000
Cumulative As consumed (μg)

Figure 2

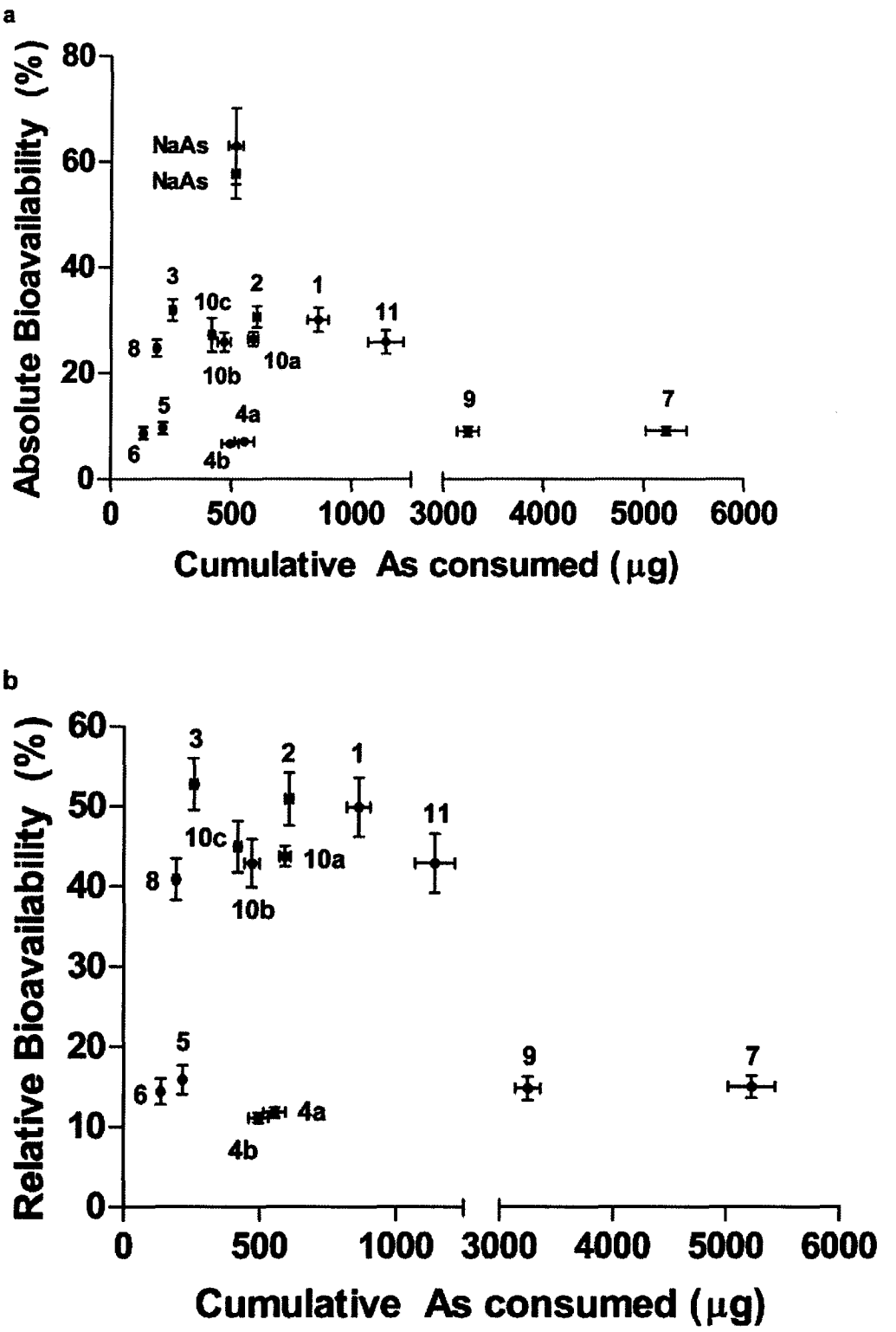
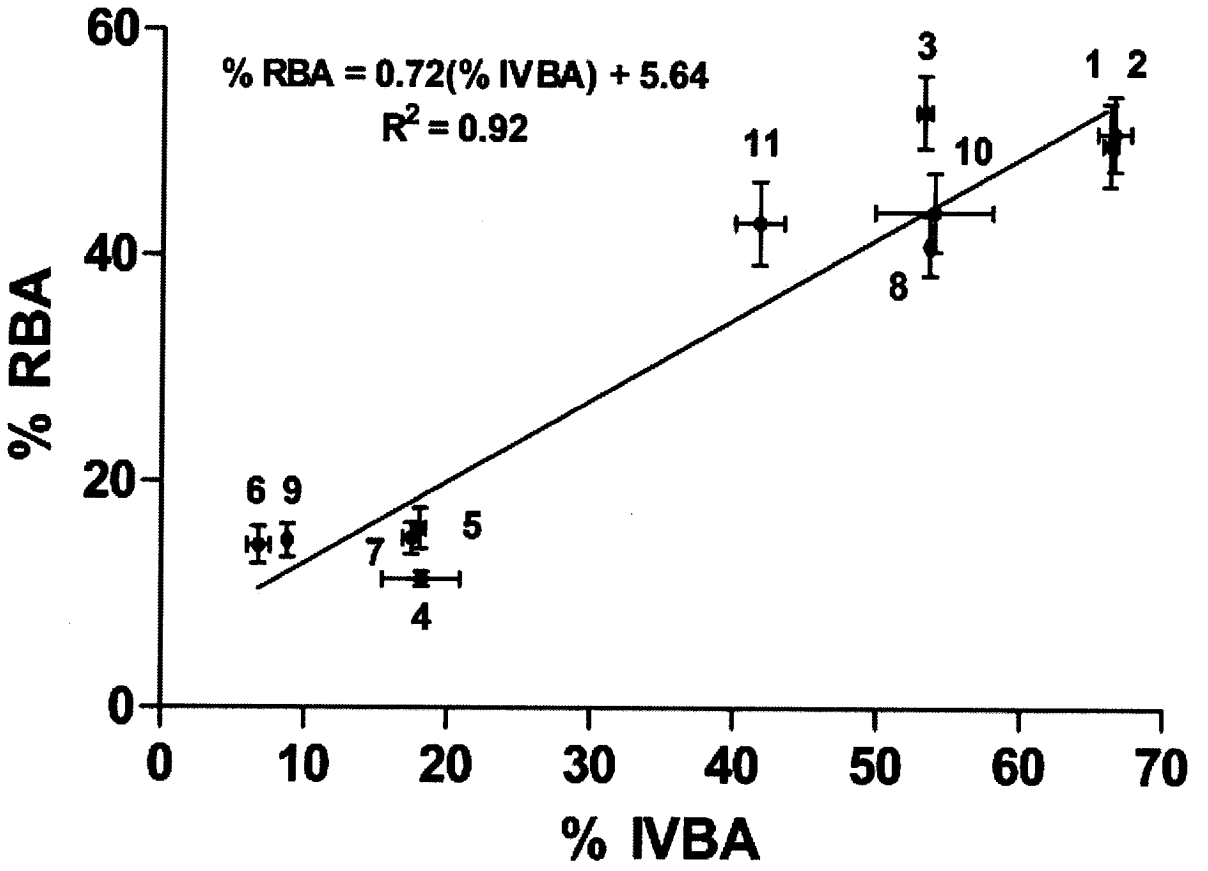

a
Absolute Bioavailability (%)
80
60
40
20
0
NaAs
NaAs
3
10c
2
1
11
8
10a
10b
5
4a
9
7
6
4b
0
500
1000
3000
4000
5000
6000
Cumulative As consumed (μg)
b
Relative Bioavailability (%)
60
50
40
30
20
10
0
3
2
1
11
10c
10a
8
10b
5
9
7
6
4a
4b
0
500
1000
3000
4000
5000
6000
Cumulative As consumed (μg)

Figure 3


% RBA = 0.72(% IVBA) + 5.64
R^2 = 0.92
% RBA
% IVBA
0
20
40
60
0
10
20
30
40
50
60
70
1
2
3
4
5
6
7
8
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10
11

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AN IN VITRO METHOD FOR ESTIMATION OF ARSENIC RELATIVE BIOAVAILABILITY IN SOIL

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This report summarizes the results of a study to develop an in vitro bioaccessibility (IVBA) extraction technique for estimating the relative bioavailability (RBA) of arsenic (As) in soil. The study was implemented in several steps. In step 1, key variables in the extraction protocol were identified. In step 2, 21 different extraction conditions were tested on 12 different soils with reliable RBA values measured in swine or monkeys to identify which yielded useful in vivo–in vitro correlations (IVIVC). In step 3, three extraction conditions were evaluated using 39 different test soils to make a final selection of the best IVIVC. In step 4, the within- and between-lab reproducibility of the extraction method was examined. The optimum IVIVC model for swine utilized a pH 1.5 IVBA extraction fluid, with an R^2 value of .723. For monkeys, the optimum IVIVC model was obtained using a pH 7 IVBA extraction fluid that contained phosphate, with an R^2 value of .755. Within-lab precision of IVBA results was typically less than 3%, with an average of 0.8% for all 4 labs. Between-lab variation in mean IVBA values was generally less than 7%, with an overall average of 3%. The principal advantages of this IVBA method compared to other in vitro methods described in the literature are that (1) the fluids and extraction conditions are simple, (2) the results have been calibrated against a larger data set than any other method, and (3) the method has been demonstrated to be reproducible both within and between labs.

Arsenic (As) is a chemical that is known to produce a range of adverse health effects in humans (ATSDR, 2007; Tsai et al., 1998; Golub et al., 1998; Orloff et al., 2009). Consequently, As is of potential concern to regulatory agencies at a number of sites. In most cases, incidental ingestion of As in soil or sediment is a primary exposure pathway. When risks to humans from ingestion of As in soil or sediment are calculated, the default assumption is that As is absorbed from soil or sediment to the same extent that it is absorbed from drinking water (the exposure medium in the studies from which the As toxicity values are derived). This ratio (absorption from soil compared to absorption from water) is referred to as the relative bioavailability (RBA). Numerous studies in animals suggest that the assumption of 100% RBA for As in soil or other soil-like media is overly conservative, with RBA estimates from As-contaminated soils at mining, smelting, herbicide, pesticide, and chemical plant

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sites generally ranging from 5 to 78% (Bradham et al., 2011; Brattin and Casteel, 2013; U.S. Environmental Protection Agency [EPA], 2010; Freeman et al., 1993, 1995; Juhasz et al., 2007; Roberts et al., 2007; Rodriguez et al., 2003). Well-performed studies in animal models that identify RBA values lower than the default are generally accepted as a basis for adjusting estimates of exposure and risk (U.S. EPA, 2007a), which often lead to substantial cost savings during site remediation compared to the use of the default RBA value. However, most animal studies of RBA tend to be relatively slow and costly, which tends to limit the application of an in vivo approach to only the largest hazardous waste sites. For these reasons, faster and less expensive methods to estimate RBA are highly desirable.

One strategy is to perform lab-based measurements of As solubilization from soil samples. In this approach, a sample of soil or sediment is extracted using a fluid that has properties that resemble a gastrointestinal (GI) fluid, and the amount of As solubilized from the sample into the fluid under a standard set of extraction conditions is measured. The fraction of As that is solubilized is referred to as the in vitro bioaccessibility (IVBA). The IVBA is then utilized to predict the in vivo RBA of As in that sample, usually through an empiric correlation model that relates IVBA to in vivo RBA (U.S. EPA, 2007b).

This study describes the development, testing, and interlab testing of an IVBA-based method for estimating the RBA of As in soil or other soil-like media. The relation between IVBA and RBA is based on 39 different As-containing test materials from mining, smelting, herbicide, pesticide, wood-treating, and chemical plant sites across the United States for which the RBA was previously measured in cynomolgus monkeys or juvenile swine.

MATERIALS AND METHODS

Basic Strategy

The starting point for the development of the As IVBA method described here was an in vitro method that was previously established for estimation of the RBA of lead (Pb) in soil (Drexler and Brattin, 2007; U.S. EPA, 2008). Method development was implemented in a stepwise fashion, as follows:

- Step 1: Identify up to three extraction fluid variables that had the largest effect on measured As IVBA values.
- Step 2: Based on the three key variables identified in step 1, test a range of different extraction fluids ($n = 21$) on an intermediate size set of test soils ($n = 12$) to see which fluids yielded potentially useful in vitro–in vivo correlations (IVIVC).
- Step 3: Based on the results from step 2, test a selected set of 3 extraction fluids on a large set of test soils ($n = 39$) to select the final extraction fluids that yield the best IVIVC.
- Step 4: Evaluate the within- and between-lab precision of IVBA results using a set of 12 different test soils extracted with 2 different extraction fluids by 4 different labs.

List of Test Soils

Table 1 provides a list and brief description of 48 soils that were used in these studies. These soils were available to the study authors in sufficient quantity to allow for multiple IVBA extraction tests, and were selected to provide a wide range of different mineralogical forms and concentrations of As. Most soils were obtained from U.S. EPA Superfund sites or other areas known to be contaminated with As, although some were uncontaminated soils that were spiked with pure mineral forms of As. Investigations of the IVIVC between IVBA and RBA values utilized only soils for which a reliable RBA value was available from studies in swine ($n = 20$) or monkeys ($n = 19$). For swine, only RBA values derived as described by Brattin and Casteel (2013) were used. That is, the in vivo study must have included dose groups to establish the sodium arsenate dose-response curve, and data must have been reduced using simultaneous weighted regression. Soils with As concentrations lower than 200 ppm were not considered due to the difficulty of accurately

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TABLE 1. Description of Test Materials

Test material identifier	Site name	Site type	Sample description	Predominant mineralogy[a]	As concentration (mg/kg)[b]	RBA in swine (%)	RBA in monkeys (%)
Aberjona River TM1	Industri-plex and Wells G&H	Industrial	Aberjona River sediment	FeOOH	676	38.1	
Aberjona River TM2	Industri-plex and Wells G&H	Industrial	Aberjona River sediment	FeOOH, Fe-sulfate, $ZnSiO_4$	313	52.4	
Anaconda Flue Dust	Anaconda Smelter	Milling and Smelting	Flue dust	FeAsO	1663		
Anaconda Tailings	Anaconda Smelter	Milling and Smelting	Tailings	FeOOH	15,952		
Barber Orchard MS-1	Barber Orchard	Former apple orchard	Orchard Soil	PbAsO	290	31.0	33.0
Barber Orchard MS-4	Barber Orchard	Former apple orchard	Orchard Soil	PbAsO, MnOOH	388	40.8	28.0
Barber Orchard MS-5	Barber Orchard	Former apple orchard	Orchard Soil	PbAsO, cobaltite, FeOOH	382	48.7	38.0
Barber Orchard MS-8	Barber Orchard	Former apple orchard	Orchard Soil	PbAsO	364	52.8	25.0
BC Channel Soil	Kennecott (South Zone)	Mining	Soil from Bingham Creek Channel	FeAs sulfate, PbAsO	149		
Butte TM1	Silver Bow Creek/Butte Area	Mining, milling	Soil	Sulfosalt, FeOOH	234	17.8	
Butte TM2	Silver Bow Creek/Butte Area	Mining, milling	Soil	Fe-sulfate, FeOOH	367	23.6	
CAMT	Mesa del Oro	Mining	Residential soil containing tailings	Arsenopyrite, FeOOH	300		19.0
Clark Fork Tailings	Clark Fork River	Mining, milling	Overbank tailings	FeOOH, Fe-sulfate, Sulfosalt	181	50.7	
CORS	VBI70	Smelter	Residential soil	As_2O_3, PbAsO	1230		17.0
COSCS	Globeville	Smelter	Composite soil	AsMO, PbAsO	394		18.0
COSS	Smeltertown	Mining, milling, smelting	Soil	Fe-Sulfate, FeOOH	1492		5.0
COW-Fe	Cave of the Winds	Natural geologic formation	Natural soil	FeAsO	689		
COW-Mn	Cave of the Winds	Natural geologic formation	Natural soil	MnOOH	490		
CRM 205-225	—	Near power plant	Native soil contaminated with fly ash from the power plant	$PbMClO_4$	90		
Drexler-5	—	—	Colorado soil spiked with sodium arsenate	NaAsO	1239	100.0	
Drexler-6	Globeville	Smelting	Composite soil	AsMO, CaMO, PbAsO	1414		
Drexler-7	—	—	Colorado soil spiked with arsenic trioxide	As_2O_3	1767		
Drexler-8	—	—	Colorado soil spiked with lead arsenate	PbAsO	2961		
Enargite	—	Mining	Native CO soil spiked with crushed enargire from Butte MT	Cu_3AsS_4	191		
FLCDV	Not specified	Cattle dip site	Soil (collected by FL DEQ)	Clay, FeOOH	150		31.0
FLCPS	Near Inglis	Chemical plant	Soil (collected by FL DEQ)	Fe-sulfate, FeOOH	268		7.0

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HIVS	Not specified	Volcanic	Soil (collected by HI DEH)	Clay, FeOOH, PbAsO	724		5.0
Iron King TM1	Iron King Mine/Humboldt Smelter	Mining, smelting	Soil	Fe-sulfate, sulfosalt	200	60.2	
Iron King TM2	Iron King Mine/Humboldt Smelter	Mining, smelting	Soil	Arsenopyrite, pyrite, Fe-sulfate, sulfosalt	3957	18.6	
Midvale Slag	Midvale Slag	Smelting	Slag	PbAsO	591		
MTSS	Anaconda Smelter	Smelting	Soil	FeOOH, sulfosalt, PbAsO	647		13.0
Murray Smelter Flue Dust	Murray Smelter	Smelting	Flue dust	As_2O_3	41,051		
NIST 2710	Silver Bow Creek/Butte Area	Mining, milling	NIST standard soil (from Butte)	FeOOH, sulfosalt	590 (c)	44.1	
NIST 2710A	Silver Bow Creek/Butte Area	Mining, milling	NIST standard soil (Butte soil spiked with lead oxide)	FeOOH, sulfosalt	1400 (c)	41.8	
NIST 2711	Silver Bow Creek/Butte Area	Mining, milling	NIST standard soil (from Silver Bow Creek)	FeOOH	105 (c)		
NYOS	Not specified	Apple orchard	Soil (northern NY State)	MnOOH, PbAsO	123		15.0
NYPS1	Not specified	Pesticide manufacture	Soil (northern NY State)	FeOOH, PbAsO	1000		20.0
NYPS2	Not specified	Pesticide manufacture	Soil (northern NY State)	FeOOH	549		19.0
NYPS3	Not specified	Pesticide manufacture	Soil (northern NY State)	FeOOH	339		28.0
St. Pete's	—	—	Florida soil spiked with sodium arsenate	NaAsO	514		93.0
VBI70 TM1	VBI70	Smelting, refining	Residential yard soil	As_2O_3, PbAsO	312	40.3	
VBI70 TM2	VBI70	Smelting, refining	Residential yard soil	PbAsO, As_2O_3	983	42.2	
VBI70 TM3	VBI70	Smelting, refining	Residential yard soil	As_2O_3, PbAsO, FeOOH	390	36.7	
VBI70 TM4	VBI70	Smelting, refining	Residential yard soil	As_2O_3, PbAsO	813	23.8	
VBI70 TM5	VBI70	Smelting, refining	Residential yard soil	As_2O_3	368	21.2	
VBI70 TM6	VBI70	Smelting, refining	Yard soil spiked with PAX pesticide	As_2O_3, PbAsO	516	23.5	
WAOS	WA State University experimental station	Orchard	Composite soil	PbAsO	301		24.0
WISS	Not specified (western United States)	Mining and smelting	Slag	PbAsO, FeOOH	1412		13.0

[a]As mineralogy was determined using electron microprobe analysis (EMPA) techniques. The predominant As forms are account for at least 80% of the As mass in the sample. PbAsO, Arsenopyrite, As_2O_3, NaAsO, and Sulfosalt are generally stoichiometric mineral forms with fixed As concentrations. FeOOH and MnOOH represent phases that are predominantly either iron or manganese oxides, with variable concentrations of As sorbed to their structure. Fe-sulfate is chemically similar to the common mineral jarosite ($KFe_3(OH)6(SO_4)_2$) with variable concentrations of As sorbed to the structure. $ZnSO_4$ is a non-stoichiometric zinc-rich sulfate with variable concentrations of As. Clay is an iron-rich, hydrated, alumino-silicate with variable concentrations of As sorbed to the structure. AsMO is a complex oxide with variable concentrations of As and other metals (M) including Pb, Sb, Cu, and Cd. PbMClO4 is a mixed chlorate salt with Pb and several other metals, including As.

[b]Soil concentrations measured by EPA Method 3050.

[c]As concentrations in NIST standard reference materials are based on the mean of multiple analyses by several different methods.

measuring RBA in such soils. For monkeys, all soils for which RBA values were reported by Roberts et al. (2007) were used when sufficient material was available, since the bioassay protocol used by these investigators included an internal sodium arsenate control for each test animal and the data reduction protocol was consistent across all studies.

IVBA Extraction Protocol

The extraction device used in these studies holds ten 125-ml wide-mouth high-density polyethylene bottles that are rotated end-over-end within a water bath by an electric motor with a magnetic flywheel. The water bath is filled such that the extraction bottles are fully immersed in water maintained at a temperature of 37 ± 2°C with a circulation heater. A schematic diagram of the extraction device is available online at http://www.colorado.edu/geolsci/legs/invitro1.html.

Extraction Fluids

The basic extraction fluid consisted of 0.4 *M* glycine adjusted to pH 1.5 with addition of hydrochloric acid. Other extraction fluids were created by varying the strength and/or pH of the fluid, or by addition of other components to the fluid. All extraction fluids were prepared utilizing American Society for Testing and Materials (ASTM) Type II deionized (DI) water and high-purity reagents to minimize As contamination of the fluids.

Extraction Procedure

All test substances were thoroughly mixed before use to ensure homogeneity. After mixing, 1 ± 0.05 g of test substrate was weighed and placed into a clean extraction bottle. To this was added 100 ± 0.5 ml of the designated extraction fluid. The bottles were tightly sealed, placed into the extraction device, and rotated at 30 ± 2 revolutions per minute (rpm). After 1 h, the bottles were removed and a sample of extraction fluid was withdrawn using a disposable 10-ml syringe fitted with a 0.45-μm cellulose acetate disk filter (25 mm diameter). The filtered extraction fluid was then analyzed for As using U.S. EPA Method 6020. If the final fluid pH of the extraction fluid was not within ±1 pH units of the starting pH, the test was not considered reliable. Most soils were extracted at least twice, and the mean value was used to represent the IVBA for the sample. In general, variation between replicate IVBA measurements was quite small (<3%) as described in the following (see discussion of step 4).

IVBA Quality Control

Each IVBA extraction (i.e., each set of 10 bottles) included one lab blank (a bottle containing 100 ml of extraction fluid with no added soil) and one blank-spike (a bottle containing 100 ml of extraction fluid to which was added 0.25 mg of As as sodium arsenate). Based on the results from many years of IVBA studies done by one of the authors (Drexler) at the University of Colorado, acceptance criteria for these quality control samples were set as follows: (a) blank concentration < 10 μg/L As, and (b) recovery of As from the blank spike = 85–115%.

Calculation of IVBA

The IVBA of As in the test material was calculated as follows:

$$\text{IVBA}(\%) = (C_{\text{fluid}} \times V_{\text{fluid}}) / (C_{\text{soil}} \times M_{\text{soil}}) \times 100$$

where C_{fluid} is the concentration of As in the extraction fluid (μg/L), V_{fluid} the volume of extraction fluid (L), C_{soil} the concentration of As in the test soil (μg/g), measured using U.S. EPA Method 3050, and M_{soil} the mass of soil placed in the extraction bottle (g). Note that results were expressed as percent total As in soil that became solubilized, and not as "bioaccessible concentration" of As in the study substrate (calculated as IVBA multiplied by C_{soil}). This is because expressing IVBA and RBA as a concentration introduces an autocorrelation between

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RBA and IVBA, since both values are multiplied by the same factor (C_{soil}), which leads to a higher coefficient of determination (R^2) value for the IVIVC regression.

In Vitro–In Vivo Correlation

The IVIVC between IVBA and RBA for a set of test materials was evaluated by fitting a linear model (RBA = $a + b \times$ IVBA) using the method of maximum likelihood estimation (MLE), assuming measurement errors in RBA are normally distributed with a constant coefficient of variation. Fitting was performed using MLE rather than ordinary linear regression because measurement error in RBA tends to rise as RBA increases, at least in swine (Brattin and Casteel, 2013). Given a regression model with an adequately strong correlation, the RBA of a sample may be estimated by measuring the IVBA and substituting the value into the regression model.

Arsenic Mineralogy (Speciation)

Arsenic mineralogy in test materials was evaluated using electron microprobe analysis (EMPA). In brief, the EMPA procedure uses an electron microprobe with combined energy-dispersive spectrometer (EDS) and multiple wavelength-dispersive spectrometers (WDS) to evaluate the elemental composition of each As-bearing particle. Based on the elemental composition, each particle is assigned to an As "phase." In some cases, these phases correspond to a specific mineral with fixed stoichiometry, while in other cases, the "phase" represents a range of elemental compositions with varying stoichiometry. A detailed speciation protocol is available online at http://www.cugeology.org/legs.

RESULTS

Step 1: Identification of Up to Three Influential Variables

Extraction fluid pH Figure 1 shows the effect of pH of the extraction fluid on IVBA values for 18 test soils. The highest IVBA values were obtained at pH 1.5, with a tendency for decreasing IVBA as pH increased. However, the magnitude of the decrease was not equal for all materials. The lines in the figure are intended only to help show which data points are derived from the same soil, and do not imply a linear rate of change between measurements.

Temperature Figure 2 compares IVBA values measured at pH 1.5 at 20°C (room temperature) and 37°C. Of the 10 materials investigated, increased temperature (37°C vs. 20°C) resulted in an elevation in IVBA in 5 cases, little change in 4 cases, and a decrease in 1 case.

Extraction time IVBA was measured as a function of time over the scale of 10 min to 48 h, as shown in Figure 3. In most cases, a majority of the total As solubilization occurred rapidly (within 10–30 min), although some test materials yielded results that tended to rise slowly after the initial solubilization phase.

Addition of phosphate Because As in solution usually exists as an oxyanion, addition of other oxyanions such as phosphate to the extraction fluid may enhance the solubilization of As from soil-like materials by competition with As for cationic adsorption sites in the soil. Rodriguez et al. (2003) found that adding 0.1 *M* sodium phosphate doubled As IVBA on average compared to an extraction without sodium phosphate. Figure 4 shows the effect of adding 0.2 *M* or 0.8 *M* phosphate on the As IVBA result for various test materials. As shown, the phosphate addition tended to increase IVBA, sometimes quite substantially. However, in other cases, there was little effect.

Addition of hydroxylamine Hydroxylamine (HA) has been used to extract trace metals that are adsorbed to the surface of iron (Fe) or manganese (Mn) oxide particles in soil (Chao and Zhou, 1983; Shuman, 1982; Tessier et al., 1979). For soils where As is present mainly due to surface adsorption to Fe or Mn in soil particles, dissolution of the surface layer of Fe and Mn minerals by hydroxylamine may tend to liberate (solubilize) the As and increase IVBA. The results of adding 0.25 *M* hydroxylamine are shown in Figure 5. At pH 1.5 (Figure 5A), hydroxylamine tended to

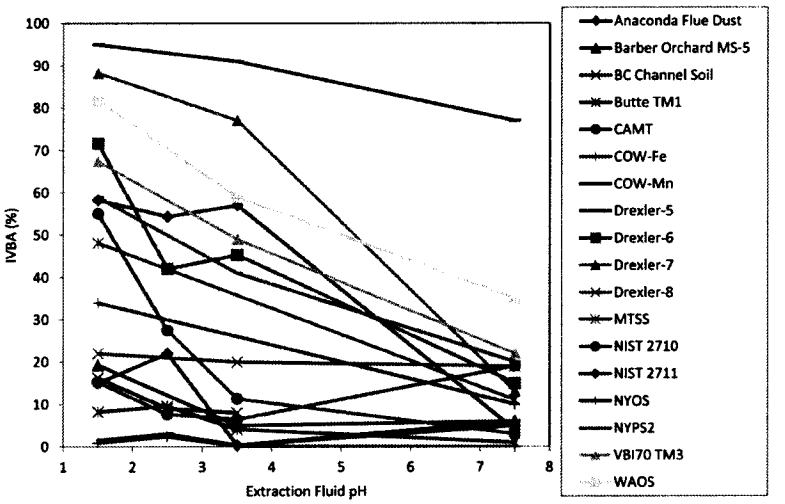

FIGURE 1. Effect of extraction fluid pH on arsenic IVBA. The IVBA of 18 different test soils was measured at pH 1.5, 2.5, 5.0, or 7.0. In most cases, the highest IVBA occurred at pH 1.5, with a general tendency for decreasing IVBA as pH increased (color figure available online).

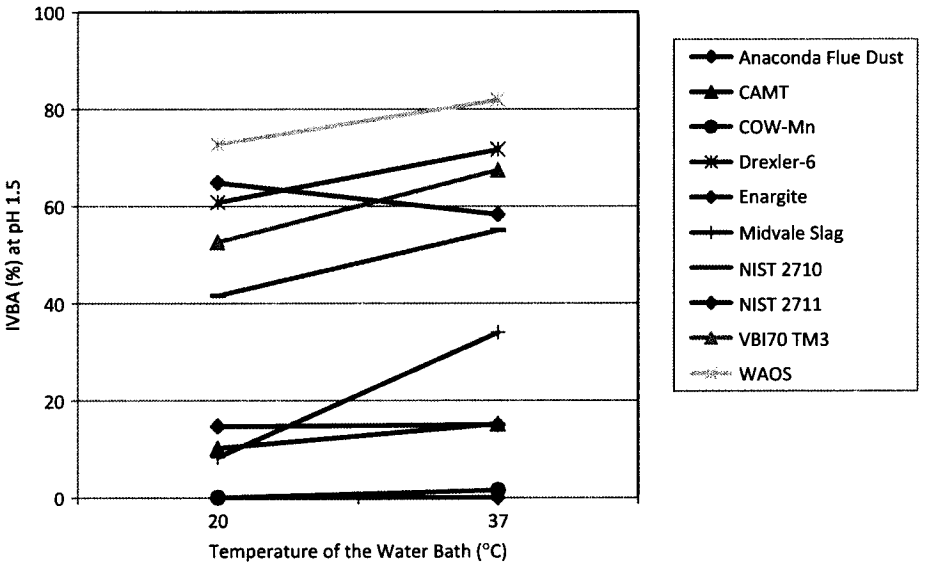

FIGURE 2. Effect of extraction temperature on arsenic IVBA. The IVBA of 10 different test soils was measured at pH 1.5 at extraction temperatures of 20°C or 37°C. In most cases, the highest IVBA occurred at 37°C, although the effect was minor for some soils (color figure available online).

elevate IVBA slightly (an average of 5%), with relatively little variation between test materials. At pH 7 (Figure 5B), the average effect was similar (an average elevation of approximately 6%), although results were more variable, with two samples showing an apparent decrease.

Other variables Several other extraction fluid variables were also investigated, including buffer strength (0.1 *M* to 0.4 *M* glycine), redox potential (modified by addition of 0.25 *M* sodium hypochlorite to create oxidizing conditions or 0.25 *M* hydroxylamine to create reducing conditions), and the mass of test material (0.2 to 1.4 g/100 ml) used in the assay. None of these variables produced marked variation in IVBA (data not shown).

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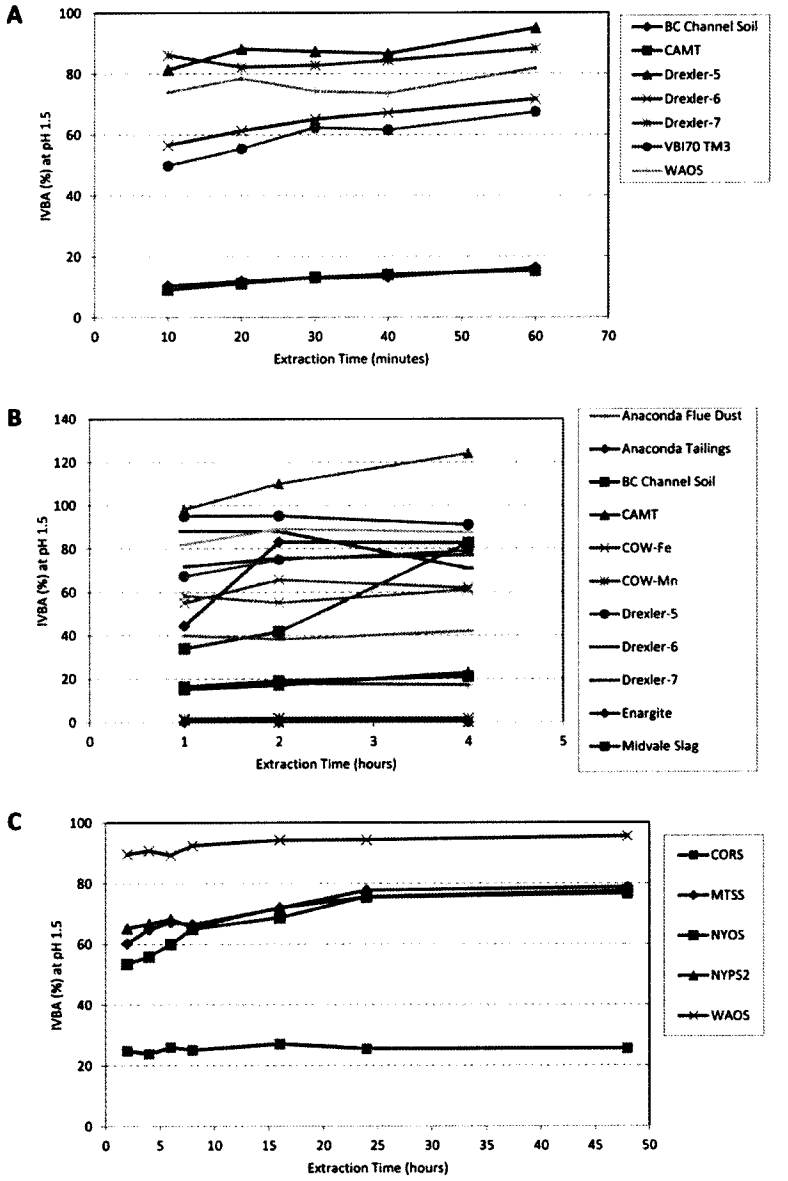

FIGURE 3. Effect of extraction time on arsenic IVBA. The IVBA of test soils was measured as a function of time over time scales of 10–60 min (A), 1–4 h (B), or 1–48 h (C). In most cases, a majority of the total arsenic solubilization occurred rapidly (within 10–30 min), although some test materials yielded results that tended to increase slowly after the initial solubilization phase (color figure available online).

Identification of influential variables The objective of step 1 was to identify up to three variables in the IVBA extraction protocol that exerted the largest effect on the IVBA of As in a variety of test soil. The results indicated that pH was clearly the most important variable tested, with phosphate and hydroxylamine affecting the results in some but not all materials. Thus, these three variables were retained for further testing. Although temperature exerted significant effects on many IVBA values, this variable was not selected for further testing because retention of 4 independent variables would have resulted in too complex a subsequent study design, and because extraction at 37°C is appropriate for simulating in vivo conditions

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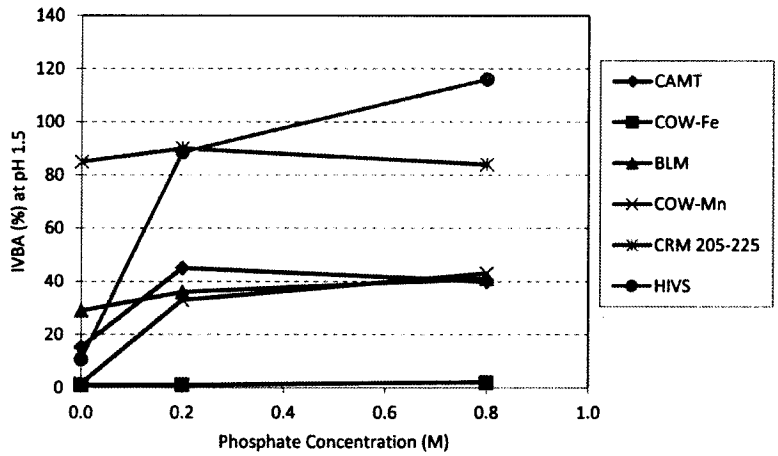

FIGURE 4. Effect of phosphate addition on arsenic IVBA. The IVBA of 6 different test soils was measured at pH 1.5 with varying levels of added phosphate (0, 0.2 *M* or 0.8 *M*). In most cases, phosphate addition tended to increase IVBA, sometimes quite substantially. However, in other cases, there was almost no effect (color figure available online).

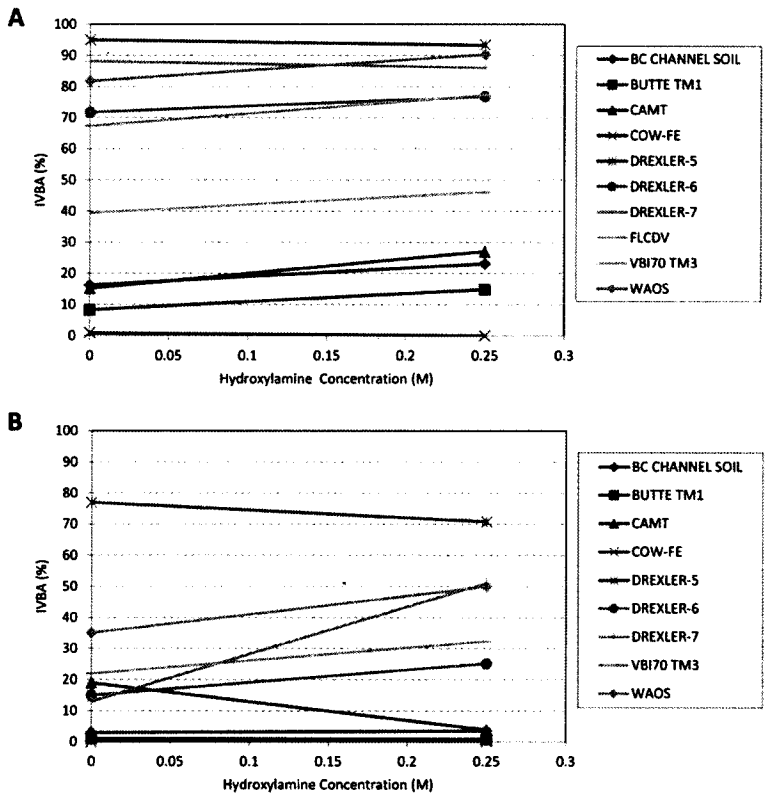

FIGURE 5. Effect of hydroxylamine addition on arsenic IVBA. The IVBA of 9–10 different test soils was measured in the absence or presence of 0.25 *M* hydroxylamine. At pH 1.5 (A), hydroxylamine tended to increase IVBA slightly (an average of 5%), with relatively little variation between test materials. At pH 7.0 (B), the average effect was similar (an average increase of about 6%), although results were more variable (color figure available online).

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within the human GI tract. Extraction time, buffer strength, redox potential, and fluid-to-solid ratio exerted little effect and were not investigated further.

Step 2: Initial IVIVC Evaluation

Based on the three influential extraction variables identified in step 1 (pH, phosphate, hydroxlyamine), 21 different combinations of extraction conditions with differing pH and hydroxlyamine and phosphate concentrations were selected for initial assessment of IVIVC. These different extraction conditions were evaluated using an initial set of 12 test materials with reliable RBA values (6 measured in monkeys and 6 measured in swine). The IVBA results for each soil for each extraction condition are presented in Table 2, and the IVIVC results are shown in Table 3. As indicated by the shaded cells, a number of different extraction conditions yielded IVIVC results with R^2 values above .7, indicating a potentially useful correlation. For swine, the best correlation was obtained at pH 1.5, and addition of phosphate and hydroxylamine decreased the strength of the correlation. For monkeys and the combined data set, correlations tended to be best at pH 5 or 7, and addition of phosphate and hydroxylamine usually tended to improve the correlation slightly. However, because the number of samples used to fit the model at this step is small, it is not appropriate to draw firm conclusions regarding the strength of the correlation from this limited evaluation.

Step 3: Final IVIVC Evaluation

Based on the results of step 2, the following three IVBA extraction conditions were selected for further evaluation using a set of 39 test soils:

- pH 1.5, without phosphate or hydroxylamine additions.
- pH 7, without phosphate or hydroxylamine additions.
- pH 7, with 0.05 *M* phosphate and hydroxylamine additions (either 0.1 *M* or 0.25 *M*).

The IVBA results for each soil for each extraction condition are presented in Table 4, and the IVIVC results are shown in Table 5. For RBA values measured in swine, the best correlation (R^2 = .72) was obtained using pH 1.5 extraction fluid (no additions), while for RBA values measured in monkeys, the best correlation (R^2 = .76) was achieved using pH 7 extraction fluid containing 0.05 *M* phosphate and hydroxylamine (either 0.1 *M* or 0.25 *M*). However, no extraction condition tested yield a good correlation when the swine and monkey data sets were combined. Figure 6 plots the relation between RBA and IVBA for the best extraction conditions for swine (Figure 6A) or monkeys (Figure 6B). The solid lines represent the model fit, and the dashed lines represent the 90% prediction interval. In these regression analyses, IVBA is the independent variable (depicted on the *x* axis), since the purpose of the regression model is to predict RBA given a measured IVBA value.

Step 4: Evaluation of Precision

In order to evaluate the reliability and reproducibility of the laboratory protocols for obtaining IVBA measurements, a set of 12 test soils was provided to each of 4 labs along with a detailed standard operating procedure for performing IVBA extractions. The participating labs were (1) University of Colorado at Boulder (UCB), (2) ACZ Laboratories, Inc. (ACZ), (3) U.S. EPA Region 7 Regional Laboratory (R7), and (4) U.S. EPA Region 8 Regional Laboratory (R8). Each lab extracted each test soil using two different extraction fluids, as follows:

- pH 1.5, without phosphate or hydroxylamine additions.
- pH 7, with 0.05 *M* phosphate .

These fluids were selected because these are the fluids that yield the best IVIVC in swine and monkeys, respectively. Based on the results shown in Table 2, it was concluded that addition of hydroxylamine in the presence of phosphate at pH 7 had little effect, so hydroxylamine was not included in the pH 7 fluid.

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TABLE 2. In Vitro Bioaccessibility Results for Initial In Vivo–In Vitro Correlations

	As IVBA (%)																						
pH	1.5							5.0							7.0								
PO_4 (*M*)	None	0.05		0.2		0.8		None	0.05		0.2		0.8		None	0.05		0.2		0.8			
HA (*M*)	None	0.1	0.25	0.1	0.25	0.1	0.25	None	0.1	0.25	0.1	0.25	0.1	0.25	None	0.1	0.25	0.1	0.25	0.1	0.25	RBA (%)	Species
CAMT	15.3	45.0	51.2	74.9	74.5	98.9	91.9	3.0	11.2	11.9	14.8	13.5	23.3	22.7	18.8	6.9	8.1	9.7	11.3	16.1	17.7	19.0	Monkey
COSS	7.7	11.8	12.0	14.5	13.8	16.6	16.9	1.0	2.1	2.3	2.5	2.3	4.1	4.0	1.0	1.6	1.8	2.1	2.2	3.9	3.5	5.0	Monkey
NYOS	33.7	81.8	79.7	96.5	93.7	104.3	101.3	9.0	18.8	20.8	26.3	27.0	51.2	55.0	10.4	15.3	16.3	22.9	25.3	44.6	42.5	15.0	Monkey
NYPS3	32.8	71.5	72.0	94.9	89.2	104.1	96.4	4.0	23.0	24.3	30.3	31.0	49.5	48.5	4.0	13.8	16.5	22.6	25.3	36.9	38.7	20.0	Monkey
WAOS	81.2	104.2	97.5	105.1	109.9	113.6	103.1	28.0	4.3	4.6	7.4	7.0	14.8	15.3	34.1	3.1	4.8	6.3	7.8	77.4	71.9	24.0	Monkey
St. Pete's	106.0	108.0	103.0	104.0	103.0	108.0	104.0	98.0	108.0	105.0	107.0	104.0	111.0	110.0	100.0	104.0	110.0	104.0	102.0	115.0	11.0	93.0	Monkey
BC Channel Soil	16.4	34.1	32.4	38.4	38.7	45.9	45.9	3.0	6.6	6.6	8.8	9.4	15.1	15.0	3.3	4.6	6.0	6.0	6.7	13.3	12.9	39.3	Swine
NIST 2710A	42.2	82.3	81.8	86.9	85.6	86.2	87.3	1.0	16.3	17.5	20.1	19.9	36.7	38.7	1.9	13.3	14.8	18.2	20.0	34.7	36.2	42.0	Swine
VBI70 TM1[a]	40.3	84.8	86.2	88.0	91.9	91.1	87.5	31.0	40.7	41.9	47.1	51.0	60.6	63.5	30.3	35.4	36.4	41.9	45.6	57.2	56.6	40.3	Swine
VBI70 TM3[a]	36.7	94.5	92.0	96.0	94.2	93.5	94.2	27.0	40.1	43.3	46.8	50.0	71.7	67.6	22.1	32.8	36.1	41.1	45.7	63.9	65.7	36.7	Swine
Butte TM1	8.6	30.8	32.7	39.6	39.9	49.0	49.0	0.0	4.3	4.5	5.9	6.0	11.4	10.8	0.6	3.2	3.3	4.2	4.6	9.0	9.0	17.7	Swine
Drexler-5	95.0	102.5	98.2	97.7	98.8	95.9	89.3	73.0	89.3	97.2	94.7	89.6	98.9	94.2	76.9	91.9	87.0	89.0	94.6	96.5	94.6	100.0	Swine

[a]Soil samples from the VBI70 site displayed unusual IVBA behavior. In most cases, IVBA values are reproducible and stable when measured repeatedly over time. However, IVBA values measured at pH 1.5 for VBI70 samples have tended to increase over time. The cause of this increase is not known. Because the RBA value was measured at the same time as the original pH 1.5 IVBA measurements, these original pH 1.5 IVBA values are retained as the most appropriate match to the RBA values.

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TABLE 3. Initial In Vivo–In Vitro Correlation Results

	pH	1.5							5.0							7.0						
	PO_4 (*M*)	None	0.05		0.2		0.8		None	0.05		0.2		0.8		None	0.05		0.2		0.8	
Data set	HA (*M*)	None	0.1	0.25	0.1	0.25	0.1	0.25	None	0.1	0.25	0.1	0.25	0.1	0.25	None	0.1	0.25	0.1	0.25	0.1	0.25
Swine,	Slope	0.88	0.57	0.55	0.56	0.57	0.66	0.58	0.87	0.78	0.72	0.74	0.73	0.64	0.66	0.87	0.78	0.82	0.78	0.73	0.68	0.68
$n = 6$	Intercept	10.9	5.5	6.9	4.4	3.6	−4.6	1.9	26.3	20.2	20.5	18.6	18.4	14.5	13.9	26.5	22.5	20.9	19.9	19.6	14.7	14.8
	R^2	0.91	0.40	0.35	0.31	0.32	0.30	0.21	0.78	0.80	0.81	0.78	0.71	0.62	0.60	0.83	0.85	0.83	0.79	0.78	0.67	0.64
Monkeys,	Slope	0.68	0.55	0.60	0.44	0.44	0.35	0.41	0.83	0.77	0.80	0.79	0.81	0.73	0.73	0.84	0.79	0.75	0.81	0.83	0.67	−0.29
$n = 6$	Intercept	−2.2	−9.5	−12.3	−6.9	−6.2	−2.7	−5.7	9.6	7.8	6.9	4.4	4.4	−1.7	−1.6	5.9	10.4	9.6	6.8	5.3	−3.5	38.2
	R^2	0.70	0.41	0.40	0.23	0.23	0.17	0.19	0.96	0.94	0.94	0.92	0.91	0.79	0.77	0.95	0.95	0.96	0.94	0.93	0.75	0.05
Combined,	Slope	0.73	0.56	0.59	0.45	0.46	0.34	0.38	0.84	0.79	0.78	0.79	0.80	0.71	0.72	0.82	0.80	0.79	0.81	0.80	0.66	0.38
$n = 12$	Intercept	6.5	−2.3	−3.3	2.9	2.2	8.9	6.7	18.2	13.6	12.9	10.7	10.4	5.2	5.1	17.0	16.0	15.2	12.7	11.5	6.3	23.2
	R^2	0.66	0.37	0.36	0.20	0.21	0.12	0.13	0.79	0.84	0.85	0.83	0.80	0.69	0.67	0.77	0.87	0.86	0.84	0.84	0.63	0.14

Note. R^2 values greater than 0.7 are shaded in gray.

TABLE 4. Expanded Relative Bioavailability and In Vitro Bioaccessibility Calibration Data Set

Animal species	Test material	RBA (%)	IVBA (%) pH 1.5 (no additions)	pH 7 (no additions)	pH 7 + PO_4 + HA
Swine	Drexler-5	100.0	96.0	76.9	89.4
(n = 20)	Aberjona River TM1	38.1	13.0	1.0	7.0
	Aberjona River TM2	52.4	32.5	3.0	14.0
	Barber Orchard MS-1	31.0	21.0	4.3	10.0
	Barber Orchard MS-4	40.8	18.6	10.4	10.0
	Barber Orchard MS-5	48.7	19.4	6.5	11.0
	Barber Orchard MS-8	52.8	30.6	6.0	10.0
	Butte TM1	17.8	8.8	0.6	3.3
	Butte TM2	23.6	6.0	2.0	4.0
	Clark Fork Tailings	50.7	50.4	5.0	9.0
	Iron King TM1	60.2	78.0	1.0	14.0
	Iron King TM2	18.6	11.0	1.0	1.0
	NIST 2710	44.1	55.1	5.8	14.0
	NIST 2710A	41.8	42.2	1.9	14.1
	VBI70 TM1[a]	40.3	41.8	30.3	35.9
	VBI70 TM2[a]	42.2	33.2	33.9	42.0
	VBI70 TM3[a]	36.7	40.3	22.1	34.5
	VBI70 TM4[a]	23.8	22.0	32.1	43.0
	VBI70 TM5[a]	21.2	18.7	32.0	43.0
	VBI70 TM6[a]	23.5	18.6	48.0	54.0
Monkeys	Barber Orchard MS-1	33.0	21.0	4.3	10.0
(n = 17–19)	Barber Orchard MS-4	28.0	18.6	10.4	10.0
	Barber Orchard MS-5	38.0	19.4	6.5	11.0
	Barber Orchard MS-8	25.0	30.6	6.0	10.0
	CAMT	19.0	15.7	18.8	7.5
	CORS	17.0	38.0	—[b]	—[b]
	COSCS	18.0	76.0	22.3	17.0
	COSS	5.0	8.5	1.0	1.7
	FLCDV	31.0	39.7	9.0	16.0
	FLCPS	7.0	5.7	1.0	2.0
	HIVS	5.0	10.4	1.0	6.0
	MTSS	13.0	49.8	10.6	14.0
	NYOS	15.0	34.1	10.4	15.8
	NYPS1	20.0	48.2	3.0	7.0
	NYPS2	19.0	58.3	19.9	35.0
	NYPS3	28.0	32.8	4.0	15.1
	WAOS	24.0	81.0	34.1	3.9
	WISS	13.0	48.3	—[b]	—[b]
	St. Pete's	93.0	106.0	100.0	107.0

[a]Soil samples from the VBI70 site displayed unusual IVBA behavior. In most cases, IVBA values are reproducible and stable when measured repeatedly over time. However, IVBA values measured at pH 1.5 for VBI70 samples have tended to increase over time. The cause of this increase is not known. Because the RBA value was measured at the same time as the original pH 1.5 IVBA measurements, these original pH 1.5 IVBA values are retained as the most appropriate match to the RBA values.

[b]Insufficient material was available to perform IVBA measurements under all conditions.

Each lab analyzed each soil in triplicate with each extraction fluid. Within-lab precision was evaluated by examining the magnitude of the standard deviation for each set of three replicate values. Results are presented in Table 6. Within-lab precision (panel A) was typically less than 3%, with an average of 0.7% for all 4 labs. Between-lab precision (panel B) was evaluated by examining the standard deviations in the mean IVBA values for each test soil for each extraction fluid condition. For most test soils, between-lab variation in mean values was less than 5%, with an overall average of 1.7%.

Quality control samples for all labs were within the acceptance limits identified for the project, with all blank concentrations <5 μg/L and all As spike recoveries within 98–108%.

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TABLE 5. Linear Regression Parameters

Data set	Fitting parameter	IVBA extraction fluid		
		pH 1.5 (no additions)	pH 7 (no additions)	pH 7 + PO_4 + HAH
Swine	Slope	0.62	0.31	0.35
(n = 20)	Intercept	19.68	35.45	32.55
	R^2	0.723	0.143	0.178
Monkeys	Slope	0.32	0.43	0.58
(n = 17–19)	Intercept	11.07	17.10	14.26
	R^2	0.336	0.706	0.755
Combined	Slope	0.44	0.33	0.44
(n = 37–39)	Intercept	16.42	27.61	23.90
	R^2	0.345	0.328	0.409

Note. Best fit model is shaded in gray.

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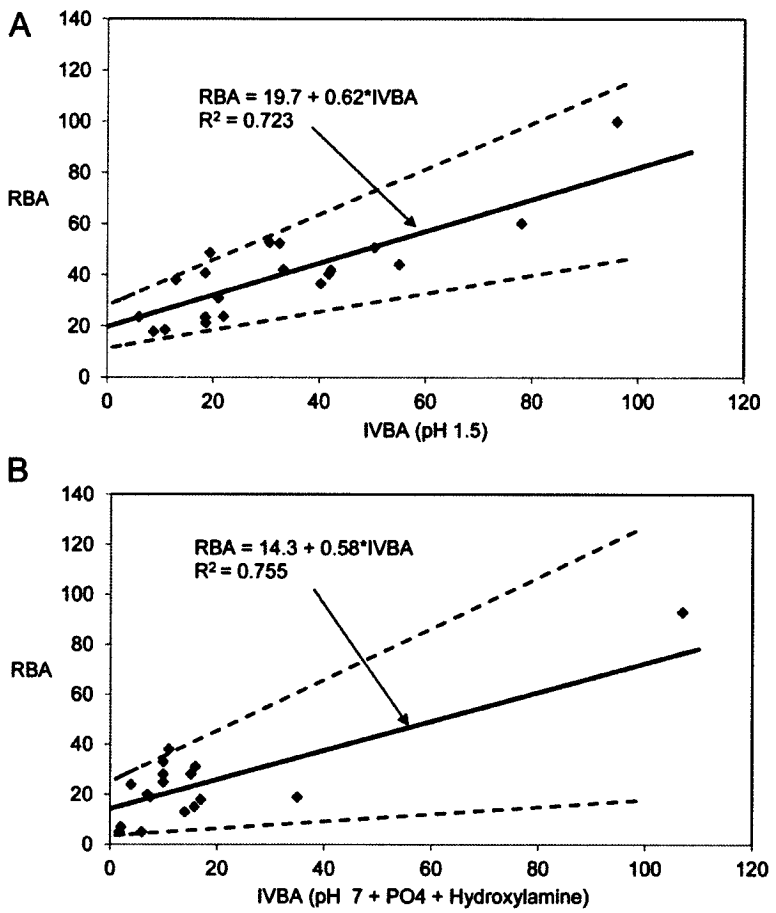

FIGURE 6. Best fit MLE linear regression models. Linear regression models (indicated by the solid lines) were fit to available RBA-IVBA data for swine (A, n = 20) or monkey (B, n = 17) by the method of maximum likelihood estimation. For swine, the IVBA data were obtained at pH 1.5, and for monkeys, the IVBA measured at pH 7 in the presence of phosphate (0.5 *M*) and hydroxylamine (either 0.1 *M* or 0.25 *M*). The dashed lines in each graph indicate the 90% predication interval.

TABLE 6. Within- and Between-Laboratory Precision

A, Within-laboratory precision[a]: Test material		pH 1.5 (no additions)				pH 7 + 0.05 *M* PO_4			
		UCB	ACZ	R7	R8	UCB	ACZ	R7	R8
1	WAOS	4.7	2.8	1.1	0.9	0.1	0.0	0.6	0.1
2	VBI70 TM1	5.9	0.5	2.4	1.5	0.3	0.6	1.0	0.8
3	NYPS2	0.7	0.6	1.7	1.8	0.2	0.3	1.3	0.3
4	COSS	0.0	0.1	0.3	0.2	0.0	0.1	0.0	0.1
5	MTSS	0.6	0.3	2.7	0.4	0.3	1.2	1.1	0.2
6	CAMT	0.4	0.1	1.6	0.1	0.1	0.3	0.8	0.2
7	NYOS	0.1	0.4	0.6	0.9	0.3	0.5	0.4	0.4
8	Barber Orchard MS-5	0.4	0.0	0.2	0.2	0.6	0.2	0.4	0.2
9	BC Channel Soil	0.5	0.6	0.6	0.8	0.2	0.1	0.0	0.1
10	Butte TM1	0.3	0.1	0.3	0.4	0.1	0.2	0.1	0.0
11	VBI70 TM3	3.0	1.0	0.4	1.0	0.3	1.3	0.6	0.5
12	NYPS3	0.8	0.6	0.3	1.0	0.3	1.6	0.4	0.4
	Mean	1.5	0.6	1.0	0.8	0.2	0.5	0.6	0.3

B, Between-laboratory precision: Test material		pH 1.5 (no additions)		pH 7 + 0.05 *M* PO_4	
		Mean[b]	SD[c]	Mean[b]	SD[c]
1	WAOS	79.9	4.2	2.8	0.3
2	VBI70 TM1	70.0	3.0	27.1	2.1
3	NYPS2	44.1	5.8	14.8	0.6
4	COSS	7.9	0.6	1.5	0.1
5	MTSS	47.9	1.2	11.4	1.2
6	CAMT	15.8	2.6	4.5	0.3
7	NYOS	32.5	4.2	10.5	1.0
8	Barber Orchard MS-5	16.9	0.7	8.7	1.0
9	BC Channel Soil	16.2	1.8	3.5	0.5
10	Butte TM1	8.2	1.4	2.5	0.2
11	VBI70 TM3	67.3	4.4	25.8	2.4
12	NYPS3	33.1	1.3	16.9	1.0

[a]Values shown are standard deviations of three replicate measurements (%).
[b]Values shown are mean (%) of means across four laboratories.
[c]Values shown are standard deviation of means (%) across four laboratories.

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DISCUSSION

Recommended Model

Based on the data that are presently available, it appears that no single statistical model (that is, the same equation with the same parameters) provides a good fit to both the monkey and swine RBA values. This suggests that the RBA measurements in swine and monkeys are not equivalent. If so, these differences may be related to differences in the bioassay protocols (e.g., dosing regimen) and/or differences in GI physiology/biochemistry that determine As absorption in the two animal species.

If future data collection efforts confirm the conclusion that the monkey and swine bioassays do not yield equivalent RBA values for the same test materials, risk assessors will need to determine which animal species is a more useful predictor of RBA in humans, and use the mathematical model based on data from that species. At present, an empirical basis for determining which bioassay best predicts bioavailability of As in humans does not exist, since this would require measuring As RBA in human subjects. If new data ultimately lead to the conclusion that the apparent differences between the species are not important, then using a model that combines data sets is likely to be the best approach.

Until it is clear whether RBA values measured in swine and monkeys are similar or dissimilar, it is recommended that the statistical models based on the swine data be used as the preferred method for estimating site-specific RBA values:

$$RBA = 19.7 + 0.62 \times IVBA_{pH\,1.5}$$

This model is preferred because the data set based on measurements in swine spans a wider range of RBA values than the data set based on monkeys, has a narrower prediction interval than the monkey model, and is much less dependent on the influence of the sodium arsenate-spiked sample than the model based on monkey data.

Advantages of IVBA Methods Compared to In Vivo Methods

The approach for estimating RBA of As in test soils described in this study has a number of advantages over direct measurement in animal models, including low cost and rapid throughput. This allows for the application of the method at smaller sites where an expensive and time-consuming animal study may not be feasible, as well as the ability to evaluate a much larger set of samples from a given site to obtain a more complete understanding of within-site variability in RBA. The extraction fluids and extraction conditions are simple and the method yields highly reproducible outcomes from which in vivo RBA can be estimated with sufficient confidence to be useful for risk assessment applications.

Comparison of This Method to Other In Vitro Methods

A number of other researchers have described in vitro systems for measuring the extractability of As from soil or other soil-like materials (Basta et al., 2007; Bruce et al., 2007; Denys et al., 2012; Ellickson et al., 2001; Juhasz et al., 2007, 2009; Makris et al., 2008; Medlin 1997; Oomen et al., 2002; Rodriguez et al., 1999; Ruby et al., 1996; Wragg et al., 2011). These methods differ from each other with regard to attributes such as (a) complexity of the extraction protocol (one step or two steps); (b) complexity of the extraction fluid(s); (c) whether or not an IVIVC has been performed and if so, (d) number and diversity of samples used in the IVIVC; and (e) strength of the correlation. The principal advantages of the method described here compared to other published methods include the following:

- The current method utilizes a larger set of calibration samples (n = 20 for swine and n = 17–19 for monkeys) to establish the regression model between IVBA and RBA than most other studies. As illustrated by comparison of the apparent high correlation obtained in our preliminary studies based on a limited calibration set (Table 3) to our final correlation based on the expanded data set (Figure 6), IVIVC correlations based on a small number of samples may be misleading.
- The data set used for IVIVC is relatively diverse, with samples from multiple types of sites that contain a range of different As forms and yield a relatively wide range of RBA values. This diversity increases the confidence that the correlation is likely to be applicable across a wide range of test materials. Other studies typically do not have soils that are so diverse.
- The current method is based on a more extensive and systematic testing of extraction conditions to identify the optimal conditions than most other published methods.
- The current IVBA method has undergone interlab testing to establish within- and between-lab precision. The results of the interlab testing indicate the method yields IVBA measurements that are highly reproducible.
- The current method utilizes a single extraction step. This is in contrast to methods that utilize two or more sequential extraction steps, with each intended to represent differing parts of the GI system.
- The current method utilizes simple extraction fluids. This is in contrast to methods that seek to create extraction fluids that closely mimic complex GI fluids, including the presence of a number of biochemical constituents such as enzymes and metabolites.

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TABLE 7. Comparison of Methods with IVIVCs

	IVBA			IVIVC			
Reference	Extraction fluid(s)	Stomach pH	Intestinal pH	Samples (Species)	RBA Range	IVIVC	Notes
Rodriguez et al. (1999)	Physiological	1.8	5.5	15 (Swine)	4-55	RBA=0.88*IVBA – 2.02, R^2 = 0.69 (a)	Stomach phase
Makris et al. (2008)	Physiological	1.0	—	5 (Mouse)	18-99	RBA=0.452*IVBA+10.04, R^2 = 0.295	Optimization for worst case
Ruby et al. (1996)	Physiological	2.5	7	3 (Rabbit, monkey)	34-50	RBA=0.857*IVBA+4.3, R^2 = 0.008	
Medlin (1997)	Physiological	1.5	6.5	6 (Swine)	8-60	RBA= 0.72*IVBA+ 19.2, R^2 = 0.43 (a)	
Juhasz et al. (2007)	Glycine	1.5	—	12 (Swine)	7-75	RBA=0.68*IVBA + 5.67, R^2=.69 (b)	
Wragg et al. (2011)	Physiological	1.2	6.3	11 (Swine)	4-52	RBA=1.26*IVBA + 8.6, R^2 =0.75	
Denys et al. (2012)	Physiological	1.2	6.3	14 (Swine)	3-100	RBA=1.12*IVBA-2.2, R^2=0.91 (b)	Based on RBA in urine,
Bradham et al. (2011)	Glycine	1.5	—	10 (Mouse)	10-55	RBA = 0.72*IVBA +5.6, R^2 = 0.92	IVBA = stomach phase
This report	Glycine	1.5	—	20 (Swine)	18-100	RBA = 0.62*IVBA + 19.7, R^2 = 0.72	

a. Parameters shown are based on a recalculation using updated RBA values that were not available at the time of the original publication.
b. Calculated using ordinary least squares regression using data provided in the publication.

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Table 7 summarizes the attributes of the method described here in comparison to a number of other methods for which IVIVC relations have been described. As indicated, although all of the published methods have some advantages, no other method includes all of the attributes already discussed.

Influence of Sodium Arsenate-Spiked Samples

The best-fit regression models for swine and monkeys are both influenced by the inclusion of sodium arsenate spiked soil (Drexler-5 for swine and St. Pete's for monkeys). The effect of excluding these soils is to decrease the strength of the correlation. For the swine data set, the R^2 value changes from .723 to .532 with exclusion of the Drexler-5 sample, while for the monkey data set the R^2 value decreases from .755 to .057 with exclusion of the St. Pete's sample. This marked effect in the monkey data set occurs because data for all but one of the test materials evaluated in monkeys (NYPS 2) have IVBA values clustered at the low end of the range (IVBA = 0–20%). This makes it difficult to fit a reliable model without additional data points that fall outside of this narrow data range. Although the inclusion of these data points may tend to overestimate the reliability of the models, the data from these two samples are considered to be appropriate for inclusion because they represent reasonable and expected outcomes for highly bioaccessible As, and the recommended models are based on the data fits with these samples included.

RBA Predictions at Low IVBA

One feature of the linear IVBA-based modeling approach described here is that the model intercept term (obtained when IVBA = 0) is 20% (swine) or 14% (monkeys) (see Figure 6). If the physical form of As in a sample has low solubility, it is possible that the RBA for that sample might be lower than the model intercept terms. Collection of additional data pairs in the low RBA/IVBA range might lead to refined models in which the intercept term is lower.

Use of Speciation Data

Although the best-fit models described in the preceding sections are able to provide a good prediction of RBA based on IVBA data alone, additional modeling was performed to investigate whether inclusion of As mineralogy data along with the IVBA data would provide an improvement in model accuracy. The basic model was:

$$RBA = k \cdot IVBA_{\text{best}} + \sum f_i \cdot RBA_i$$

where k is the empiric fitting constant, $IVBA_{best}$ is IVBA measured at pH 1.5 (no additions) for swine or at pH 7 (with phosphate and hydroxylamine) for monkeys, f_i is the fraction of sample in phase i, and RBA_i is the phase-specific RBA (estimated by fitting)

The concept is that each unique mineralogical type of As ("phase") has an inherent phase-specific RBA, and that RBA of a soil sample containing a mixture of As phases reflects the amount-weighted average of the phase-specific RBA values. The model utilizes both the measured best IVBA value (pH 1.5 for swine, pH 7 with phosphate and hydroxylamine for monkeys) with the measured phase data to predict RBA. In total, 15 different mineral phases of As were observed in one or more samples included in the final data set of 39 samples.

The model was fitted to each data set (monkeys, swine) using MLE, assuming normal errors in RBA with a constant coefficient of variation. The quality of fit was evaluated using Akaike's information criterion (AIC), which considers both the absolute quality of the model fit to the data (as reflected in the log-likelihood value), and also the number of fitting parameters in the model. A model that included phase data was considered to be an improvement over the model that used IVBA data alone only if the R^2 value was higher and the AIC value was equal or lower. Fitting was performed in a series of steps, as follows:

1. Solve for 15 phase-specific RBA_i values using MLE.
2. Rank order the 15 RBA_i values (low to high).
3. Combine phases with similar RBA_i values into bins. Investigate a range of different binning strategies, ranging from 1 bin (all phases are assigned to the same bin) to 15 bins (each phase is assigned to a different bin).
4. Find the optimum number of bins based on minimization of AIC. In nearly all cases, the best fit was obtained by combining the 15 As phases into two or three bins.

In all cases, this approach yielded optimized models that were a substantial improvement over the models that were based on IVBA data alone. For the swine data set, the R^2 value increased from .723 to .906, and for the monkey data set, the R^2 value increased from .755 to .816. However, round-robin interlab testing of the speciation protocol (three labs, three test soils) indicated that there was poor agreement between labs (data not shown), and that the time and cost to obtain speciation data were prohibitive. Therefore, at this time, use of phase data as an input for quantitative RBA models cannot reliably be used to improve the predicted RBA. In the future, if the speciation protocol can be simplified so that it yields more reproducible data with less cost, then this strategy for model development may be worthy of reassessment.

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In Vivo Validation of the Unified BARGE Method to Assess the Bioaccessibility of Arsenic, Antimony, Cadmium, and Lead in Soils

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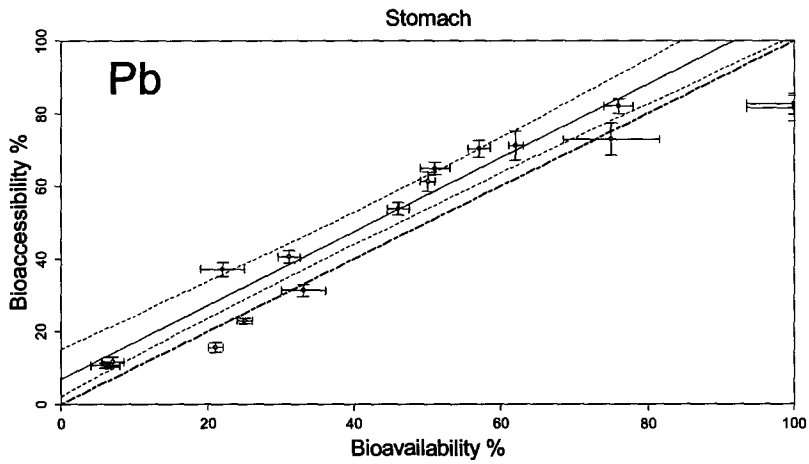
Supporting Information



ABSTRACT: The relative bioavailability of arsenic, antimony, cadmium, and lead for the ingestion pathway was measured in 16 soils contaminated by either smelting or mining activities using a juvenile swine model. The soils contained 18 to 25 000 mg kg^{-1} As, 18 to 60 000 mg kg^{-1} Sb, 20 to 184 mg kg^{-1} Cd, and 1460 to 40 214 mg kg^{-1} Pb. The bioavailability in the soils was measured in kidney, liver, bone, and urine relative to soluble salts of the four elements. The variety of soil types, the total concentrations of the elements, and the range of bioavailabilities found were considered to be suitable for calibrating the in vitro Unified BARGE bioaccessibility method. The bioaccessibility test has been developed by the BioAccessibility Research Group of Europe (BARGE) and is known as the Unified BARGE Method (UBM). The study looked at four end points from the in vivo measurements and two compartments in the in vitro study ("stomach" and "stomach and intestine"). Using benchmark criteria for assessing the "fitness for purpose" of the UBM bioaccessibility data to act as an analogue for bioavailability in risk assessment, the study shows that the UBM met criteria on repeatability (median relative standard deviation value <10%) and the regression statistics (slope 0.8 to 1.2 and r-square > 0.6) for As, Cd, and Pb. The data suggest a small bias in the UBM relative bioaccessibility of As and Pb compared to the relative bioavailability measurements of 3% and 5% respectively. Sb did not meet the criteria due to the small range of bioaccessibility values found in the samples.

INTRODUCTION

Soils contaminated by potentially harmful elements (PHE), such as cadmium (Cd) and lead (Pb) constitute a potential risk to human health.[1,2] Other important PHEs are the metalloids arsenic (As) and antimony (Sb). These elements are distributed through the environment as a result of both natural and anthropogenic activities such as mining or smelting.[3,4] Once released into the environment, soils often serve as a sink for these PHEs and the question of human exposure to such elements must then be addressed. Indeed, As and Sb were recognized as priority pollutants by the US-EPA in 1979 because of their contribution to cancer development, genotoxicity, and apoptosis in mammals.[5,6] Ingestion is one of the major routes of soil exposure to these contaminants by children.[7−9] Exposure is currently assessed using the total soil

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concentration of individual contaminants. However, several in vivo studies, using diverse animals such as monkeys, juvenile swine, rabbits, and rodents, have demonstrated that only a fraction of a contaminant, the bioavailable fraction, is absorbed following oral administration.[10−16] In the literature, the juvenile swine model is considered to be a good physiological model for gastrointestinal (GI) absorption of contaminants in children.[17] Recently, in the particular case of As, the swine model was described as being a particularly accurate representation of human physiology.[18] Bioavailability is defined as the fraction of an ingested dose that crosses the GI epithelium and becomes available for distribution to internal target tissues and organs.[19,20] Absolute bioavailability is directly determined in the blood plasma and consists in comparing the concentration in the plasma following an intravenous injection and an oral administration.[13,19−21] However, this method is not easily achievable due to both experimental issues linked to blood sampling and to analytical limitations such as the generally low concentrations in the blood compared to quantification limits.[22] Thus, in vivo protocols have been developed to estimate the relative bioavailability (RBA). This is measured as the uptake of the contaminant in the target organ from the soil matrix relative to the uptake from a readily soluble salt of the contaminant (reference matrix).[16,19,23] Several studies have established that either absolute or relative bioavailability of soil metals were below 1 and are dependent on soil edaphic properties (e.g., pH, granulometry) and the soil metal speciation.[10,15,16,20] Consequently, human exposure to soil bound contaminants can be overestimated when the bioavailability is not considered. The BioAccessibility Research Group of Europe (BARGE) [24] have developed an in vitro test, the Unified BARGE Method (UBM), to measure the bioaccessibility of soil contaminants. So far, a preliminary study [25] suggests that the UBM bioaccessibility data are correlated to in vivo bioavailability data. However, problems with the soils used in the study (they contained an unusually high content of mining slag) require that a more rigorous and robust validation of the UBM against in vivo data is essential before the UBM can be used as a routine tool in risk assessment. The aim of this study is to measure the relative bioavailability of As, Sb, Cd, and Pb in soil using a juvenile swine model, for 16 soils contaminated by either smelting or mining activities and to use the data from these soils to validate the UBM. So far, most other studies have focused on a single element and not on multicontaminated soil samples which are commonly found together on contaminated lands. Moreover, no study has been carried out on the human bioavailability of Sb.

The first part of this study is to measure the relative bioavailability (RBA) of As, Cd, Pb, and Sb from selected contaminated soils using a swine model. While this data gives some insight into the fraction of inorganic contaminants that is bioavailable, risk assessors need specific information about each site being studied. However, due to the high number of sites with soils contaminated with As, Cd, Pb, and/or Sb, it is not possible to determine the bioavailability in each case, as in vivo experiments are time-consuming, costly, and ethically problematic.[19] To address this, numerous in vitro protocols have been designed to simulate the human digestive processes using artificial digestive fluids to determine the bioaccessible fraction of contaminants, i.e., the fraction of the PHE content of the soil released into solution within the GI system which is then potentially available for absorption, and have been comprehensively reviewed.[26,27] The underlying hypothesis is that the bioaccessibility reflects the bioavailability of a soil contaminant and allows for a more accurate estimation of the exposure concentration compared to the total soil concentration of the contaminant. However, from one in vitro test to another, the bioaccessibility can greatly vary for the same soil sample.[28−31] Consequently, before such assays can act as a surrogate measurement for relative metals bioavailability, a correlation between in vitro bioaccessibility and in vivo bioavailability is necessary, for both regulatory and scientific acceptance. The objective of this research was to carry out a more robust validation study to demonstrate the physiological accuracy of the UBM for As, Cd, Pb, and Sb.

■ MATERIALS AND METHODS

Soil Collection Sample Preparation and Chemical Analysis. Full details of the soil collection, sample preparation, and chemical analysis of the soil and swine samples are given in the Supporting Information, SI.

Determination of in Vivo Relative Bioavailability. The RBA of As, Pb, Cd, and Sb were determined for each soil sample using readily soluble forms of the contaminants, sodium arsenate (NaH_2AsO_4), Pb-acetate ($(CH_3COO)_2Pb$), Cd-chloride ($CdCl_2$), and potassium antimonate ($KSbO_3$). These reference matrices were chosen to estimate the RBA as they had been used in previous RBA studies for As and Sb[14,21,32] and Pb and Cd.[11,33]

The RBA of all elements studied were determined in four end points: urine; bone (metacarpal IV); liver; and kidney. The number of swine is 15 for the reference groups and 9 for the soil groups, leading to a total of 204 swine. Full details of the methodology are given in the SI.

Dose Response Curve and RBA Calculation. For a given contaminant, each soil and reference matrix, a dose−response curve was established by plotting the concentration in the target end point as a function of the administered dose. Before calculating the RBA, three conditions needed to be verified:[34]

- That the response was linear for the soil and reference dose;
- That the intercepts for all of the lines were equal (i.e., had a common intercept);
- That the response at the zero level (called "blanks" i.e., the 3 g of moistened feed without any soil or reference dose; for details see the SI) was less than or equal to the common intercept value of the lines.

These assumptions were verified using SAS 9.1 (SAS Institute, Cary, NC, U.S.) using a standard methodology for animal bioavailability studies.[34]

For each linear response, the slope value and the standard deviation were determined for each value. The RBA was calculated as the ratio of the soil to the reference matrix slope values, when the difference between the two slope values was significant ($P < 0.05$).[34] In the case of a nonsignificant difference between the two slope values, the RBA was assumed to be 100%.

Unified BARGE Method. Bioaccessibility measurements were performed on five replicates of each soil and reference matrix (Na-arsenate, K-antimoniate, Pb-acetate and Cd-chloride) using the UBM. A full description of the method is given in the SI.

Bioaccessibility Calculation. The following equations are used to calculate bioaccessible concentration for the "stomach"

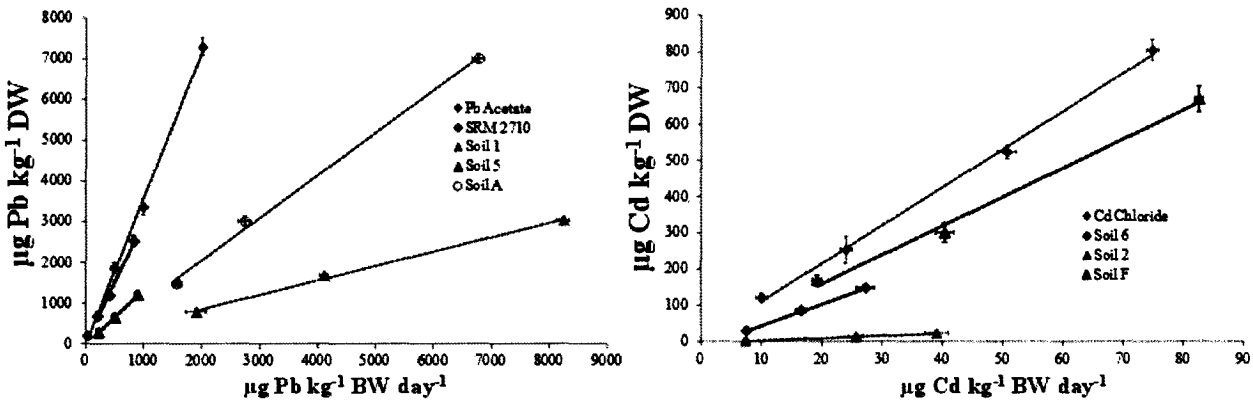

Figure 1. Examples of linear dose–response curves for Cd (kidney) and Pb (liver).

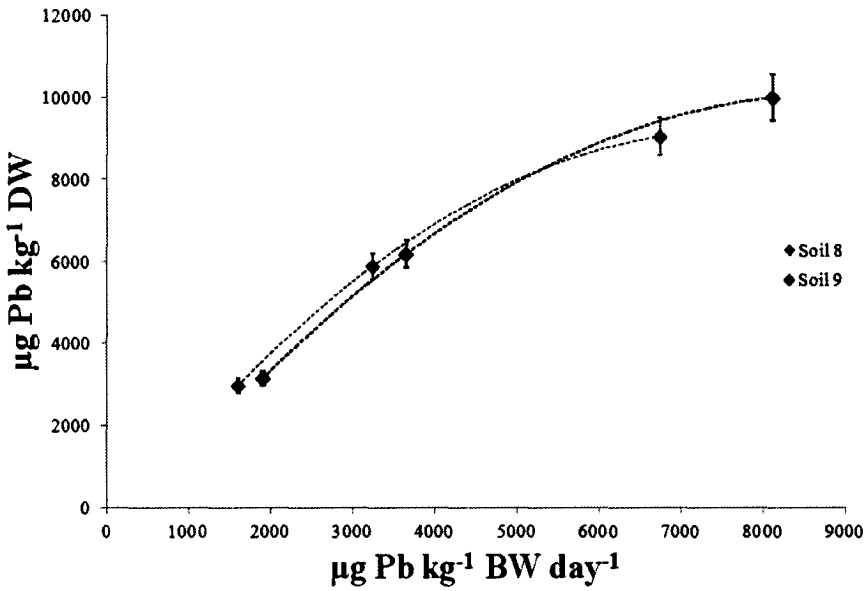

Figure 2. Nonlinear dose–response curve for Pb in liver.

and "stomach and intestine" phases and the bioaccessible fraction in the soil.

$$BA_{s\&int} = V_{s\&int} \times C_e \times d/m \quad (1)$$

$$BA_{s\&int} = V_{s\&int} \times C_e \times d/m \quad (2)$$

$$BAF_s = 100 \times BA_s/T_e \quad (3)$$

$$BAF_{s\&int} = 100 \times BA_{s\&int}/T_e \quad (4)$$

where:

BA_s = bioaccessible concentration for the "stomach" phase in the soil (mg kg^{-1})
$BA_{s\&int}$ = bioaccessible concentration for the "stomach and intestine" phase in the soil (mg kg^{-1})
V_s = volume of fluid used in the "stomach" phase extraction including any pH adjustments (mL)
$V_{s\&int}$ = volume of fluid used in the 'stomach and intestine' phase extraction including any pH adjustments (mL)
C_e = measured concentration of the contaminant e in the diluted extract solution (mg L^{-1})
d = dilution applied to the extract solution prior to analysis
m = mass of soil used in the extraction (g)
T_e = total concentration of the contaminant e in the soil (mg kg^{-1})
BAF_s = The "stomach" phase bioaccessible fraction (%)
$BAF_{s\&int}$ = The "stomach and intestine" phase bioaccessible fraction (%)

Statistical Analysis. The statistical analysis was carried out using the R programming language.[35] The regression analysis was carried out using Siegels's repeated medians method [36] as implemented in the "mblm" R statistical analysis package.[37]

■ RESULTS AND DISCUSSION

Animal Health over the Time Frame of the Experiment. During the 14 runs of the in vivo experiments, the animals exposed to As, Cd, Pb, and Sb contamination remained healthy, continued to consume their feed, grew normally, and none died. The mean BW of the swine at the beginning of experiment was 9.5 ± 1.2 kg (n = 168 swine) and, at the end 16.8 ± 1.5 kg (n = 168 swine). Moreover, there was no

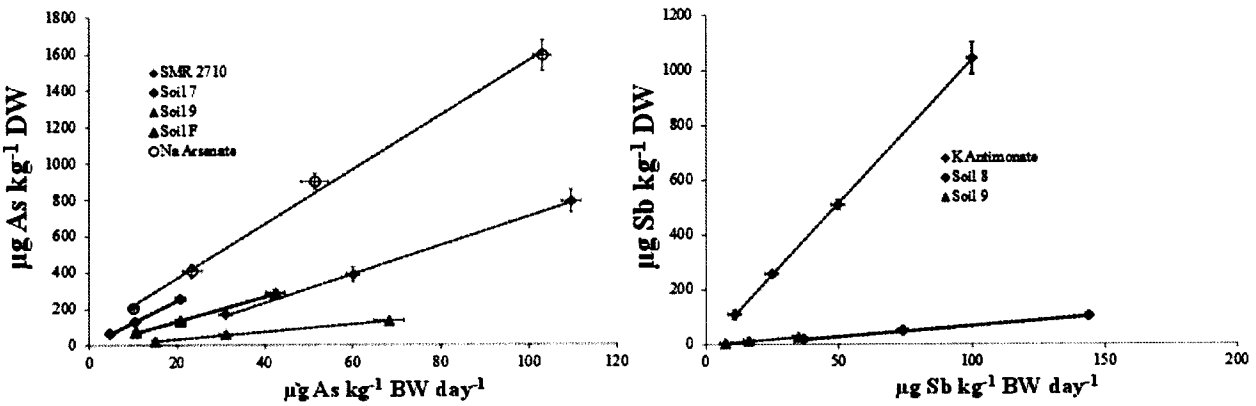

Figure 3. Examples of linear dose response curves for As and Sb in urine.

correlation between the several exposure doses for each contaminant and the final BW of each swine (r-square = 0.12, $p > 0.05$, $n = 168$). Similarly, for the different target end point (kidney, liver, and metacarpal IV), there was no impact of exposure doses on their final weight.

Dose–Response Curves. To ensure comparability between the dose response curves for the soluble salt and for the soils, the concentration of the soluble salt dose was designed to give a response which encompassed those obtained for each element in each soil for each end point (see Figures 1, 2, and 3).

Metals—Cd and Pb. The concentrations of Cd and Pb in the end points resulting from dosing with the reference matrix were all above quantification limits. For the soils, Pb concentrations were all above the quantification limits, whereas for Cd some concentrations were below. When the concentrations were measurable, the dose–response curves for both soils and reference matrix fitted to a linear model ($p < 0.05$) (example plots in Figure 1) except for soils 8 and 9 for the Pb response in the liver (Figure 2). A similar pattern in the dose–response curves (Figure 1) has been previously reported for both Pb and Cd.[11,16,33]

The repeatability of each response was also evaluated by calculating the relative standard deviation (RSD) $n = 3$ data for each end point. Where RSD is calculated as the mean value divided by the standard deviation expressed as a percentage) For Pb, the RSD values were the lowest for Pb-acetate (less than 1%) and the highest for soils F and G (around 20%). For Cd, the RSD values were lowest for Cd-chloride (less than 1%) and highest for soil 2 (around 30%)

Metalloids—As and Sb. Arsenic was quantified in each end point, giving linear models ($p < 0.05$). For Sb, however, apart from soils 1 and 2 with high total Sb content (Table S1 of the SI), dose response data could only be obtained for urine. The dose–response curve for this end point fitted a linear model ($p < 0.05$) (Figure 3). Example dose response curves for both As and Sb are given in Figure 3.

The repeatability of the response was also evaluated by calculating its RSD for each end point. For As, the lowest RSD value was obtained for the reference matrix (around 0.6%) and the highest value was obtained for the soil 7 (70%). For Sb, the lowest RSD was obtained for urine on the reference material (less than 1%). The soils ranged from 15% to 50%. This reflects the difficulty of obtaining reproducible values of Sb concentrations due to the combined effect of relatively low concentrations (apart from soils 1 and 2) and low bioavailability of this element.

Relative Bioavailability of Pb and Cd. The Cd and Pb RBA values and associated uncertainties are given in the SI (Table S4). Cd-RBA could not be calculated for soils 1, 4, 10, and A, C, E in any of the end points because the concentrations were below the quantification limits. The Pb-RBA could not be calculated in soils 8 and 9 from the liver results, as the dose–response curves for these end points were not linear. For soils E and F (kidney, bone and urine) and for soil D (bone and urine) there was no significant difference between the slopes obtained for the reference matrix and the contaminated soil for Pb. In these cases, the RBA was 100% meaning that Pb in these soils is as bioavailable as Pb-acetate for the purposes of oral exposure.

The RBA values were consistent among the end points (Table S2 of the SI) and were reproducible between the replicates. This confirms the robustness of the juvenile swine in vivo model to estimate the RBA of Pb and Cd in contaminated soils. The RBA values are within the range of other juvenile swine studies with the same soluble reference compounds.[11,15,16,33]

Both Pb and the Cd showed a similar range of RBA values with a good coverage of the % RBA range with minimum to maximum values of 6–100% RBA for Pb and minimum to maximum values of 9–89% RBA for Cd. This is a fundamental prerequisite to use these data in correlation studies.[22,38]

Relative Bioavailability of As and Sb. RBA values for As and Sb estimated from each end point and each soil samples are given in the SI (Table S3).

The RBA for As could not be calculated for any of the target compartments for soils 5, D and E and the RBA of Sb could not be calculated for soils 3, 5, D and E as the concentrations of the elements in the end points were below the quantification limits. This reflects a strong decrease of both As and Sb bioavailability compared to the reference matrix.

For Sb, the RBA could be calculated from kidney, liver, and bone only for soils 1 and 2, with the highest Sb content (Table S1). For these two soils, the RBA values of Sb were consistently low among the target end points, (<4%). For the other soils, the RBA was measured only in urine and did not exceed 11%. For As, the average minimum to maximum % RBA range was 3–74%.

The results obtained for Sb are critical for the overall objective of this study as a fundamental criterion of such a validation study is to have values of RBA evenly spread between

the minimum and maximum interval for the overall data set.[22,38] This is probably due to a particularly low overall bioavailability of Sb irrespective of the soil properties. Unfortunately, no previous study on Sb has been published in the literature for comparison with the data produced here. The low average % RBA range for Sb (2–6%) is unlikely to be suitable for validation of in vitro bioaccessibility tests.

For As (Table S3 of the SI), however, the RBA values are evenly dispersed over the RBA range (3–100%). Moreover, the RBA values are similar to the range of values obtained by several authors on soils contaminated by both mining and smelting activities. For instance, Rodriguez et al. [39] reported values ranging between 3% and 43%, and Juhasz et al. reported[13] 7–75%. A major factor that explains the variation observed among the soil samples is the solid phase distribution of As within the soil which differs according to soils type and physicochemical properties.[13]

Bioaccessibility of As, Sb, Cd, and Pb in the Reference Matrix. The BAF of each PHE in the soluble salts used to measure the in vivo RBA were determined using the UBM procedure (As in Na-arsenate, Sb in K-antimonate, Pb in Pb-acetate, and Cd in Cd-chloride). These soluble salts were spiked to give a 1 mg kg^{-1} concentration of each of the elements in the final "stomach" or "stomach and intestine" extract. This allowed the calculation of the relative bioaccessibility (RBAc), to allow a direct comparison with the RBA values. For the cations in the "stomach" phase, the BAF values were 99 ± 2% and 98 ± 3% for Pb-acetate and Cd-chloride, respectively. For the anions, the As BAF was 95 ± 3% and the Sb BAF was 93 ± 5%. This showed that all four elements were either indistinguishable or within 2% of being 100% bioaccessible for the reference compounds in this compartment. In contrast, in the "stomach and intestine" phase the cations had much reduced BAFs with Pb and Cd giving values of 66 ± 3% and 68 ± 3% with As and Sb BAFs of 92 ± 4% and 90 ± 2%, respectively. The lower recoveries of Pb and Cd can be explained by the fact that the behavior of these elements is strongly pH dependent. In the higher pH environment of the "stomach and intestine" phase these metals can precipitate from solution, be reabsorbed onto the soil, and complexed by pepsin.[40,41] This is not observed in the case of elements (such as As and Sb) that form anions in solution and is consistent with previous studies.[42]

Relative Bioaccessibilities of As, Cd, Pb, and Sb in the Contaminated Soils. The RBAc was estimated as the ratio of the soil bioaccessibility to the reference matrix bioaccessibility (%) for each phase and each element and are tabulated in the SI (Tables S4 and S5). When individual *t* statistic 95% confidence intervals were calculated for Cd and Pb the data indicated that, in general, the "stomach and intestine" bioaccessibility is not significantly different from the "stomach" phase bioaccessibility except for soils 5, 7, C and E for Pb and soil 5 for Cd where the "stomach phase" gives a significantly higher bioaccessibility. For Cd and Pb the "stomach phase" bioaccessibility is usually significantly higher than the GI bioaccessibility for these elements.[29] This is because of the behavior of Pb and Cd is strongly pH dependent with lower solubility in the higher pH environment of the GI compartment. In this instance, however, the bioaccessibility results have been calculated relative to the bioaccessibility of the soluble salts (Pb-acetate and Cd chloride) which also show reduced solubility at high pH. Taking measurement relative to the soluble salts therefore corrects for the lower absolute Pb and Cd bioaccessibilities in the "stomach and intestine" phase.

For the mining soils, RBAc of Pb and Cd ranged from 9% to 75% and from 7% to 70%, respectively. For the smelting soils, the relative Pb bioaccessibility ranged from 40% to 90% and the relative Cd bioaccessibility ranged from 28% to 87%. These values are similar to values reported in the literature.[16,42,43]

For As and Sb, no difference was observed between the two phases, apart from soil 2 for As. The values of As RBAc ranged between 3% and 11% for the mining soils and between 11% and 74% in the smelting soils. Thus, it seems that the bioaccessibility seems to be influenced by the source of contamination, being higher in the smelting contaminated soils. This might be due to the difference in the solid phase distribution of As within the soil constituents between the mining and smelting soils. In the mining soils As appears to be associated with iron oxides and sulphide minerals and consequently has a low bioaccessibility.[44–46]

For Sb, RBAc was always 20% lower than RBA and no significant difference was observed between mining and smelting soils. This overall low bioaccessibility might be explained by the association of Sb and soil bearing phases like iron oxy-hydroxides, sulphides, and refractory soil constituents[47–50] that are not easily dissolved by the artificial digestive solutions used during the UBM.

Correlation between Relative Bioavailabilities and Bioaccessibilities. For a given contaminant, the bioavailability theoretically results from three steps:

- the dissolution of the contaminant in the lumen that is determined as the bioaccessibility (BAc);
- the absorption of the contaminant through the GI membrane (ABS); and
- the metabolism of the contaminant within the internal media (this is assumed to be negligible for trace elements).[42]

The RBA can be determined from the following formula:[42]

$$\mathrm{RBA} = \mathrm{RBAc} \times \mathrm{ABSR} \tag{5}$$

where:

- RBAc = the relative bioaccessibility of the contaminant, i.e., the soil:reference matrix bioaccessibility of the contaminant
- ABSR = the relative absorption of the contaminant.

If the RBA is properly reflected by the RBAc, then the bioaccessibility should be the limiting factor.[38,42] As such, ABSR should be close to 1, meaning that the absorption step is independent from the initial form of the contaminant that is ingested. In this case, RBA should be equal to RBAc, i.e., the slope of the regression between RBA and RBAc should be equal to 1. The slopes of the regression between RBA and RBAc were calculated for each target compartment and for the two phases of the UBM.

Regression of the UBM Relative Bioaccessibility against in Vivo Relative Bioavailability. An earlier study comparing UBM data against in vivo bioavailability on test soils, [25] set out a series of benchmark criteria that should be met by the in vitro and in vivo data and any subsequent mathematical regression relationship in order for the in vitro methodology to supply "fit for purpose data" for risk assessments. The first criterion is that the median repeatability on the bioavailability data should be better than 20% RSD.

Figures S1 and S2 of the SI show boxplot summaries of the repeatability (RSD of the RBA replicate measurements) of the bioavailability the four end points of the sixteen soils for As, Cd, and Pb.

Sb has not been included since the bioavailability data were of insufficient quality to carry out a correlation with bioaccessibility data.

For both Cd and Pb, the median repeatability values are well within the benchmark (Figure S1 of the SI). The repeatability values for As values are higher for all end points with the kidney end point benchmark value of 20.6% and the liver end point only just above at 22.5% (Figure S1 of the SI). Although not strictly met, it is considered that a median value of 20.6% vs the ideal criteria of 20% for the two compartments was considered acceptable for the kidney end point and should not to compromise the use of the UBM for As in a soil risk assessment.

The second benchmark relates to the bioaccessibility repeatability (within-laboratory variability) and reproducibility (between-laboratory variability). The former should have a median value of 10% RSD and the latter a median value of 20% RSD.

Only within-laboratory data are available for this study so, only the repeatability can be tested. Figure S2 of the Supporting Information shows boxplots of the repeatability (RSD of the RBAc replicate measurements) for each of the elements studied.

In this case, Sb values have been included since robust results were obtained for this element from the UBM bioaccessibility test. Figure S2 of the SI shows that the median repeatability values for the UBM are all below the 10% benchmark for all elements in both the "stomach" and "stomach and intestine" compartments. The median reproducibility values are very similar for each compartment although the spread of values is consistently higher in the "stomach and intestine" compartment. Median repeatability values are all very similar at c. 5–7% RSD but As shows higher variability in values compared the other three elements. This is a similar pattern to the in vivo data shown in Figure S1 of the SI.

The next set of benchmark criteria relate to the statistical parameters associated with linear regression fits to the relationship between RBA and RBAc. Since there is significant error (median RSD of up to 30% for bioavailability and 8% for bioaccessibility, Figures S1 and S2 of the SI) on both the bioaccessibility and bioavailability data (Tables S2–S5 of the SI), ordinary linear regression is not appropriate as it assumes that there are errors only on the "y" coordinate. In this study, a repeated medians approach [36] is used, which makes no assumptions about errors and is robust to outliers. The method has been applied using a Monte Carlo approach varying each point over a normal distribution described by its mean value and standard deviation. The advantage of this is that it produces a distribution of values for the descriptive statistics for the regression (intercept, slope, and r-square) so that 95% confidence intervals can be calculated and can then be judged against a benchmark value. Wragg et al [25] suggested that the benchmark criteria should be as follows:

(i) The intercept is not significantly different from 0;

(ii) The slope should be between 0.8 and 1.2; and

(iii) The r-square value (measure of the scatter around the line) should be greater than 0.6.

Using this methodology, the linear regressions of relative bioaccessibility against relative bioavailability were calculated using the data from the SI (Tables S2–S5). All data were included in the calculation apart from the RBA values which could not be calculated because the absolute concentration of the elements in the target organ was below detection limit or because the dose response curves were not linear. Summary statistics, in the form of a mean value of the intercept, slope, or r-square value and their associated 95% confidence intervals for each element regression for each end point and each stomach compartment are shown in Figures 4, 5, and 6.

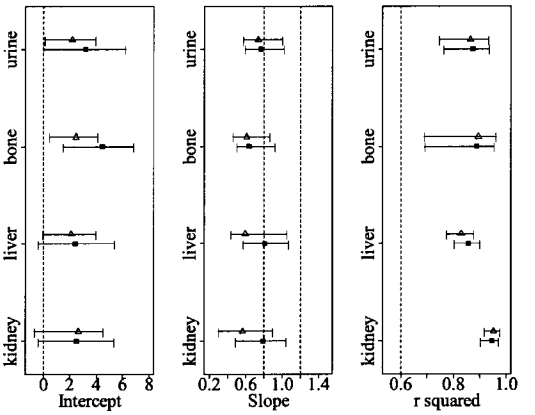

Figure 4. Summary of the RBA vs RBAc regression statistics for the four end points for As. Black squares show data for the "stomach" phase and white triangles for the "stomach and intestine" phase. Error bars represent 95% confidence limits dotted lines show benchmark values.

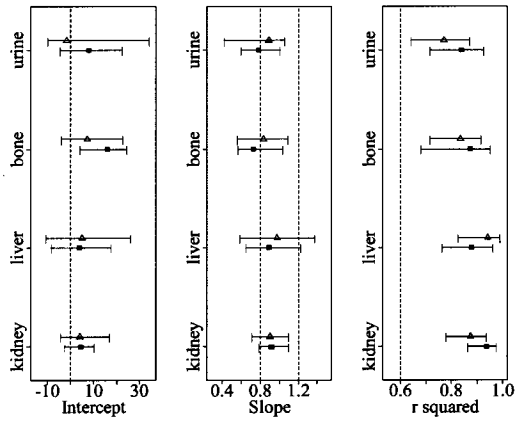

Figure 5. Summary of the RBA vs RBAc regression statistics for the four end points for Cd. Black squares show data for the "stomach" phase and white triangles for the "stomach and intestine" phase. Error bars represent 95% confidence limits, dotted lines show benchmark values.

Examination of Figures 4–6 shows that, for all elements in all end points the slope and the r-square values all meet the benchmark criteria. For Cd (Figure 5) the intercepts only shows one incidence out of eight where the intercept is positive (bone in the stomach compartment). For both As and Pb (Figures 4 and 6), however, there are five incidences out of eight where the intercepts are shown to be >0. This suggests there is a small bias in the RBAc measurement for these

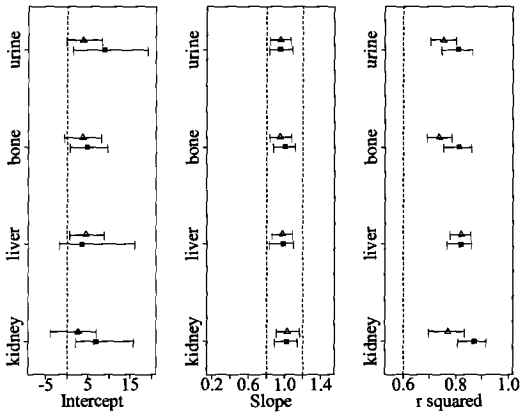

Figure 6. Summary of the RBA vs RBAc regression statistics for the four end points for Pb. Black squares show data for the "stomach" phase and white triangles for the "stomach and intestine" phase. Error bars represent 95% confidence limits, dotted lines show benchmark values.

elements compared to the RBA (3% RBAc for As and 5% RBAc for Pb averaged over all end points and compartments). The plots also confirm that there is no significant difference between the "stomach" and "stomach and intestine" compartments for all three elements and all four end points.

For the four target end points selected for this study (kidney, urine, bone, and liver), the *r*-square value for the RBAc and RBA regressions were all significantly different from 0 both for the "stomach" and the "stomach and intestine" phases. Since the slopes of regressions are all close to 1, it appears that the RBAc is actually the limiting factor of the RBA. This confirms the ability of the UBM test to assess the bioaccessibilities of As, Cd, and Pb in the contaminated soils studied. The bioaccessibility as measured by UBM better reflects the external exposure to soil contaminants following an oral ingestion than the total concentration.

Figures 7 and 8 show example RBAc plots versus RBA showing how the fitted regressions are very close to the ideal 1:1 relationship for As (Figure 8, parts a and b), Cd and Pb (Figure 7) but with evidence for small positive intercepts in As in the "stomach" phase (Figure 8a) and Pb in the "stomach" phase (Figure 7 a) . For Sb, however, the low bioavailabilities and bioaccessibilities that were measured for the soils sampled in this work meant that the correlations could only be studied in the 0–20% area. Under these conditions, the UBM test could not be validated for Sb due to a lack of statistical significance, which is clearly illustrated in Figure 8, parts c and d. The 95% confidence interval in the line of best fit is far too wide to provide a useful relationship between RBAc and RBA, which could be used by a risk assessor.

The juvenile swine model has been shown to produce RBA values that are consistent within the target end points for As, Cd, and Pb for the 16 soils studied. The variety of soil types and the range of total element values are representative of the total concentrations of these elements that would normally be considered for bioaccessibility testing.[25] The RBA values for all three of these elements covered at least 70% of the RBA range making them highly suitable for calibrating in vitro testing protocols.

For Sb, however, the RBA values were approximately 10% or less for all soils and it was difficult to measure the amount of Sb absorbed into the target end points, apart from urine, for all but

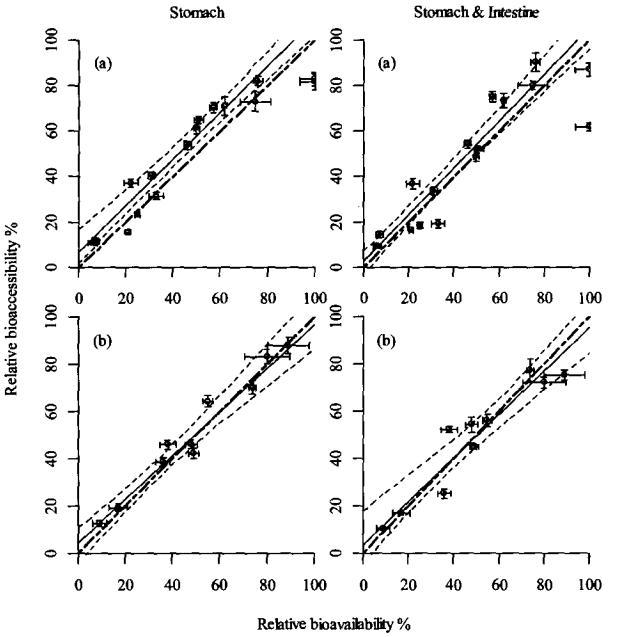

Figure 7. Correlation plots for RBAc against RBA for (a) Pb and (b) Cd for the "stomach" and "stomach and intestine" phases for the kidney end point. Bold dashed dotted line is the line of equivalence, dashed lines are the 95% confidence intervals, and the solid lines is the best line of fit.

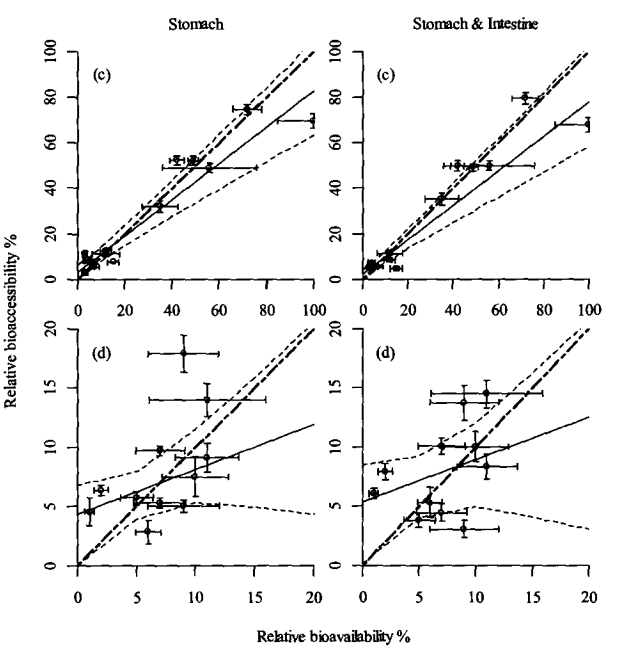

Figure 8. Correlation plots for RBAc against RBA for (c) As and (d) Sb for the "stomach" and "stomach and intestine" phases for the urine end point. Bold dashed dotted line is the line of equivalence, dashed lines are the 95% confidence intervals, and the solid line is the best line of fit.

soils 1 and 2, which are grossly contaminated with Sb (>50 000 mg kg^{-1}, Table S1 of the SI). The small RBA range covered will not make this data set suitable for calibrating Sb bioaccessibility measurements from in vitro testing methods.

While it would be impossible to show that the UBM has been validated for all soil types, this study has concentrated on soils with anthropogenic contamination (combined with their natural PHE content) which are likely candidates for human health risk assessment. The study has used soils from a variety of spatial locations with a range of physicochemical properties and which exhibit a good range of PHE bioaccessibilities. These results provide strong evidence that, through a pragmatic choice of soils, the UBM provides a robust tool for use in risk assessment of As, Cd, and Pb. The study suggests the "stomach" compartment alone is a good analogue of in vivo bioaccessibility but this need to be confirmed by use of the method on a wider variety of soils.

This study has addressed many of the issues arising from a preliminary interlaboratory trial of the UBM [25] showing that a specifically designed in vivo study with soils relevant to European conditions along with better control on pH in the "stomach" phase that the UBM produces bioaccessibility data that is a very good analogue of juvenile swine bioavailability measurements for As, Cd, and Pb. The one point that this study has not yet addressed is the interlaboratory reproducibility that was problematic in the study of Wragg et al.[25] A further follow up study on interlaboratory performance is required to provide the last piece of evidence that the method can be used as a routine test in risk assessment studies.

■ ASSOCIATED CONTENT

Supporting Information

Details of the procedures used to determine the bioavailability and bioaccessibility of the PHEs and methods used for the preparation, analysis, and quality control of the PHEs in the soil and swine samples. Tabulations of the soil properties and the bioavailability of the bioaccessibility of the PHE in each of the soils tested, along with box and whisker plots of the repeatability of the bioavailability and bioaccessibility measurements. This material is available free of charge via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

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Comparison of *in vivo* and *in vitro* methodologies for the assessment of arsenic bioavailability in contaminated soils

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Abstract

An *in vivo* swine assay was utilised for the determination of arsenic (As) bioavailability in contaminated soils. Arsenic bioavailability was assessed using pharmacokinetic analysis encompassing area under the blood plasma–As concentration time curve following zero correction and dose normalisation. In contaminated soil studies, As uptake into systemic circulation was compared to an arsenate oral dose and expressed as relative As bioavailability. Arsenic bioavailability ranged from $6.9 \pm 5.0\%$ to $74.7 \pm 11.2\%$ in 12 contaminated soils collected from former railway corridors, dip sites, mine sites and naturally elevated gossan soils. Arsenic bioavailability was generally low in the gossan soils and highest in the railway soils, ranging from $12.1 \pm 8.5\%$ to $16.4 \pm 9.1\%$ and $11.2 \pm 4.7\%$ to $74.7 \pm 11.2\%$, respectively. Comparison of *in vivo* and *in vitro* (Simplified Bioaccessibility Extraction Test [SBET]) data from the 12 contaminated soils and bioavailability data collected from an As spiked soil study demonstrated that As bioavailability and As bioaccessibility were linearly correlated (*in vivo* As bioavailability (mg kg^{-1}) = $14.19 + 0.93 \cdot$ SBET As bioaccessibility (mg kg^{-1}); $r^2 = 0.92$). The correlation between the two methods indicates that As bioavailability (*in vivo*) may be estimated using the less expensive, rapid *in vitro* chemical extraction method (SBET) to predict As exposure in human health risk assessment.
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Keywords: Arsenic; Bioavailability; Bioaccessibility; *In vivo*; SBET; Swine

1. Introduction

In order to reduce the uncertainty in estimating risk associated with incidental ingestion of As-contaminated soil, an understanding of As bioavailability is essential. A variety of animal assays have been developed in order to determine As bioavailability in contaminated soils for human health risk assessment. Rodents (Ng et al., 1998), rabbits (Freeman et al., 1993), dogs (Groen et al., 1994), primates (Freeman et al., 1995; Roberts et al., 2002) and swine (Casteel et al., 1997; Rodriguez et al., 1999; Juhasz et al., Submitted for publication) have been utilised to quantify the amount of As that enters systemic circulation following administration of contaminated soil.

Although primates are the first choice for bioavailability studies due to their close relatedness to man, few studies have been undertaken with this animal model due to the prohibitive costs. Immature swine are considered remarkably similar to humans in terms of their metabolism of As, nutritional requirements, bone development and mineral metabolism. In addition, their body size, weight and bone to weight ratio is similar to young children, the age

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group at greatest risk of As absorption due to incidental ingestion of soil (Weis and LaVelle, 1991; Casteel et al., 1997). As a result, the swine model has been used for assessing As bioavailability in soils impacted by mining activities. Casteel et al. (1997) determined that As bioavailability ranged from 0% to 52% in contaminated soils, tailing and slag while swine assays conducted by Rodriguez et al. (1999) reported that As bioavailability in mining and smelting material ranged from 4% to 43%.

While few studies have assessed As bioavailability in contaminated soils using the swine models (due to time and expense limitations), numerous researchers have employed *in vitro* assays to estimate the contaminant fraction that is potentially available for absorption (bioaccessible fraction) (Ruby et al., 1996; Williams et al., 1998; Rodriguez et al., 1999; Basta et al., 2001; Oomen et al., 2003; Sarkar and Datta, 2003; Sarkar et al., 2006). *In vitro* assays overcome the time and expense limitations of *in vivo* studies thereby providing a surrogate measurement of bioavailability that is quick and inexpensive compared to animal models (Ruby et al., 1996; Basta et al., 2001). However, to date, limited studies utilizing only a handful of soils have been performed in order to validate the relationship between *in vitro* As bioaccessibility and *in vivo* As bioavailability (Rodriguez et al., 1999). Before *in vitro* assays can act as a surrogate measurement of As bioavailability, further evaluation of the relationship between As bioaccessibility and As bioavailability in a variety of soil types is required.

In a previous study, As bioaccessibility in contaminated soils was assessed using the simplified bioaccessibility extraction test (SBET) (Juhasz et al., in press). Arsenic bioaccessibility varied greatly in railway corridor, dip site, mine site and gossan soils (1–89%) and was dependent on As mineralogy and soil properties. The objective of this study was to assess As bioavailability using the swine model to determine the suitability of *in vitro* bioaccessibility assays (SBET) for predicting As bioavailability in a variety of As-contaminated soils.

2. Materials and methods

2.1. Arsenic-contaminated soil

Soils used in this study were collected from four regional areas where the soil type, mode of As input and As residence time varied. Soils were collected from railway corridors (South Australia), cattle tick dip sites (North-eastern New South Wales), mine sites (Victoria) and locations in South Australia containing naturally elevated concentrations of As (gossans). In a previous study (Juhasz et al., in press), As-contaminated soils were characterised and SBET extractable As determined. Table 1 outlines soils properties (pH, total As, Al, Fe, P, free Fe) and As bioaccessibility values for soils used in this study.

2.2. Assessment of As bioavailability – in vivo swine assays

Female Large White swine, weighing 20–25 kg, were used for *in vivo* bioavailability assays. Following acclimation for 12 days to animal house conditions, swine were fasted for 24 h prior to surgery for the insertion of jugular

Table 1
Selected properties of soils used in this study

Sample no.	Soil properties					
	Total As (mg kg^{-1})[a]	Total Al (g kg^{-1})[a]	Total Fe (g kg^{-1})[a]	Total P (mg kg^{-1})[a]	pH[a]	% Bioaccessible As[b,c]
Railway corridors						
2	267	22.2	17.6 (10.6)	234	8.8	89
4	42	18.3	13.7 (8.5)	385	8.4	43
5	1114	16.3	68.3 (16.6)	874	7.8	32
10	257	27.8	25.8 (9.9)	242	6.4	23
16	751	10.8	14.5 (11.4)	422	8.3	43
18	91	5.1	10.0 (3.2)	130	7.5	59
Dip sites						
24	713	94.7	98.6 (48.6)	3144	5.7	25
27	228	22.4	17.9 (12.5)	2941	5.2	89
Mine sites						
33	807	10.9	23.5 (7.1)	546	7.6	35
34	577	17.6	24.6 (12.5)	468	6.6	5
Gossans						
44	190	8.3	21.0 (15.6)	200	8.6	22
45	88	9.6	21.0 (13.2)	370	8.1	14

The <250 μm particle size fraction was used for all analyses.
Values in parenthesis represent dithionite citrate bicarbonate extractable Fe (Free Fe).
[a] Data represent the mean of duplicate analysis. Values varied by less than 5%.
[b] Data represent the mean of triplicate analysis. Values varied by less than 2%.
[c] As bioaccessibility determined using the SBET method.

catheters using the method of Bain et al. (1991). During bioavailability assays, animals were housed in metabolic cages. Swine were fed twice daily (500 g of low As pig pellets), 2 and 10 h following As dosage while water was supplied *ad libitum*. Prior to As dosage, blood samples were taken to determine baseline blood As concentrations. Arsenic-contaminated soils (<250 μm particle size fraction) were administered as soil slurries via gavage (10–25 g of soil in 150 ml of As free water) while sodium arsenate (100 μg As kg^{-1}) was administered as the reference dose. Intravenous As dosages (As^{III} and As^{V}: 20 μg As kg^{-1}) were administered using a catheter separate from the blood sampling catheter. Blood samples were routinely taken over a 26 h period following dosage and collected in 7.5 ml heparinised collection tubes. Plasma was separated from red blood cells by centrifugation (4000 rpm for 10 min) then stored at −20 °C prior to As analysis. For each *in vivo* treatment (As^{III}/As^{V} intravenous dose, As^{III}/As^{V} oral dose or As-contaminated soil dose), three separate animals were used.

As bioavailability was assessed using pharmacokinetic analysis encompassing areas under the blood plasma-concentration (AUC) time curves following zero correction and dose normalisation. Absolute and relative As bioavailability were calculated according to Eqs. (1) and (2) respectively. When calculating relative As bioavailability, the AUC for the sodium arsenate oral treatment was used for comparison.

$$\text{Absolute As bioavailability, } \% = \left(\frac{AUC_{Oral\text{-}As}}{AUC_{IV\text{-}As}} * \frac{DR_{IV\text{-}As}}{DR_{Oral\text{-}As}}\right) * 100 \quad (1)$$

where, $AUC_{Oral\text{-}As}$ is the area under the As blood plasma concentration versus time curve for an Oral-As dose; $AUC_{IV\text{-}As}$ is the area under the As blood plasma concentration versus time curve for an intravenous As dose; $DR_{IV\text{-}As}$ is the dose of intravenously administered As (mg kg^{-1}); $DR_{Oral\text{-}As}$ is the dose of orally administered As (mg kg^{-1}).

$$\text{Relative As bioavailability, } \% = \left(\frac{AUC_{Oral\text{-}Soil}}{AUC_{Oral\text{-}AsV}} * \frac{DR_{Oral\text{-}AsV}}{DR_{Oral\text{-}Soil}}\right) * 100 \quad (2)$$

where, $AUC_{Oral\text{-}Soil}$ is the area under the As blood plasma concentration versus time curve for an Oral-As-contaminated soil dose; $AUC_{Oral\text{-}AsV}$ is the area under the As blood plasma concentration versus time curve for an oral dose of sodium arsenate; $DR_{Oral\text{-}Soil}$ is the dose of orally administered soil (mg kg^{-1}); $DR_{Oral\text{-}AsV}$ is the dose of orally administered sodium arsenate (mg kg^{-1}).

2.3. Arsenic determination in blood plasma

Two methods were used for the determination of As in blood plasma. Samples (3 ml) were digested with nitric acid (2 ml; 70%) and H_2O_2 (1 ml; 30%) using USEPA method 3015A (USEPA, 1998). Following digestion, samples were diluted with Milli-Q water to reduce the acid content to 10%. Alternatively, blood serum was diluted 10-fold in diluent solution containing 1-butanol (2% w/v), EDTA (0.05% w/v), Triton X-100 (0.05% w/v) and ammonium hydroxide (1% w/v) in Milli-Q water (Agilent Technologies, 2006) prior to analysis. All samples were analysed by ICP-MS with the appropriate number of duplicate samples, duplicate analysis, spiked sample recoveries and check values included for quality assurance and quality control purposes.

3. Results and discussion

3.1. Arsenic bioavailability

In order to determine As bioavailability in contaminated soils (railway corridors, dip sites, mine sites and gossan soils), *in vivo* swine experiments were performed. Arsenic doses were administered to fasting animals to represent a 'worst-case scenario' for As exposure. As food ingestion increases gastric pH conditions, which in turn influences As dissolution (Ruby et al., 1996), feed was administered to swine 2 h following As dosage to ensure the lowest gastric pH conditions in the animals at the time of As exposure. Initially pharmacokinetic studies were performed with As^{III} and As^{V} to determine the absolute bioavailability of these As species. Only the bioavailability of inorganic As species was assessed as these species are reported to be the dominant forms present in soil extracts (Bissen and Frimmel, 2000; Montperrus et al., 2002). The absolute As bioavailability was determined by comparing AUCs for oral and intravenous routes of administration (Fig. 1). For both As^{III} and As^{V}, the absolute bioavailability was approximately 100% although some variability was observed between animal treatment. For As^{III} and As^{V}, 103.9 ± 25.8% and 92.5 ± 22.3% of the administered oral dose was absorbed from the gastrointestinal tract and entered systemic circulation respectively.

Following pharmacokinetic studies, feeding trials were conducted with selected As-contaminated soils. Arsenic uptake in these soils was compared to an As^{V} oral dose and expressed as relative As bioavailability (Eq. (2)). Mean relative As bioavailability varied significantly between contaminated soils. In railway corridor soils ($n = 6$), As bioavailability ranged from 11.2 ± 4.7% to 74.7 ± 11.2% while in dip site soils As bioavailability was 33.0 ± 17.0% and 49.9 ± 11.0% in the two soils studied. In mine site soils ($n = 2$), As bioavailability was 6.9 ± 5.0% and 40.8 ± 7.4% while As bioavailability was generally low in gossan soils (16.4 ± 9.1% and 12.1 ± 8.5%). Previous *in vivo* studies with mining impacted soils, slags and dust have reported that As bioavailability ranged from 10% to 52% (Casteel et al., 1997; Freeman et al., 1993; Freeman et al., 1995). In a study by Roberts et al. (2002), As bioavailability in soils ($n = 5$) collected from an electrical substation, a wood preservation site, a dip site and two pesticide sites ranged from 11% to 25%. Juhasz et al. (Submitted for publication)

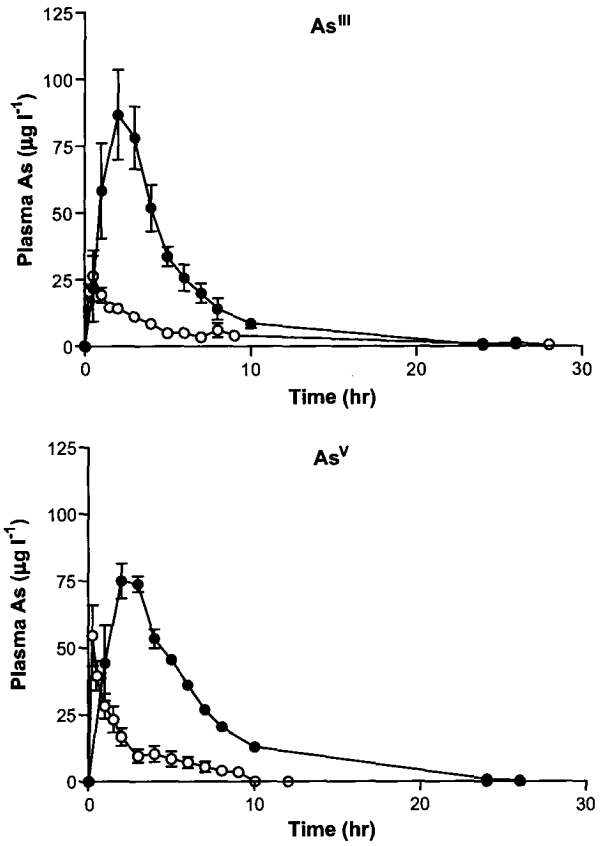

Fig. 1. Arsenic concentration in blood plasma following oral (●) or intravenous (○) administration of As^{III} or As^{V}. Each swine received a single administration of 20 μg As kg^{-1} or 80 to 100 μg As kg^{-1} for intravenous and oral doses respectively. Data points represent the mean and standard deviation of three separate *in vivo* assays.

utilised the swine model for the determination of As bioavailability in spiked soils aged over a 12 month period. Juhasz et al. (Submitted for publication) reported that after the addition of As^{V} (1000 mg kg^{-1}) to a Red Ferrosol (pH: 5.8; Fe content: 99.6 g kg^{-1}; % clay: 24), As bioavailability was reduced to 25% after 12 months of aging. In contrast, there was no reduction in As bioavailability observed following the addition of 1000 mg As kg^{-1} to a Brown Chromosol (pH: 7.8; Fe content: 8.0 g kg^{-1}; % clay: 7.5) soil and subsequent aging.

The determination of As bioavailability using *in vivo* assays is time consuming laborious and expensive. However, *in vitro* assays that simulate human gastric conditions, such as the SBET, may provide a surrogate assay for predicting As bioavailability that is rapid and inexpensive. While numerous researchers have reported the use of *in vitro* assays for determining As bioaccessibility, a dearth of information is available regarding the relationship between As bioaccessibility (*in vitro*) and As bioavailability (*in vivo*). In a previous study with railway corridor, dip site, mine site and gossan soils, Juhasz et al. (in press) determined As bioaccessibility using the SBET method. SBET data was collected from the same soils and the same ageing time-frame from which the present *in vivo* study was conducted. Using data from these studies, the Pearson correlation method was used to calculate the relationship between As bioaccessibility as measured by the SBET method and As bioavailability as measured by the *in vivo* method (Fig. 2). As the spiked soil study of Juhasz et al. (Submitted for publication) utilised the SBET method, and *in vivo* experiments were conducted under the same condition as the present study, this data was also included in Pearson calculations. Comparison of *in vitro* and *in vivo* results indicate that the correlation between As bioaccessibility and As bioavailability was significant ($p = 0.01$; $n = 49$), with SBET assessment of contaminated soils providing a good prediction of *in vivo* As bioavailability (*in vivo* As bioavailability (mg kg^{-1}) = 14.19 + 0.93 · [SBET As bioaccessibility (mg kg^{-1})]; $r^2 = 0.92$). While some variability was observed in the data collected during *in vivo* studies, this may be attributable to physiological intra-species variability including genetic factors, disparity in stomach clearance times, stomach pH and rates of As absorption. The same variability was not evident in the *in vitro* assay with the data being extremely reproducible under laboratory conditions.

Although data on As bioavailability is accumulating in the literature, few studies have correlated As bioavailability with As bioaccessibility as determined by *in vitro* assays. This is surprising given that *in vitro* assays are used as surrogates for estimating As bioavailability for incorporation into human health risk models. To the best of our knowledge, the work described in Rodriguez et al. (1999) is the only other study where *in vivo* and *in vitro* As bioavailability/bioaccessibility were compared. In the study of Rodriguez et al. (1999), there was no statistical difference in the relative availability of As in mining and smelting material when measured by *in vitro* (IVG method) or

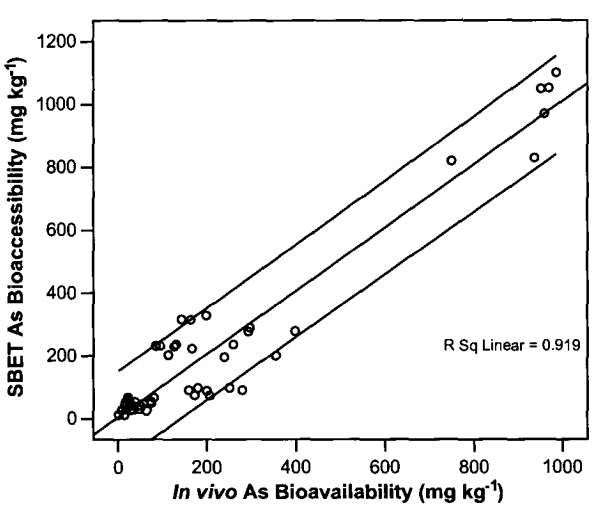

Fig. 2. Correlation between As bioaccessibility (*in vitro* SBET assay) and As bioavailability (*in vivo* swine assay) for railway corridor, dip site, mine site, gossan (this study) and As-spiked soils (Juhasz et al., in press) ($n = 49$). 95% confidence limits are also shown.

in vivo (swine feeding trials) methods. However, the calcine samples analysed by the *in vitro* methods were not statistically equivalent to the *in vivo* method as As bioavailability was underestimated by the *in vitro* method. In this study, no calcinated materials were tested, however, a much wider range of As-contaminated soil types were evaluated compared to the study of Rodriguez et al. (1999). From the soils used in this study, it can be concluded that the assessment of As bioaccessibility using the SBET method will yield a reproducible value with a low standard deviation that can be used to predict *in vivo* As bioavailability.

3.2. Predicting As bioavailability using soil properties

In order to develop a model to predict As bioavailability in contaminated soils, linear and multivariate regression analysis was performed to describe *in vivo* As bioavailability as a function of soil properties. Soil properties that were included in the analysis were pH, total As, Fe, Al and P concentrations (Table 2). The selection of these soil properties was based on previous studies that have been identified these parameters as being important factors in controlling As bioavailability in spiked soils (Yang et al., 2002). Regression analysis identified that total As and Fe concentrations were the variables that best described the variation in *in vivo* As bioavailability. Results from the regression model summary produced the following model:

$$\textit{In vivo}\ \text{As bioavailability (mg kg}^{-1}) = 11.310 + 0.678 \cdot \text{Total As (mg kg}^{-1}) - 4.368 \cdot \text{Total Fe (g kg}^{-1})\ r^2 = 0.72.$$

Although a workable model appears to adequately describe As bioavailability using total As and Fe, there is some discrepancy in the predicted data (Fig. 3). Statistical analysis of the residuals indicates that the model developed is not highly significant. This is evident from a high residual in relation to the regression model, as well as the model producing a Durbin–Watson factor of 0.585. Durbin–Watson values near zero indicate positive autocorrelation of the random error while a value of 2 indicates no correlation. No correlation is necessary for regression models to be deemed reliable. While the importance of Fe and pH in controlling As sorption has been demonstrated by a number of researchers (Smith et al., 1998; Goldberg, 2002; Yang et al., 2002), it is evident that other variables, such as As speciation, mineralogy, As-soil contact time etc. will impact on As bioavailability. These variables will also influence the prediction of As bioaccessibility (based on soil properties) as exemplified by the research of Juhasz et al. (in press).

Table 2
Pearson correlation data for *in vivo* As bioavailability (swine assays) and soil properties

Soil parameter	Correlation coefficient	*p*-Value
Total arsenic (mg kg^{-1})	0.694	0.000
pH	0.078	0.296
Total iron (g kg^{-1})	−0.162	0.133
Total aluminium (g kg^{-1})	−0.048	0.373
Total phosphorous (mg kg^{-1})	−0.147	0.157

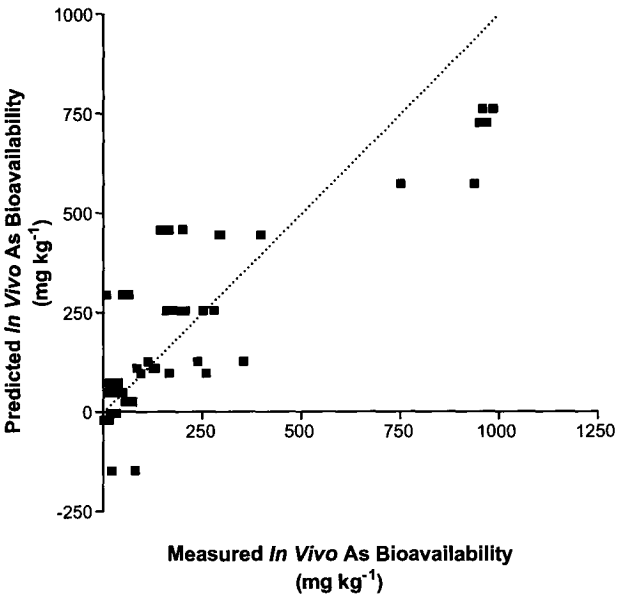

Fig. 3. Comparison of As bioavailability values for railway corridor, dip site, mine site, gossan and As-spiked soils as determined by *in vivo* assays or predicted using a linear regression model based on soil properties.

4. Conclusion

The bioavailability of As in contaminated soil was determined by monitoring blood As concentrations in swine following oral administration of contaminated soil. Arsenic bioavailability varied considerably between soils ranging from 6.9 ± 5.0% to 74.7 ± 11.2% of the total As concentration. When *in vivo* As bioavailability data was compared to As bioaccessibility data obtained SBET analysis, the rapid, inexpensive *in vitro* assay could accurately predict *in vivo* As bioavailability. This suggests that the *in vitro* chemical extraction method may be used as a surrogate assay for the assessment of As bioavailability.

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In Vitro Model Improves the Prediction of Soil Arsenic Bioavailability: Worst-Case Scenario

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There is a strong interest in developing an in vitro arsenic (As) model that satisfactorily estimates the variability in in vivo relative oral bioavailability (RBA) measurements. Several in vitro tests have been developed, but none is universally accepted due to their limited success in predicting soil As RBA. A suite of amorphous and crystalline solid As phases were chosen, utilizing a worst-case scenario (WCS) that simulated fasting children's gastric solution chemistry. The objectives of this study were to (i) determine the effects of residence time, pH, and solid-to-solution ratio on As bioaccessibility and speciation in the in vitro gastric test; (ii) provide the fundamental basis for an optimized in vitro model constrained by the WCS; and (iii) validate the optimized in vitro test with the in vivo RBA obtained with BALB/c mice. The gastric pH was the only significant ($p < 0.05$) factor influencing solid As bioaccessibility. Bioaccessible As retained the oxidation state after its release from the solid into the gastric solution. The optimized in vitro model adequately predicted RBA values for a suite of solid As phases typically encountered in soils, with the exception of aluminum-based solids. This study is an excellent starting point for developing an in vitro test applicable to different As-contaminated soils.

Introduction

The phenomenon of "urban sprawl" around metropolitan areas has given rise to serious concerns regarding the risk of human contact with arsenic (As)-contaminated soils. Agricultural soils previously amended with arsenical pesticides that are currently used for residential development may pose serious human health risks, especially to children playing in As-contaminated houseyards or playgrounds. Oral ingestion is the primary exposure route for As in soils, and the adverse effects of As-related geophagia on human health are largely dependent upon the relative bioavailability of the As-containing soil particles (*1*, *2*).

Arsenic bioavailability varies as a function of different soil types, necessitating the use of site-specific human health risk assessments. Relative oral bioavailability (RBA) data for soil As using in vivo models are expensive and time-consuming; thus, there is a strong interest in developing in vitro models that adequately predict RBA (*3*). Several soil As bioaccessibility in vitro models have been developed, generating data at little cost and time (*4–6*). The physiologically based extraction in vitro test was primarily developed for lead, and little is known regarding its ability to predict soil As bioaccessibility (*4*, *7*). Other in vitro gastric or gastrointestinal tests are the SBET method developed by the British Geological Survey, the German DIN method, the Dutch RIVM model, as well as, the Belgian SHIME model, and the TIM Dutch method. These five European in vitro models have not been validated against a representative animal model, and an interlaboratory study was unable to conclude which in vitro test best predicted As bioaccessibility in contaminated soils (*6*).

The in vitro gastrointestinal As bioaccessibility test (IVG) originally developed by Rodriguez et al. (*5*) has been tested in As-contaminated (smelter) soils (*5*), soils adjacent to chromated copper arsenate-treated wood structures/utility poles (*8*), and it was also compared with a representative in vivo immature swine data set (*5*). The IVG in vitro test partially explained ($r^2 = 0.69$) the variability observed in the As RBA values obtained with immature swine (*5*). In addition, the absolute amount of As extracted by the in vitro test was lower than that obtained in vivo (*5*). Major factors held responsible to explain the dynamics of soil As bioaccessibility are the residence time of fluid and particles in the gastric environment, the gastric pH, and the soil/solution ratio (*6*). Our in vitro method development proceeded by statistically evaluating the effects of these three variables on soil As bioaccessibility for a suite of solid As phases that are most commonly found in As-contaminated soils. We hypothesized that residence time (RT), gastric pH, and solid/solution ratio (SSR) were the main factors regulating the magnitude of soil As bioaccessibility in the human gastric environment. Our approach focused on the gastric phase, because extending the gastric to the intestinal phase did not improve the predictive ability of the in vitro models (*5*, *8*). In addition, a worst-case scenario was employed by evaluating conditions that simulate fasting children's gastric solution chemistry. An analysis of variance (ANOVA) identified the significant factors, and a subsequent numerical nonlinear optimization routine identified the optimized in vitro model conditions, constrained by the worst-case scenario of fasting children (plausible lower bound) (*9*). Worst-case scenarios are commonly used in human health risk assessment protocols (*9*). Finally, in vitro bioaccessible As concentrations obtained with the optimized in vitro model were validated against in vivo RBA obtained with an animal data set.

The objectives of this study were to (i) determine the main and interaction effects of RT, gastric pH, and SSR on soil As bioaccessibility and speciation in the in vitro gastric test; (ii) provide the fundamental basis for an optimized in vitro model based on the significant factors that maximize soil As bioaccessibility constrained by a worst-case scenario; and (iii) compare the RBA in vivo As data obtained with a representative animal model to the optimized in vitro test.

Materials and Methods

Materials Collection. A suite of representative amorphous and crystalline As phases typically encountered in soils was used in the in vitro model construction. Orpiment, arsenopyrite, and scorodite were selected as the major As crystalline phases (Ward's Natural Science, Rochester, NY).

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TABLE 1. An Example of the Central Composite Design with Three Factors, Five Levels Each, Applied to a Specific Solid As Phase[a]

run #	residence time (h)	gastric pH	solid/solution ratio (mL g^{-1})
1	1	3.4	300
2	1.5	2	1240
3	1.5	2	650
4	0.66	2	650
5	1.5	2	650
6	1.5	2	650
7	2	3.4	300
8	1.5	0.2	650
9	2.34	2	650
10	1.5	2	650
11	1	3.4	1000
12	1.5	2	650
13	2	3.4	1000
14	1.5	2	650
15	1.5	2	60
16	1	0.6	1000
17	2	0.6	300
18	2	0.6	1000
19	1.5	4.35	650
20	1	0.6	300

[a] The runs above represent the dots in the schematic of Figure S1.

Amorphous Fe–hydroxides in the form of an As geosorbent, that is, the drinking-water treatment residuals (Fe-WTR) were obtained from drinking water treatment facilities in Tampa, Florida. The Fe-WTR was spiked with either sodium arsenate or sodium arsenite to reach a load of approximately 500 mg of As kg^{-1} and was immediately used in the in vitro tests. The WTR were used in this study because (i) amorphous Fe/Al hydroxides are the main component of WTR, which may serve as major As sorbents in soils (*10, 11*), and (ii) the WTR have been proposed as a low-cost remediation practice for As-contaminated soils via sorption and immobilization of As onto the hydroxyl groups of the WTR surfaces (*10–12*). Two surface (0–15 cm) Texas soils contaminated with As(V) and dimethylarsinic acid (DMA) that were aged for three years at 70% water holding capacity were also used in the model construction. Material selection was aimed at including the most common solid As phases that are naturally encountered in As-contaminated soils (*3, 7*). Study materials were air-dried and subsequently passed through a 250 μm sieve, separating the solid particle size fraction used in soil–As health risk assessment protocols (<250 μm) (*7*). Total-recoverable As concentrations were measured after wet digestion using U.S. EPA method 3050B (*13*).

Experimental Design and in Vitro Model Construction. A central composite design (CCD) (*14*) was used to investigate the main and interaction effects of factors, such as, RT, pH, and SSR on the magnitude of in vitro As bioaccessibility measured for the suite of solid As phases (Table 1). Five levels of each factor, ranging from 0.66 to 2.3 h, 0.2 to 4.3, and 60 to 1240 mL g^{-1} for the RT, gastric pH, and SSR, respectively, were used to encompass a wide range of values measured in the human gastric phase. Synergistic or antagonistic effects between RT, pH, and SSR during the in vitro test were evaluated in experimental units composed of appropriate combinations (Table 1). There were 14 single-run experimental units (dots), plus six replicated runs for the dot in the center of the cube (Figure S1, Supporting Information). The central composite design has been widely used in the fields of science and engineering (*14, 15*). The major advantage of the CCD is that three variables at five levels can be evaluated with 20 experimental units per solid As phase, avoiding the extremely large sample size (>2000 experimental units) associated with a conventional experimental design, for example, a five-level factorial design. There was a total of 20 experimental units × 7 solid As phases = 140 samples that were subjected to the in vitro test.

Original in Vitro Soil Arsenic Bioaccessibility and Speciation. All solid As phases were subjected to the in vitro As bioaccessibility test originally developed by Rodriguez et al. (*5*) and modified by Sarkar and Datta (*16*). Samples (at five SSR levels) were added to 100 mL of a gastric solution (without dough) adjusted to five different pH levels. The gastric solution was a mixture of 0.15 M NaCl and 1% porcine pepsin (Acros Organics, NJ). Samples were anaerobically incubated for five different time periods. Stomach conditions were simulated at 37 °C and an atmosphere of 5% CO_2, 10% H_2, and 85% N_2 inside an anaerobic chamber. After the predefined time interval, 10 mL of supernatant was withdrawn, centrifuged at 4000*g* for 20 min, passed through 0.22 μm nylon filters, and analyzed for bioaccessible As by inductively coupled plasma mass-spectrometry (ICP-MS). Several As species [As(III), As(V), MMA, and DMA] are analyzed using high-performance liquid chromatography coupled to an inductively coupled plasma mass-spectrometer. Arsenic speciation analysis followed the protocol developed by Jackson and Bertsch (*17*). Method detection limits for As(III), MMA, DMA, and As(V) were 0.58, 0.38, 0.61, and 0.70 μg L^{-1}, respectively. Method reagent blanks were used, as well as certified standards from a source other than normal calibration standards. Their percent recovery ranged from 95 to 108% of the values obtained by the calibration curve. Spike recovery (every 10 samples) ranged between 90 and 107% of the expected values. Another 5% of the set was used to determine the analytical precision of the ICP-MS measurements (duplicates).

Optimizing the in Vitro Arsenic Bioaccessibility Test. ANOVA tests identified the significant main and interaction effects of the three factors at the 95% confidence level (*18*). Significant factors obtained with the in vitro test were optimized to maximize As bioaccessibility for the different solid As phases. The worst-case scenario was related to conditions that maximize the magnitude of soil As bioaccessibility in the gastric phase constrained by data collected by actual fasting children (*19*). Optimization (optimum maximum) of the gastric solution properties was conducted using a numerical nonlinear (quadratic) optimization algorithm with constraints (*18*). The numerical optimization routine was in search of those conditions that maximize soil As bioaccessibility, by including a plausible lower bound (worst-case scenario) typically utilized in risk assessment protocols (*9, 20*).

Optimized conditions were identified using the desirability function (*D*), which is the geometric mean of all transformed responses (eq 1).

$$D = (d_1 \times d_2 \times d_3 \times d_4 \times \ldots \times d_n)^{1/n} \quad (1)$$

The desirability function has been widely used in response surface methodology to simultaneously optimize a series of quadratic models (*21*). The desirability function (*D*) reflects the desirable ranges for each response (d_n). The goal of maximum optimization for soil As bioaccessibility will result in desirability function values between 0 and 1, where *D* values closer to 1 correspond to the level combination of the factors that bring optimized As bioaccessibility values closer to those actually measured in vitro.

In Vivo Animal Study and in Vitro Model Validation. Five solid samples that were not the same as those used in the in vitro model construction were used for the in vitro model validation. These five samples were used in the in vivo animal study, and they were collected from a three-year greenhouse experiment evaluating the effect of WTR on the in vitro As bioaccessibility in contaminated soils (manuscript in prepara-

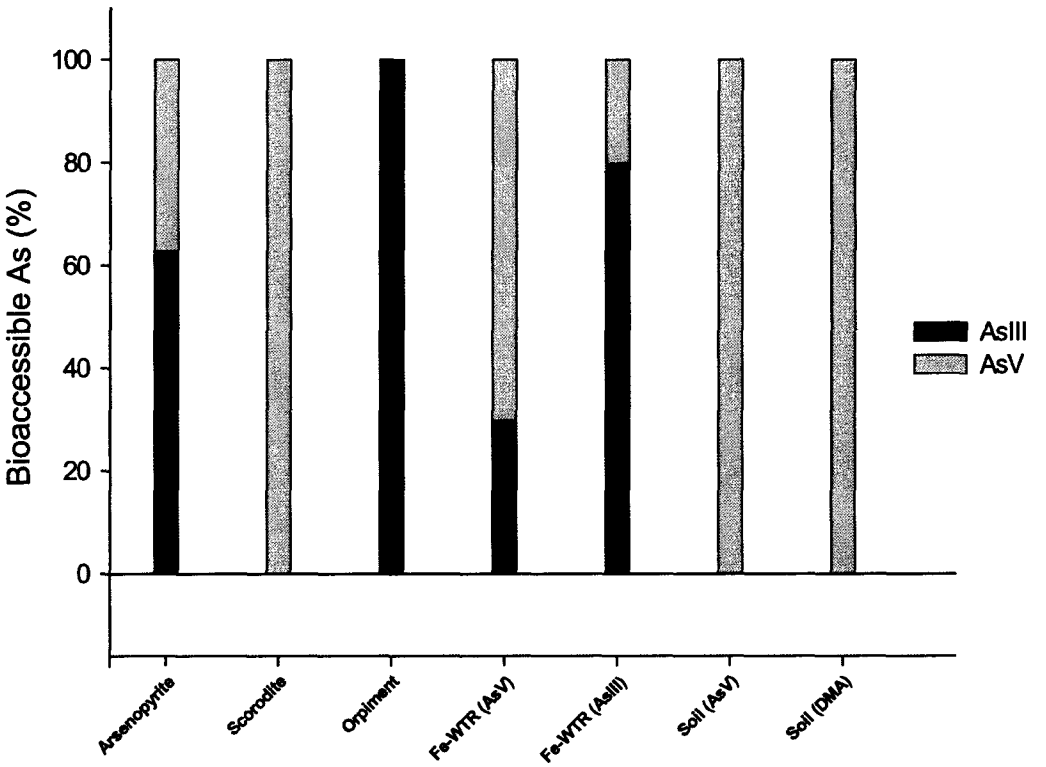

FIGURE 1. Arsenic speciation in the human gastric solution using the optimized in vitro test for different solid As phases, including both crystalline and amorphous As phases. No DMA or MMA was detected in any of these As phases. In the absence of a solid As phase, the oxidation states of aqueous As solutions (AsIII, AsV, DMA, and MMA) subject to the optimized in vitro gastric test did not change.

tion). In brief, the soil (Immokalee series) was spiked with sodium arsenate ($Na_2AsO_4 \cdot 7H_2O$) to reach the load of ~1500 mg of As kg^{-1}. Soil subsamples were either amended with an Al-based WTR (10% by weight) or with an Fe-based WTR (10% by weight); the appropriate soil control (no WTR added) was also included. Two other samples were prepared by spiking Al- and Fe-WTR with a sodium arsenate solution to attain the 1500 mg of As kg^{-1} load. Subsequently, 3 kg of the above As-contaminated soil treatments were transferred to PVC columns (38 × 15 cm) and planted with rice seedlings (*Oryza sativa* L.). After three years of aging, representative subsamples (two replicates) from the above-mentioned treatments were collected, air-dried, and passed through a 250 μm sieve. Mansfieldite ($AlAsO_4 \cdot 2H_2O$) was synthesized in the laboratory according to the protocol by Rochette et al. (*22*).

BALB/c mice (six-week-old) were dosed with 0.1 g of a solid sample suspended in 0.3 mL of d-H_2O, using the gavage method. A solution of sodium arsenate ($Na_2AsO_4 \cdot 7H_2O$) used for the intramuscular dosing treatment was administered with a syringe to each animal, having an equivalent As concentration to that of the corresponding solid As phase. Blood samples were collected after 1 h of oral and intramuscular administrations, and they were subsequently digested and analyzed for As (*23*). Four replicates were used per treatment. RBA was calculated as the ratio of the absolute As bioavailability (ABA) present in the sample and the ABA of As in the appropriate reference material ($Na_2AsO_4 \cdot 7H_2O$). ABA was defined as the ratio of the As absorbed compared to the amount of As ingested.

The in vitro model validation was independently conducted by comparing the RBA values obtained for the five solid As phases with either the "original" (*5, 16*) or the "optimized" in vitro gastric tests.

Results and Discussion

Gastric Solution Chemistry Effects on Arsenic Speciation and Bioaccessibility. Selected properties for the solid As phases are shown in Table S1, Supporting Information. Standard aqueous solutions of As(III), As(V), DMA, or MMA that were subjected to the in vitro gastric test did not result in alteration of the As oxidation state (data not shown), suggesting that bioaccessible As represents species present initially at the surface of the solid As phase (either crystalline or amorphous). Subjecting arsenopyrite into the in vitro gastric test released both As(III) and As(V) into the solution, although bioaccessible As(III) > As(V) [62% As(III)] (Figure 1). In unaltered arsenopyrite, the As oxidation state is either 0 or −1, but surface oxidation may result in higher oxidation states of lattice As (+3, +5) that alter the bioaccessible As(III)/As(V) ratios (*24*). Scorodite was a fully oxidized mineral with As(V) being 100% of the total bioaccessible As in the gastric test. Arsenite was the only As species that was measured in the in vitro gastric test using orpiment, being consistent with the orpiment surface As oxidation state (*25*).

Depending on the oxidation state of sorbed As, a mixture of As(III) and As(V) was bioaccessible in the gastric test of the amorphous solid As phases (Figure 1). The predominant bioaccessible As species were As(V) (90%) and As(III) (80%) for the Fe-WTR amended with either As(V) or As(III), respectively (Figure 1). X-ray absorption spectroscopy showed that the oxidation state of dissolved As remained unchanged upon sorption by the surface hydroxyls of an Fe-WTR (*26*), corroborating our findings during this in vitro test. Similar data were obtained for the soil contaminated with sodium As(V) pesticide, but this was not the case for the soil contaminated with DMA pesticide. Specifically, As(V) was the main bioaccessible As species, suggesting that DMA degradation to the more toxic inorganic As(V) had already occurred on the soil particle surface, prior to its release in the gastric compartment (data not shown). Incubation data for a DMA-contaminated soil supported a C–As bond cleavage mechanism during DMA transformation to As(V) (*27*).

An analysis of variance conducted for each solid As phase showed a significant ($p < 0.05$) fit of a quadratic model to

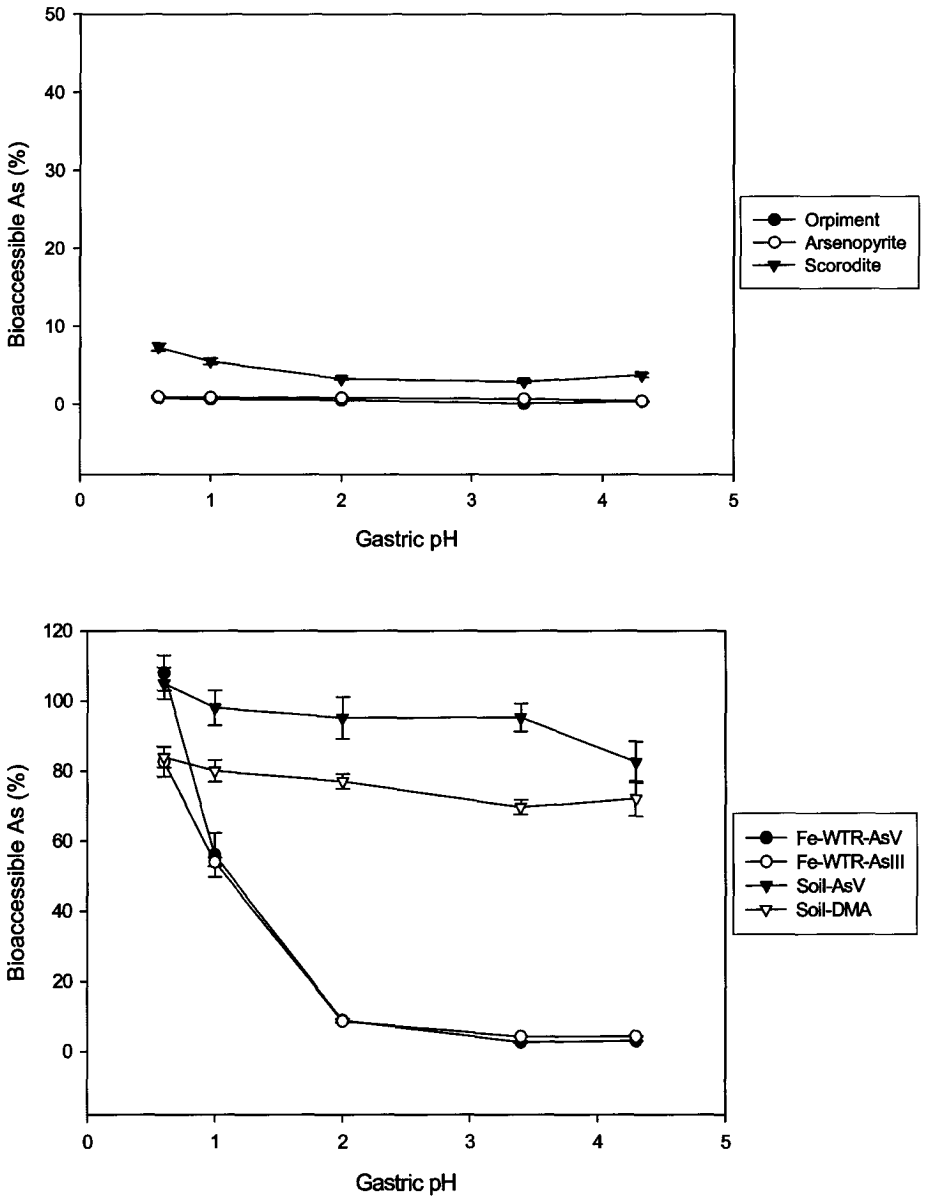

FIGURE 2. Changes in As bioaccessibility as a function of solution pH during the in vitro gastric phase test for a suite of major solid As phases. Crystalline As phases in graph A (top) and amorphous As phases in graph B (bottom). Residence time = 1 h, and solid/solution ratio = 150 mL g^{-1}.

the in vitro As bioaccessibility data as obtained with various combinations of the three factors (RT, pH, and SSR; Table S2, Supporting Information). Out of the three factors studied, only the gastric pH significantly ($p < 0.05$) influenced the magnitude of soil As bioaccessibility for all seven solid As phases (Table S2, Supporting Information). The range in values of RT and SSR did not significantly ($p > 0.05$) influence the magnitude of As bioaccessibility for the seven solid As phases, similar to earlier conclusions regarding the SSR effect on soil As bioaccessibility (*28*). The range of RT (0.66–2.3 h) and SSR (60–1240 mL g^{-1}) used during the model construction corresponds to typical values measured in actual toxicological studies with human patients (*29*). Interactions between the three factors at the 95% confidence level were not significant ($p > 0.05$) for all solid As phases (data not shown).

Decreasing the gastric pH (from pH 4.0 to 0.6) resulted in concomitant increases of As bioaccessibility for all solid As phases (Figure 2). For the crystalline phases, the magnitude of bioaccessible As was very small (<1%), even at the lowest pH measured (pH 0.6) for both orpiment and arsenopyrite (Figure 2A). The magnitude of bioaccessible As in the scorodite system was greater, reaching up to 7% of the total As at the lowest pH measured (pH 0.6). Crystalline As phases released little As into the gastric solution within the experimental conditions (pH 0.6–4.0), but the pH effect was significant ($p < 0.05$) within the narrow range of pH 0.6–2.0 (Table S2, Supporting Information). The amorphous As phases released greater amounts of bioaccessible As in the gastric solution, and the pH effect was more obvious than that observed with the crystalline As phases (Figure 2B). Changing the pH from 2 to 0.6 resulted in a steep increase of bioaccessible As concentrations, especially for the Fe-WTR, but this trend was less pronounced with the soil data. The increasing trend of bioaccessible As with lowering the gastric pH has been previously observed by decreasing the gastric pH from 4.0 down to 1.0 (*6*). This trend suggests that lowering the gastric pH to ~1.0 tremendously impacts the magnitude of solid As bioaccessibility. Such a low gastric pH (pH ~1.0) is realistic in fasting children, since pediatric studies on a fasting children population showed a dramatic pH decrease down to 1.0 (*19, 30*). Fasting children have the ability

TABLE 2. Numerical Optimization Output for the Factors Maximizing in Vitro Soil As Bioaccessibility Constrained by the Lowest Actual Measured Gastric pH Values (pH = 1.0) Measured in Fasting Children (*19*)[a]

	residence time (h)	gastric pH	solid/solution ratio (mL g^{-1})	desirability
orpiment	1	1.0	150	0.93
scorodite	1	1.08	150	0.60
arsenopyrite	1	1.04	150	0.62
Fe–WTR–As(III)	1	1.05	150	0.59
Fe–WTR–As(V)	1	1.05	150	0.73
soil–As(V)	1	1.05	150	0.56
soil–DMA	1	1.02	150	0.50

[a] Residence time and solid/solution ratios were kept constant, and only the gastric pH was optimized since it was the only significant factor.

to develop a highly acidic gastric pH environment within a couple of hours, and the pH reduction occurs much faster in children than in adults (Dr. Ingebo, MD, University of Arizona College of Medicine, Gastroenterology Dept., personal communication). Thus, the inclusion of such low gastric pH values (pH 1.0) in soil As bioaccessibility studies is pertinent, and it represents a worst-case scenario that should not be neglected. Intentionally (poverty-stricken in developing countries) or unintentionally fasting children playing in contaminated soils represent a worst-case scenario that needs to be addressed.

Optimization of the in Vitro Arsenic Bioaccessibility Model. A numerical nonlinear optimization routine was set up, utilizing all experimental data from the CCD study, keeping RT and SSR values constant (RT = 1 h and SSR = 150 mL g^{-1}), since these factors were not significant (Table 2). The goal of the nonlinear optimization was to identify the levels of the studied factors that maximize soil As bioaccessibility under the worst-case scenario constraint, thereby, formulating the optimized in vitro As bioaccessibility test. This worst-case scenario encompassed extremely low pH values (down to pH 1.0) that have been actually measured in fasting children (*19*). The numerical optimization output showed that the maximum soil As bioaccessibility was obtained with a numerical combination of levels corresponding to the lowest boundary of the algorithm (average pH 1.03; Table 2). Desirability function values for most of the solid As phases were between 0.50 and 0.73, with the exception of orpiment (0.93). The reason behind the relatively low desirability values (<1) was that the lowest boundary (pH = 1.0) constrained the nonlinear algorithm of reaching the highest bioaccessible As values measured at pH values <1.0 during the CCD model construction stage. Thus, the following experimental conditions represented the optimized in vitro As gastric test under the constraints of the worst-case scenario applicable to fasting children: RT = 1 h, gastric pH = 1.0, and SSR = 150 mL g^{-1}.

Validation of the Optimized in Vitro Bioaccessibility Model. Bioaccessible As concentrations that were independently obtained with the optimized in vitro test were validated against RBA data obtained with an animal model (BALB/c mice; Figure 3). Results showed excellent agreement between both in vitro tests (original and the optimized) and the RBA values for the As-contaminated soil (Figure 3). Excellent agreement between the optimized in vitro and the RBA in vivo As values was obtained for the As-contaminated soil amended with an Fe-WTR and the Fe-WTR samples (Figure 3). The optimized in vitro As concentrations were 96% and 116% of the RBA values measured for the Fe-WTR-amended soil and the Fe-WTR, respectively (Figure 3). On the contrary, the original in vitro test did not match the RBA values obtained with the Fe-WTR-amended soil and the Fe-WTR (39 and 54% recovery, respectively). The optimized in vitro test overpredicted the RBA values obtained for the Al-WTR-amended soil and the Al-WTR (287% and 430%, respectively). The original in vitro test also performed poorly, showing 140% and 50% recovery of the respective RBA values for the Al-WTR-amended soil and the Al-WTR (Figure 3). It was speculated that the high total-recoverable Al concentrations in the Al-WTR-amended soil and the Al-WTR (total Al content in Al-WTR is ~9%) led to a different reaction than the Fe-based solid As phases upon lowering the pH from ~2.0 to 1.0.

The response of Al-WTR, the Al-WTR-amended soil, and synthetic mansfieldite ($AlAsO_4 \cdot 2H_2O$) to changes in gastric pH was almost linear, reaching 100% of bioaccessible As by lowering the gastric pH from 1.8 to 1.0 (Figure 4). Obviously,

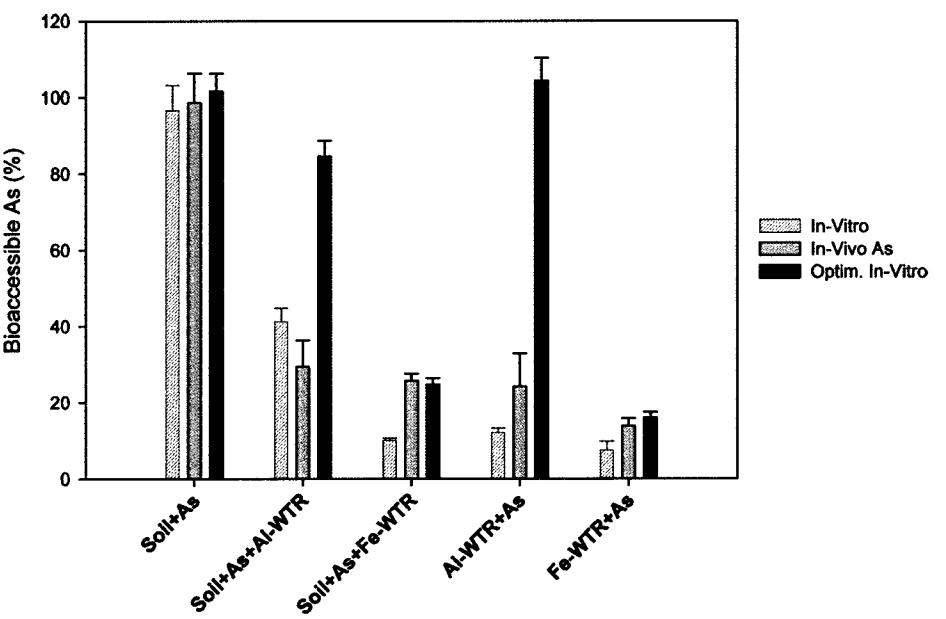

FIGURE 3. Comparison of the optimized in vitro test with RBA bioavailable As data obtained with an animal model, as well as with the original in vitro test. Numbers are the mean of two replicates ± one standard deviation, except for the case of the in vivo As data, which are three replicates per treatment.

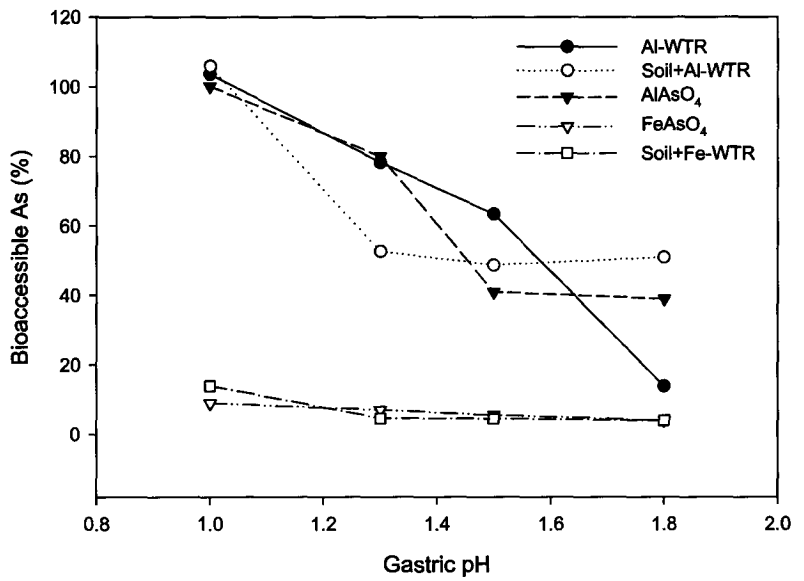

FIGURE 4. Changes in As bioaccessibility as a function of solution pH during the in vitro gastric phase test for materials where As sorption is manifested by the presence of either a crystalline alumino–arsenical compound ($AlAsO_4$, synthetic mansfieldite) or amorphous alumino–arsenical material (Al–WTR+As), or soil mixed with 10% (by wt) of the amorphous alumino–arsenical material. For comparison, a crystalline ferric–arsenate mineral ($FeAsO_4$, scorodite) and an amorphous Fe hydroxide-based soil amended with Fe–WTR are also included.

other reaction mechanisms than simple dissolution allowed for the complete recovery of As in the gastric solution for the Al-based materials. Congruent Al dissolution followed by the formation of nanosized secondary precipitation products is possible, but no direct evidence exists for such speculation; visual inspection did not reveal any precipitates. The Fe-based materials did not show the linear response that was exhibited by the Al-based solid As phases in the narrow range of pH 1.8 to 1.0, showing maximum bioaccessible As concentrations up to 15% at a pH of 1.0 (Figure 4).

Predominant solid As phases in the environment are Fe- and sulfidic-based minerals, because Al-based As minerals, albeit rarely, can be encountered in nature. Mansfieldite ($AlAsO_4 \cdot 2H_2O$) is a crystalline Al–As mineral rarely found around the globe; there is a single location in the U.S.A. where mansfieldite has been found [Hobart Butte, Oregon (*31*)]. Partially Al-substituted scorodite may be found similarly to aluminum-substituted ferrihydrites. Primary solid As phases in U.S. soils do not include Al to an appreciable extent (*7*). Iron oxide content (not Al oxides) was a major factor that influenced As(V) and As(III) bioaccessibility for a suite of contaminated soils (*32, 33*). Electron microprobe analysis revealed 18 different As mineralogical phases present in contaminated soils, but none of those included Al (*3*). Iron sulfate was the only As solid phase that was linearly correlated to RBA As bioavailability values obtained with in vivo experiments (cynomolgus monkeys) (*3*).

The proposed in vitro model adequately predicted RBA values for a suite of Fe-based, solid As phases typically encountered in As-contaminated soils, with the exception of Al-based solid As phases. Aluminum-based solid As phases are not important in soil As biogeochemical processes; in the rare scenario where Al-based As phases dominate soil As biogeochemistry, use of the optimized in vitro test should be avoided. Partial dissolution of Fe-based solid As phases in the gastric compartment releases not only bioaccessible As but also dissolved Fe^{2+} that eventually circulates through the neutral pH environment of the intestinal phase (pH 7). At that pH, amorphous Fe gels may form, influencing the magnitude of solid As bioavailability. However, there are studies suggesting no difference in soil As bioaccessibility between the gastric and intestinal phase in vitro tests (*5*). Advantages of the proposed in vitro model that includes a worst-case scenario (fasting children) may be (i) the inclusion of environmentally relevant solid As phases encountered in contaminated soils, (ii) statistical evaluation on the main and interaction effects of the most important factors regulating gastric solution chemistry and particle dissolution mechanisms, (iii) the optimized in vitro model being based on the output of the nonlinear numerical optimization algorithm that was constrained by a worst case scenario, and (iv) the optimized in vitro model being successfully validated against RBA values obtained with a BALB/c mice model.

Data from this study are encouraging, but the limitation of the proposed in vitro model in high Al-based As phases in contaminated soils needs to be addressed. This study provides the proof-of-concept and the fundamental basis for testing the proposed model on a larger number of contaminated soils. Budget limitations forced us to use the mouse model without losing scientific integrity, because BALB/c mice present a genetically well-characterized strain of mice that has been previously used in toxicological As studies (*34, 35*). Livestock genomics may act synergistically to rodent-based genomics traditionally used in human health studies (*36, 37*).

Acknowledgments

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Supporting Information Available

One figure and two tables show the experimental design details undertaken in this study. This material is available free of charge via the Internet at http://pubs.acs.org.

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An In Vitro Gastrointestinal Method To Estimate Bioavailable Arsenic in Contaminated Soils and Solid Media

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A method was developed to simulate the human gastrointestinal environment and to estimate bioavailability of arsenic in contaminated soil and solid media. In this in vitro gastrointestinal (IVG) method, arsenic is sequentially extracted from contaminated soil with simulated gastric and intestinal solutions. A modified IVG-AB method, where iron hydroxide gel is used to simulate the absorption of arsenic, was also evaluated. Fifteen contaminated soils collected from mining/smelter sites ranging from 401 to 17 460 mg As kg^{-1} were analyzed. In vitro results were compared with in vivo relative bioavailable arsenic (RBA) determined from dosing trials using immature swine which ranged from 2.7 to 42.8% RBA. Arsenic extracted by the IVG and IVG-AB methods was not statistically different than RBA arsenic measured by the in vivo method. Arsenic extracted by the IVG stomach and intestinal phases was linearly correlated ($r = 0.83$ and 0.82, respectively) with in vivo arsenic ($P < 0.01$). Similarly, the IVG-AB method was linearly correlated ($r = 0.79$) with in vivo bioavailable arsenic ($P < 0.05$). All IVG methods extracted similar amounts of arsenic and provided estimates of bioavailable As in contaminated media. The IVG method may aid in the design and cost-effectiveness of remedial strategies of arsenic-contaminated sites.

Introduction

Arsenic is ubiquitous in soils with natural background concentrations ranging from 0.1 to 40 mg kg^{-1} (*1*). Arsenic contamination of soil may result from mining, milling, and smelting of copper, lead, and zinc sulfide ores (*2, 3*); raw and spent oil shale (*4*); and coal fly ash (*5, 6*). Chronic exposure to arsenic may result in skin and internal organ cancers, impaired nerve function, kidney and liver damage, and skin lesions (*7*). Arsenic has been found at high levels (10 000–20 000 mg kg^{-1}) that present risk to human health from the incidental ingestion of soil (*8, 9*). Incidental soil ingestion by children is an important pathway in assessing public health risks associated with exposure to arsenic-contaminated soils. Incidental ingestion of soil results from normal hand-to-mouth activities and represents the principal direct pathway for exposure to nondietary sources of arsenic in contaminated areas. Soil ingestion by children as a health issue fully illustrates the importance of this pathway in terms of subsequent chemical exposure (*10–14*).

Most risk from arsenic is associated with the forms of arsenic that are biologically available for absorption into systemic circulation or "bioavailable" to humans. Presently, methods are not available to quantify the percentage of bioavailable arsenic in soils or to estimate risk from incidental ingestion of arsenic-contaminated materials. Some baseline risk assessments developed for contaminated sites have used the conservative assumption that all (i.e., 100%) of the arsenic present in soils and wastes is bioavailable. However, arsenic may exist in many geochemical forms (e.g., oxides, sulfides) and physical forms (e.g., flue dust, slag, tailings, calcine, waste ore) at hazardous waste sites contaminated by mining and smelter wastes. These waste forms vary in their solubilities and geochemical stabilities to the extent that many are not likely to be very bioavailable and therefore may pose only minimal risks to humans.

The bioavailability of metals, especially lead and arsenic, in some mining wastes have been assessed by conducting expensive and lengthy dosing trials using animal models. The animal model of choice for investigating the enteric bioavailability of arsenic in children requires selection based on similar age and anatomical and physiological characteristics. Pigs are remarkably similar to humans with respect to their digestive tract, nutritional requirements, bone development, and mineral metabolism (*15*). Also, pigs, like humans, tend to ingest food intermittently allowing the stomach to evacuate periodically. This physiology is consistent with the way children most likely ingest arsenic-contaminated materials, between meals when the gastric pH is lowest. Immature pigs have therefore been used successfully as a model for the gastrointestinal function of children (*16, 17*).

To overcome some of the difficulties and expenses associated with animal dosing trials used to assess bioavailability of lead in soils, a research effort has been directed toward development of in vitro chemical methods that simulate the gastrointestinal environment. One such method is the physiologically based extraction test (PBET) (*18*). The PBET method is a good predictor of lead bioavailability. However, PBET research with arsenic-contaminated materials has been limited to only a small number of materials, and the ability of PBET to predict arsenic bioavailability is not known.

The gastrointestinal digestive processes are quite complicated and difficult to simulate in vitro. Several studies in the area of human nutrition have reported in vitro methods to assess bioavailable iron in foodstuffs (*19–22*). Many of these procedural steps are based upon the medical and biochemical scientific literature to gain an understanding of the digestive process, especially in terms of digestive solution volumes produced in response to food intake volume, pH conditions during digestive phases, and quantities of digestive juices and enzymes produced such as pepsin, bile acids, pancreatin, etc. (*23, 24*).

There are two predominant mechanisms involved during digestion of metals-contaminated soil: the solubility of the metal from the soil matrix and the uptake (absorption) of the metal across the intestinal membrane. Previous in vitro type studies have looked at the solubility of metals under gastrointestinal conditions as an indicator of potential

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TABLE 1. Chemical Element Content and Select Properties of Soils and Solid Media

	Soils and Solid Media														
properties	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
pH[a]	2.6	2.6	3.1	3.1	5.7	7.4	7.7	7.1	7.4	7.4	3.9	4.6	7.5	7.3	7.6
TOC (%)[b]	0.36	0.22	0.58	0.41	0.61	0.89	3.13	1.58	3.38	3.22	0.81	1.52	2.28	0.23	4.58
% <2 μm[c]	5.7	10.1	13.4	9.8	7.4	6.5	18.4	8.4	7.3	7.5					
% <50 μm[c]	51.6	49.8	57.4	45.5	49.4	30.2	59.1	36.5	45.1	45.6					

	Soluble Anions[d] mg kg^{-1}														
properties	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
chloride	2550	2950	1240	1080	1710	944	1170	2200	976	1130	4220	9870	912	2450	14200
sulfate	158300	83120	23400	224300	219800	1310	3290	10510	2900	2530	221100	347180	2480	1360	9450
nitrate	103	160	100	49.4	297	147	942	507	552	628	324	2470	53.8	77.5	876

	Major Elements[e] %														
properties	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Si	17.4	17.0	18.0	18.0	22.7	16.8	21.3	23.0	20.1	20.5	22.6	28.8	16.7	12.8	26.5
Al	1.19	1.17	1.60	1.80	3.02	2.43	3.62	3.20	2.64	2.74	7.56	4.64	1.73	2.48	3.56
Ca	1.20	0.68	0.41	2.90	2.86	12.1	9.64	8.57	7.50	6.07	2.43	3.98	12.1	14.0	8.43
Fe	29.7	31.7	28.5	25.0	16.6	20.9	11.7	16.6	17.2	18.3	7.07	2.01	20.4	22.5	6.17

	Trace Elements[f] mg kg^{-1}														
properties	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Pb	11070	12100	10980	8430	5530	8740	6840	3510	12600	11530	9200	214	11800	12060	3680
Zn	1600	1610	1650	1660	4740	3850	1560	2510	4045	3400	11200	5650	4400	6290	10770
Cu	385	318	384	524	997	1810	1610	2210	4230	4010	975	8240	2210	2550	954
Ni	39.1	35.9	31.4	32.2	37.4	24.5	24.4	31.9	35.3	34.0	14.8	17.3	36.7	24.5	24.3

[a] 1:1, soil:0.01 $MCaCl_2$ (*29*). [b] Total organic carbon (*30*). [c] Pipette method (*31*). [d] 1 g soil:10 mL of H_2O, shake 1 h, filter 0.45 μm. [e] X-ray diffraction (*32*). [f] SW 846, method 3050 (*33*).

bioavailability (*18, 25*), but in vitro gastrointestinal methods that simulate the mechanism of absorption have not been reported. Arsenate and the chemically similar phosphate have been shown to have a high affinity for amorphous iron hydroxide gel (*26–28*). Incorporation of iron hydroxide gel in an in vitro procedure to simulate intestinal absorption is also evaluated in this study.

The primary objective of our study is to develop a method to measure the bioavailable fraction of arsenic in soil and waste which is correlated with the bioavailable arsenic, as measured in vivo (per pig dosing trials). A second objective is to compare results from our in vitro methods with those from the PBET method.

Experimental Methods

Contaminated Soils and Solid Media. Two matrices were collected for this study from a typical mining/smelter site in the western U.S. where wastes were deposited between 20 and 50 years ago. These aged and weathered wastes included a calcine material (a waste product which results from the roasting and smelting of arsenopyrite ore for the extraction of arsenic) and an iron slag material (a waste product that results from the smelting of ores for lead which is also high in iron). Five calcine (soils and solid media 1–5) and five iron slag (soils and solid media 6–10) samples are fairly consistent in their respective chemical and physical properties for each matrix (Table 1); however, they differ in their total arsenic concentrations (Table 2), ranging from 401 to 17 456 mg kg^{-1}. Mineralogical composition of one calcine (soil 4) and one slag (soil 9) was determined by microprobe analysis for the various and arsenic-bearing solid phases. Soil 4 contained 38% of total arsenic as an arsenic jarosite analogue and 60% arsenic associated with Fe and Mn oxides. Soil 9 contained 17% of total arsenic as an arsenic jarosite analogue, 53% associated with Fe and Mn oxides, and 30% of total arsenic associated with lead oxide.

Approximately 20 kg of each soil was collected, air-dried under ambient conditions, and sieved to collect the particle size fraction <250 μm which adheres to fingers and is thus available for incidental ingestion. Soils were thoroughly homogenized/mixed prior to use and stored in secured, air-tight containers. Five more contaminated materials (soils and solid media, soils 11–15) were included in the study to test the in vitro method over a broader range of matrices. These materials, consisting of soils and slags, had been archived from previous studies involving chemical analyses and pig dosing trials.

Immature Pig Dosing Trial. Standard operating procedures developed by Dr. Stan Casteel of the University of Missouri—Columbia Veterinary Medical Diagnostic Laboratory, approved by the U.S. Environmental Protection Agency (EPA) Region 8 (*34*), were utilized in the immature pig trials. Intact male pigs weighing 10–12 kg were randomly assigned to treatment groups consisting of a calcine dosing group, slag dosing group, negative control group (no soil), and positive control group (oral Na_2AsO_4). Five pigs were used per treatment group, with the exception of three pigs per negative control group. All pigs were individually housed in arsenic-free cages and fed water and a grower ration formulated by the University of Missouri feed mill. After a three-day acclimation period, the pigs were exposed to soil/treatment doses. Pigs were dosed with 6.25 mg of soil per kg body weight per day with one-half of the dose administered 2 h before feeding in the morning and the remaining half given 2 h before the afternoon feeding. Soil doses were placed in the center of a 5 g portion of moistened low-arsenic/low-lead diet material (Ziegler Bros., Inc., Gardners, PA) and hand administered to each animal. The soil mass per dose

TABLE 2. Chemical Content and Bioavailability of Arsenic in Soils and Solid Media

arsenic	soils and solid media														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
total (mg kg^{-1})[a]	11300	17500	13500	11500	6250	405	450	1180	5020	4650	331	233	799	1460	401
TCLP (mg L^{-1})[b]	2.97	3.01	3.03	2.94	3.00	2.96	2.78	2.91	3.17	2.93	2.65	2.75	2.61	2.73	2.95
TCLP (mg kg^{-1})[b]	59.4	60.3	60.5	58.8	60.0	59.2	55.6	58.1	63.4	58.6	53.0	55.1	52.2	54.5	59.0
bioavailable (%)[c]	2.7	3.3	8.3	22.1	30.1	bdl[d]	bdl[d]	28.7	30.1	16.4	6.2	42.8	29.1	18.7	36.5

[a] SW 846, method 3050 (*33*). [b] SW 846 method 1311 (*33*). [c] Relative bioavailable arsenic from in vivo swine study. [d] Below detection limit.

varied from 23 to 30 mg initially and was adjusted every 3 days to account for growth of the pigs. Soil masses delivered during the final 3 days of the dosing trial ranged from 41 to 45 mg. Every 3 days thereafter, for five collection periods, 24-h excretions of urine were collected from each pig. The urine samples were filtered (Whatman 2), placed into plastic bottles, and preserved to pH 2 with concentrated HCl. Urinary samples were packed securely in coolers on ice and shipped by overnight carrier under chain-of-custody procedures to Oklahoma State University (OSU) for arsenic analysis. Following an additional filtering through 0.45 μm filters, arsenic analysis was performed by a Thermo-Jarell Ash Inductively Coupled Plasma (ICP) (Maxim) utilizing Hydride Generation (HG). To prepare the urine samples for hydride generation, 10.0 mL aliquot of urine was placed into a test tube and mixed with 3.3 mL of concentrated HCl and 4.0 mL of a solution containing 10% potassium iodide and 1% ascorbic acid. After a reaction period of at least 1 h, arsenic was determined by ICP-HG. Adequate blanks, duplicates, and matrix spikes were analyzed to meet quality assurance and quality control requirements.

In Vitro Procedures. Bioavailable arsenic was estimated in our study by two separate in vitro methods and compared to the in vivo study results (Figure 1). An additional comparison of our in vitro results was made with another previously published in vitro procedure (*18, 35*). Canning jars (1 L) were used as reactor vessels because of their wide-mouth and heavy glass composition. All in vitro procedures were conducted in a water bath at body temperature (37 °C), anaerobic conditions were maintained by constantly diffusing argon gas through the solution, and the pH of the in vitro solutions was monitored constantly and adjusted as necessary throughout the procedure. Constant mixing was maintained throughout the procedures (to simulate gastric mixing) by use of individual paddle stirrers at a speed of approximately 100 rpm. A schematic diagram depicting the in vitro reactor design is illustrated in Figure 2.

The in vitro methods were conducted in two sequential phases: (1) gastric phase, low pH by adjustment with trace metal grade HCl, followed by (2) intestinal phase, pH raised by adjustment with a saturated solution of $NaHCO_3$. Throughout the gastric and intestinal phases, a small amount of antifoam agent was added (e.g., decanol) to control excessive foaming due to constant argon gas diffusing through the solutions. A 40 mL sample was collected using a new Luer-lock syringe at the end of each phase (1 h). Samples were centrifuged at 10 000 rpm for 15 min; and the supernatant was filtered through a 0.45 μm filter, acidified to pH 2 with concentrated HCl, and analyzed for arsenic by ICP-HG (following preparation for hydride generation as described above for urine). All in vitro tests were performed in triplicate for each contaminated material. The three in vitro methods studied are presented below. Adequate blanks, duplicates, and matrix spikes were analyzed to meet quality assurance and quality control requirements. The experimental parameters for each of the in vitro methods along with their respective literature references are presented in Table 3.

(1) In Vitro Gastrointestinal Method (IVG). Gastric phase solution was 0.15 M NaCl and 1% porcine pepsin (Sigma Chemical Co., St. Louis, MO. Soil (4 g) was added to 600 mL of gastric solution. An equivalent amount of the dosing vehicle (200 g dough) was added to the gastric solution to mimic the in vivo dosing of 100 mg of soil to 5 g of dough. Gastric solution pH was adjusted to 1.8 following the addition of soil. The gastric phase solution was modified to the intestinal phase solution by adjusting the pH to 5.5 with a saturated solution of $NaHCO_3$ followed by addition of porcine bile extract (2.10 g; Sigma Chemical Co., St. Louis, MO, cat. no. B8631) and porcine pancreatin (0.21 g; cat. no. P1500).

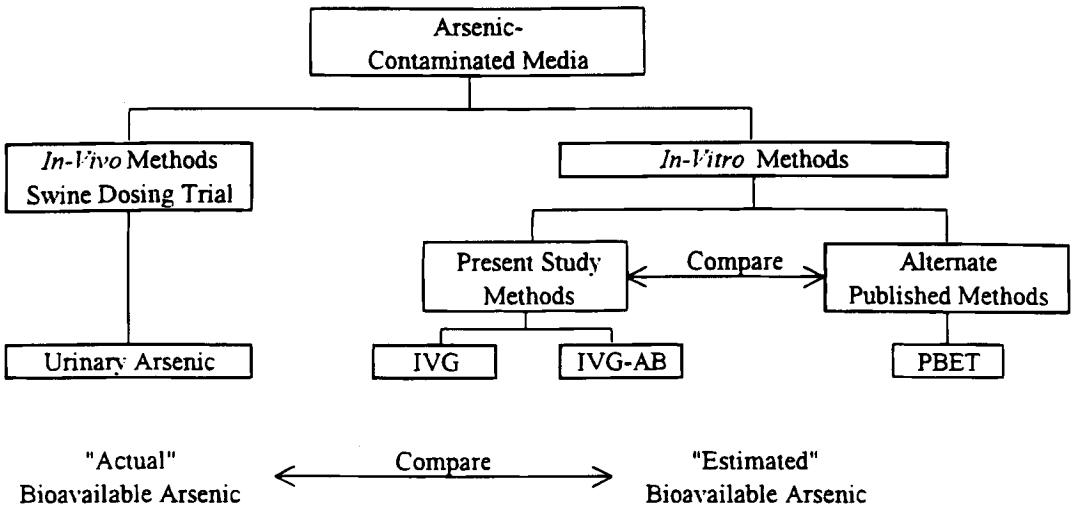

FIGURE 1. Conceptual approach to the in vitro method evaluation.

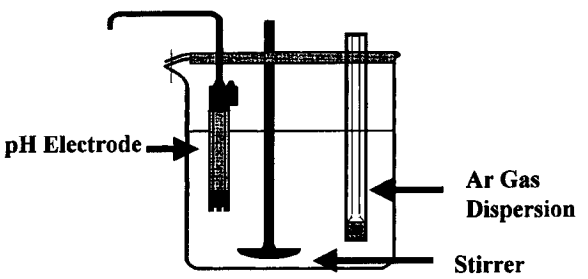

FIGURE 2. In vitro reactor design.

TABLE 3. In Vitro Experimental Parameters and Literature References

parameter	IVG method	IVG reference	IVG-AB method	IVG-AB reference	PBET[a]
		Gastric Solution			
pH	1.8	24	1.8	24	2
NaCl	0.15 M	22	0.15 M	22	none
pepsin	1.0%	22	1.0%	22	0.10%
citrate	none		none		0.05%
malate	none		none		0.05%
lactic acid	none		none		0.5%
acetic acid	none		none		0.50%
soil:solution ratio	1:150	24	1:150	24	1:100
food added	yes	33	yes	33	no
		Intestinal Solution			
pH	5.5	24	5.5	24	7.0
pancreatin	0.35%	22	0.35%	22	0.018%
bile extract	0.035%	22	0.035%	22	0.05%
adsorbent (iron gel)	no		yes		no

[a] Reference *18*.

(2) In Vitro Gastrointestinal Method with Adsorption (IVG-AB). A second in vitro procedure was performed to determine if an intestinal absorption step could be simulated. This procedure is the same as the IVG method described above with the exception of adding freshly prepared amorphous iron hydroxide gel during the intestinal phase as an adsorbent. Iron hydroxide gel is prepared by making a 0.65 M $FeCl_3$ solution and then slowly adding a solution of 2.7 M NH_4OH until the pH is approximately 6 (*28*). The amorphous iron hydroxide gel is collected by centrifuging the solution at 10000 rpm for 15 min and then carefully pouring off the supernatant. Iron hydroxide (10 g) is placed onto a square (161 cm^2) of 8 μm nylon membrane filter. The nylon filter is tied with nylon string, similar to a tea bag, which is then allowed to suspend freely in the reactor vessel throughout the entire intestinal phase. At the end of the intestinal phase, the iron hydroxide bag is removed and placed into a 250-mL Erlenmeyer flask. Arsenate is desorbed by adding 200 mL of 0.2 M H_2SO_4 to the flask and shaking on a reciprocal shaker for 1 h. The resulting solution is filtered through a 0.45 μm pore size filter and analyzed for arsenic by ICP-HG.

(3) Physiologically Based Extraction Test (PBET). The PBET procedure was performed (*18, 35*) with the following exceptions. To maintain anaerobic conditions, argon gas was diffused through the in vitro solutions continuously rather than utilizing closed reactor vessels, and the pH of the gastric solution was raised to 7.0 (to perform the intestinal phase step) by addition of a $NaHCO_3$ solution rather than using dialysis tubing packed with $NaHCO_3$ powder. The $NaHCO_3$ solution reacted much quicker (1.5−2 h faster) than using the $NaHCO_3$-packed dialysis tubing, which was subject to breaking by inadvertent contact with the mixing blade.

In Vivo Bioavailability Calculations. The amount of arsenic absorbed through the gastrointestinal tract (bioavailable arsenic) may be described in absolute or relative terms. Absolute bioavailability (ABA) is the ratio of the amount of arsenic absorbed compared to the amount ingested:

$$\mathrm{ABA} = \frac{\text{absorbed dose}}{\text{ingested dose}} \tag{1}$$

Relative bioavailability (RBA) is the ratio of the absolute bioavailability of arsenic present in test material (study soil) compared to the absolute bioavailability of arsenic in an appropriate reference material:

$$\mathrm{RBA} = \frac{\mathrm{ABA}\ (\text{study soil})}{\mathrm{ABA}\ (\text{reference material})} \tag{2}$$

In our study, we selected the $Na_2AsO_4{\cdot}7H_2O$ reference material as the control because it is a readily soluble form of arsenic that is easily absorbed. Arsenic excretion in urine was found to be a linear function of the administered dose and was approximately independent of time after 5 days of exposure during dosing trials. In most animals, including pigs, absorbed arsenic is excreted primarily in urine. Thus, the urinary excretion fraction (UEF), defined as the amount excreted in the urine divided by the amount dosed, is a reasonable approximation of the oral absorption fraction or ABA. However, this ratio will underestimate total absorption,

TABLE 4. Comparison of Methods Used To Measure Bioavailable Arsenic in Contaminated Soils and Solid Media[a]

samples	bioavailable arsenic method						
	IVG			PBET			critical value[b]
	stomach	intestinal	IVG-AB intestinal	stomach	intestine	in vivo	
all media ($n = 13$)	16.7 ab	14.8 b	15.3 b	11.8 bc	8.26 c	21.0 a	5.3
CV (%)[c]	75.2	74.6	73.0	95.2	76.4	65.6	
calcine ($n = 5$)	3.66 b	3.52 b	4.00 b	1.44 b	1.47 b	13.5 a	5.1
CV (%)	74.0	75.9	77.2	77.4	47.3	88.8	
iron slag ($n = 3$)	24.8 a	22.7 a	24.1 a	13.9 b	12.0 b	25.4 a	7.4
CV (%)	27.4	28.9	26.6	61.0	33.6	41.6	
all media except calcine ($n = 8$)	24.8 a	21.9 ab	23.0 ab	18.3 bc	12.5 c	25.9 a	6.6
CV (%)	41.3	42.4	38.7	58.9	40.7	49.1	

[a] Values reported are mean percent relative bioavailable arsenic for that group. Mean separation statistics were generated using Duncan's Multiple Range Test (*36*). Multiple comparison of mean values are made between bioavailable arsenic method (horizontally). Mean values with the same letter designation indicate no difference between groups at $P < 0.05$. [b] Quantitative difference between means necessary for methods significantly different at $P < 0.05$. [c] Coefficient of variation.

because some absorbed arsenic is excreted in the feces via the bile and some enters tissue compartments (e.g., liver, kidney, skin, hair, etc.) from which it is cleared very slowly or not at all. Thus, the urinary excretion fraction is not equated with the ABA. The UEF can be used, however, to compute the RBA as follows:

$$\text{RBA} = \frac{\text{UEF (study soil)}}{\text{UEF (reference material)}} \quad (3)$$

All in vivo bioavailabilities in this study are reported as RBAs.

In Vitro Bioavailability Calculations. The standard analysis for soil metal content, including arsenic, during the investigation of the nature and extent of contamination sites is by hot digestion with HNO_3 and H_2O_2, USEPA SW 846, Method 3050 (*33*). The resulting total metal concentration is then used for estimating risks to human health. The realization that probably not all (100%) of the total metal measured by complete digestion is bioavailable has led risk assessors to use a fraction (percentage) of total metal that better represents the bioavailable in the risk calculation. For our in vitro results, bioavailable arsenic is calculated by dividing the arsenic concentration measured in the in vitro stomach phase or the in vitro intestinal phase solutions by the total soil arsenic as described by the following equation:

$$\text{in vitro bioavailable As, \%} = \left[\frac{\text{in vitro As}}{\text{total As}}\right] \times 100 \quad (4)$$

For the in vitro method utilizing iron hydroxide adsorbing gel (IVG-AB), the intestinal phase solution arsenic and the arsenic dissolved from the iron hydroxide gel are summed to represent the total intestinal phase arsenic.

Statistical Methods. Analysis of variance using a randomized complete block design and subsequent separation of means by Duncan's Multiple Range Test (*36*) was used to compare results between in vitro chemical and in vivo methods. Linear regression was used to determine agreement between in vitro chemical and in vivo results. Linear regression parameters (slope equal to one and intercept equal to zero) were evaluated using t-tests to determine agreement between methods.

Results and Discussion

The length of time to perform the stomach phase and intestinal phase (reaction time) was not clearly described in the literature. Hence, an experiment was conducted using the PBET method (*18, 35*) (on one calcine and one slag sample) to determine the dissolution of arsenic over time for each of the phases. The soluble concentration of arsenic remained relatively constant during the stomach phase with samples collected every 20 min. Likewise, samples were collected every 60 min over a 3-h intestinal phase, and, again, arsenic concentration in solution remained relatively constant. A 1-h duration was selected for reaction time of each phase.

Other studies have shown the type of food incorporated into the in vitro method can affect lead bioavailability (*35*). To replicate conditions of the in vivo experiment as closely as possible, an experiment was conducted to evaluate food added (using the soil dosing vehicle) versus without food added. An equivalent volume of soil dosing vehicle (which represented 200 g of vehicle) was added to the reactor vessel. One calcine sample and one slag sample were tested with and without food. For the slag sample, there was no difference in the soluble arsenic measured in either the stomach or intestinal phases of the vessels with-food as compared to the vessels without-food (21.1 mg kg^{-1} stomach phase and 24.4 mg kg^{-1} intestinal phase, without-food conditions versus 19.7 mg kg^{-1} stomach phase and 24.3 mg kg^{-1} intestinal phase, with-food conditions). However, for the calcine sample, more arsenic was solubilized in the with-food treatment as compared to the without-food treatment (2.65 mg kg^{-1} stomach phase and 6.92 mg kg^{-1} intestinal phase, without-food conditions versus 7.86 mg kg^{-1} stomach phase and 10.3 mg kg^{-1} intestinal phase, with-food conditions). Apparently, adding food would not inhibit arsenic solubilization and, in some cases, may increase arsenic solubilization. For the IVG and the IVG-AB in vitro experiments, 200 g of dough, used as the pig dosing vehicle, was added to represent the addition of food. Presence of food in the digestive tract can affect bioavailability of heavy metal (*37*). For example, milk may lower Pb bioavailability by coprecipitation of Pb with calcium phosphate (*38*). The effect of food on Pb bioavailabity in gastrointestinal in vitro tests affects Pb bioavailability in some contaminated media (*35*). However, the effect on Pb bioavailability was found to depend on type of contaminated material and food included in the in vitro test. Inclusion of food affected dissolution of arsenic in our in vitro method but the exact mechanism is unclear.

Comparison of bioavailable arsenic estimated by in vitro methods with in vivo arsenic in contaminated media was accomplished using mean separation by Duncan's Multiple Range Test following analysis of variance (*36*) (Table 4). Only the IVG stomach phase method was equivalent with the in vivo method ($P < 0.05$) across all media. Evaluating the media separately, the iron slag material tested by the IVG stomach phase method was statistically equivalent to the in vivo method, yet the calcine materials were different (at $P < 0.05$). Arsenic extracted by in vitro methods (% RBA) was much lower than in vivo arsenic RBA. When only the slags and soils were evaluated (all media except the calcines), the agreement

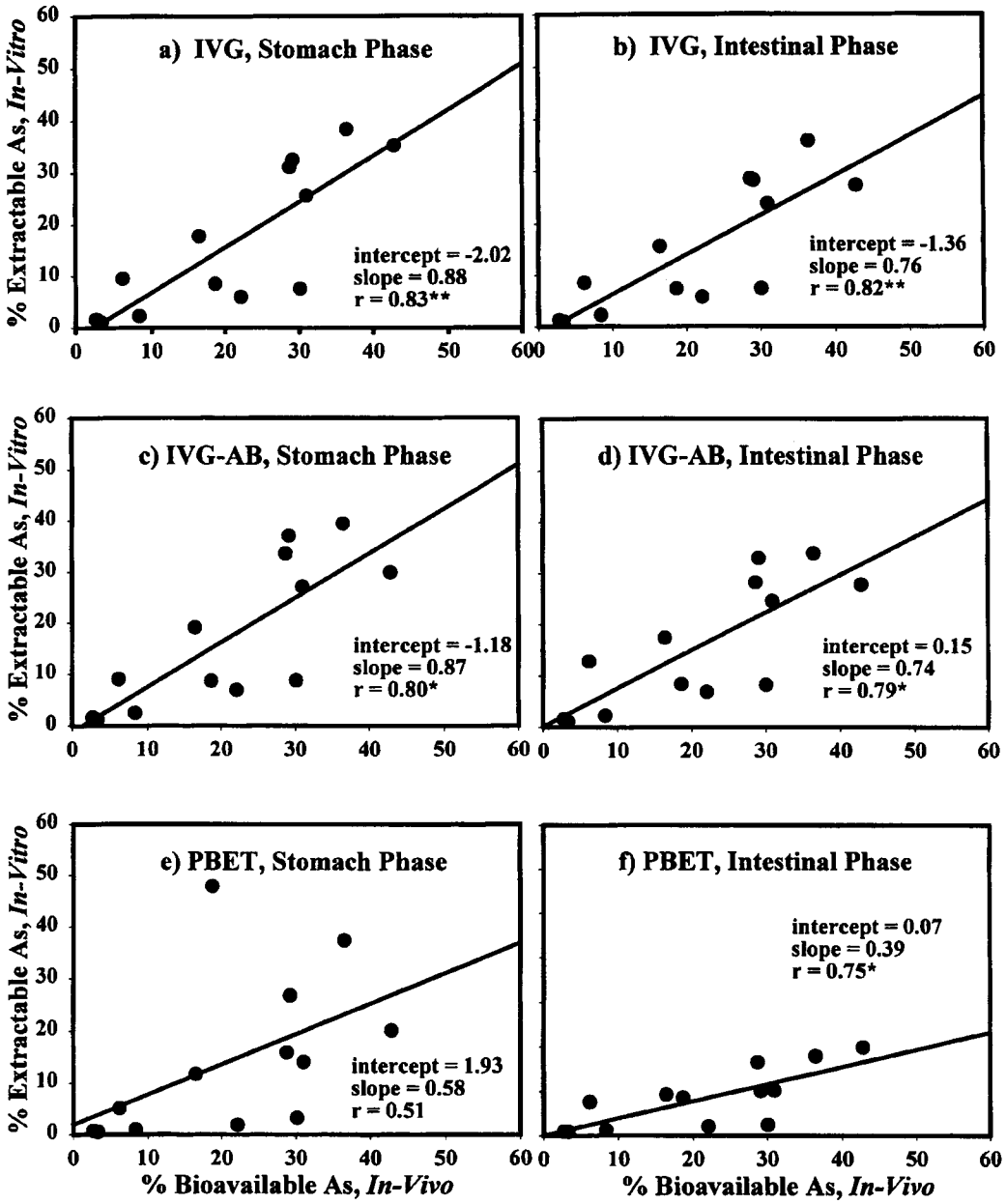

FIGURE 3. Comparisons of gastrointestinal in vitro stomach and intestinal phase bioavailable arsenic with in vivo bioavailable arsenic: (a) IVG, stomach phase; (b) IVG, intestinal phase; (c) IVG-AB, stomach phase; (d) IVG-AB, intestinal phase; (e) PBET, stomach phase; (f) PBET, intestinal phase. **Statistically significant at $P < 0.01$, *statistically significant at $P < 0.05$.

between percent RBA of the IVG stomach phase and in vivo methods improved. Similar results were demonstrated for the IVG-AB intestinal phase method. When only the slags and soils were evaluated, the IVG-AB intestinal method was statistically equivalent with the in vivo method (at $P < 0.05$). The calcine samples, as analyzed by any of the in vitro methods, were not statistically equivalent with the in vivo method.

Few statistical differences between the IVG stomach phase, IVG intestinal phase, and IVG-AB intestinal phase were found for most groups of material (Table 4). In other words, extending the in vitro method beyond the gastric phase did not improve the ability of the method to measure bioavailable As. To simulate absorption across the intestinal membrane, iron hyroxide gel was added to the IVG-AB intestinal phase solution. Intestinal absorption is a different process than adsorption of arsenic to iron hydroxide gel. However, both processes are sinks that remove arsenic from solution. To determine the quantity of iron hydroxide gel to use, an experiment was conducted using iron hydroxide gel to adsorb arsenic from the intestinal phase solution. Ten grams of Fe gel adsorbent in the IVG-AB method adsorbed 60 mg of arsenic from simulated gastric and intestinal solutions that contained 100 mg L^{-1} arsenic as sodium arsenate and 10 000 mg L^{-1} of sulfate. Arsenic concentrations in gastric and intestinal solutions of the IVG method for contaminated media ranged from 0.38 to 12.1 mg L^{-1} with a median value of 1.90 mg L^{-1}. Dissolved sulfate up to 3470 mg L^{-1} occurred in the in vitro solutions of contaminated media, which is below the sulfate concentration of the simulated IVG method solution. Therefore, the 10 g of Fe gel adsorbent was capable of adsorbing all of the arsenic from the gastric and intestinal solutions of the IVG method for contaminated media. However, the simulated absorption step of the IVG-AB did

not increase arsenic extracted from contaminated media compared to the IVG method (without adsorbent). Dissolution of arsenic solid phases of contaminated media by simulated gastrointestinal solutions appears to be the rate-limiting step rather than the subsequent Fe gel adsorption step in controlling dissolved arsenic in the IVG method.

Also of note is that neither the PBET stomach phase nor PBET intestinal phase in vitro methods were found to be statistically equivalent with the in vivo method for any group of contaminated materials tested (Table 4).

Coefficients of variation (CV) values, used to describe variability in bioavailability measurements, for in vivo and in vitro methods were determined (Table 4). The CV values for the IVG and IVG-AB methods for all media were similar ranging from 73.0 to 75.2%. The IVG and IVG-AB methods had a slightly lower degree of precision than the in vivo method (CV of 65.6%). The degree of precision for bioavailability measurements varied with test material. Determination of bioavailable arsenic by all methods for calcine was less precise than noncalcine materials (Table 4). The degree of precision of in vivo and in vitro methods for all media except calcine was very similar, with CV values ranging from 40.7 to 58.9%.

Linear regressions of percent RBA arsenic measured by in vitro tests with the swine in vivo method are presented in Figure 3. Although 15 soils were tested throughout all in vitro experiments, only 13 points are presented on each plot. Samples 5 and 6 (Table 2) had very low arsenic concentrations and were below in vivo bioavailability detection limits. Results of the IVG stomach phase were linearly correlated ($r = 0.83$) with in vivo bioavailable arsenic ($P < 0.01$) (Figure 3a). Statistical analysis of linear regression parameters showed the slope of 0.88 was not different than one, and the intercept of −2.02 was not different than zero; IVG stomach phase results were statistically the same as in vivo results. The IVG intestinal phase was also linearly correlated with in vivo arsenic with an r of 0.82 ($P < 0.05$) (Figure 3b). Statistical analysis of linear regression parameters showed the slope of 0.76 was not different than one, and intercept of −1.36 was not different than zero; IVG intestinal phase results were statistically the same as in vivo results. Comparison of stomach and intestinal phase results of the IVG methods (Table 4, Figure 3a,b) suggests arsenic bioavailability measured by the IVG method is controlled by dissolution of arsenic in gastric phase.

Figure 3c presents the results of the IVG-AB stomach phase. Because the IVG-AB stomach phase is the same procedure as the IVG stomach phase, the gastric solution arsenic for both methods is the same (Figure 3a,c). Slight differences were found between the IVG and the IVG-AB intestinal phases (Figure 3b,d). However, adding the adsorbing Fe gel to the in vitro solution of the IVG-AB method had little effect on the r values of the linear regressions of IVG methods vs in vivo (Figure 3b,d). Statistical analysis of linear regression parameters showed the slope of 0.79 was not different than one, and intercept of 0.15 was not different than zero (Figure 3d); IVG-AB intestinal phase results were statistically the same as in vivo results. Similar results between IVG or IVG-AB and in vivo methods were expected because the simulated absorption step of the IVG-AB did not increase arsenic extracted from contaminated media (Table 4).

Results from the PBET in vitro methods are shown in Figure 3e,f. The PBET stomach phase results are not linearly correlated with in vivo arsenic, while the intestinal phase is correlated with an r of 0.75 ($P < 0.05$). Slopes of the PBET vs in vivo method were different than one but intercepts were equivalent to zero (Figure 3e,f); results from the PBET method were not the same as in vivo results. The PBET method underestimated arsenic bioavailability in calcine materials (Table 4). Excluding calcine-derived contaminated media improved the PBET gastric phase vs in vivo linear regression. The PBET gastric phase arsenic was correlated ($r = 0.70$, $P < 0.10$) with in vivo arsenic when calcine was excluded producing a slope of 0.59 which was equivalant to one. Although both the PBET and IVG methods underestimated bioavailable arsenic for calcine materials (Table 4), parameters in the IVG method improved extraction of arsenic from contaminated media. One difference between the PBET and IVG methods is that the PBET method does not incorporate any type of food into the gastric solution. Food has been shown to have an affect on bioavailability (*35*). Another difference between these methods is the amount of pepsin used in the in vitro solutions. The PBET solution contains one-tenth the pepsin concentration of the IVG solutions. We selected the IVG pepsin concentrations from the human nutrition and medical literature (*22, 24*). Pepsin is one of the most important of the digestive enzymes; it hydrolyzes peptide bonds in proteins and polypeptides with a low degree of specificity. Perhaps hydrolyzed products are enhancing arsenic solubilization.

It is unlikely that an in vitro method can be developed which will replicate in vivo bioavailability. The human digestive system is too complex and dynamic to simulate in the laboratory. A more reasonable approach may be to develop in vitro methods that are based upon human gastrophysiology and correlate well with in vivo method results. From this correlation, mathematical relationships can be developed that will be useful in making risk estimates. The discipline of soil science has used this concept successfully when early work was performed to find suitable chemical extractants to measure plant-available nutrients. Chemical extractants cannot extract plant nutrients in the same manner as a living plant under the conditions of the plant root environment. However, good correlation between soil extractants and plant uptake has allowed soil scientists to use that relationship to make reasonable predictions of plant available nutrients in soil and fertilizer recommendations (*39*). Similar relationships between in vitro and in vivo methods may lead to the development of mathematical relationships from which predictions can be made to derive bioavailable As concentrations in soils for risk estimates that have a lower degree of uncertainty and aid in the design and cost-effectiveness of remedial strategies at contaminated sites.

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Estimation of Lead and Arsenic Bioavailability Using a Physiologically Based Extraction Test

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The physiologically based extraction test (PBET) is an *in vitro* test system for predicting the bioavailability of metals from a solid matrix and incorporates gastrointestinal tract parameters representative of a human (including stomach and small intestinal pH and chemistry, soil-to-solution ratio, stomach mixing, and stomach emptying rates). For lead (Pb), the results of the PBET are linearly correlated with results from a Sprague-Dawley rat model ($r^2 = 0.93$ between *in vitro* and *in vivo* results, $n = 7$). For arsenic (As), the results of the PBET are overpredicting bioavailability study results in rabbit and primate models (2–11% difference between *in vitro* and *in vivo* results, depending on the animal model). The PBET was not designed to supplant bioavailability studies using animal models, but rather to estimate Pb and As bioavailability when animal study results are not available. Dissolution of Pb in the acidic stomach environment was strongly pH dependent; the extent of dissolution decreased by 65% when stomach pH was increased from 1.3 to 2.5. Arsenic solubility decreased by only 16% over the same pH range. Lead was removed from solution to a greater extent than As by neutralization during the small intestinal simulation, consistent with adsorption and precipitation reactions occurring for Pb—but not As—at neutral pH values. In addition to providing mechanistic explanations for controls on Pb and As bioavailability, the PBET allows estimates of site-specific Pb and As bioavailability from soil for the purpose of exposure assessment.

Introduction

When assessing risks associated with lead (Pb)-contaminated soils, one exposure pathway typically evaluated is soil ingestion by children. Standard procedures recommended by the U.S. Environmental Protection Agency (EPA) for estimating soil Pb exposures in children assume that 30% of ingested soil Pb will be absorbed into the systemic circulation (i.e., will be bioavailable) (*1*). However, recent studies suggest that Pb bioavailability may be dependent on the form and solubility of Pb present (*2–4*) and site-specific soil chemistry (*5*). Studies in rats of the bioavailability of Pb derived from mining wastes or smelter emissions have confirmed the dependence of Pb bioavailability on Pb form (*6–9*). Therefore, application of a default 30% bioavailability value may not be appropriate for all types of Pb contamination.

To address this issue, development and validation of a physiologically based extraction test (PBET) for site-specific estimation of soil Pb bioavailability was undertaken (*10*). This test was based on the premise that the form and solubility of Pb in a soil or mine waste will control its bioavailability in an animal model or in humans. This paper describes method development and validation of an *in vitro* test method that is predictive of Pb bioavailability in an animal model. In addition, the PBET has been used to screen for Pb bioavailability of Pb-containing soils and waste materials to determine whether a Pb bioavailability study in an animal model would be warranted. The PBET also appears to be useful in studying the gastrointestinal (GI) tract parameters that control lead bioavailability (e.g., stomach pH and residence time, lead mineralogy, and soil type) and in evaluating the efficacy of *in situ* soil amendments designed to reduce lead bioavailability.

In evaluating arsenic (As)-related risk, the U.S. Environmental Protection Agency (EPA) has derived a cancer slop factor (CSF) and a reference dose (RfD) for use in assessing the cancer risks and other noncancer adverse health effects, respectively, that might be associated with oral exposures to As (*11*). Oral toxicity values typically are derived from animal or human studies that characterize adverse health effects in response to an orally administered dose. However, the administered dose of a compound is seldom completely absorbed, and for many compounds, there are significant differences in the extent of oral absorption from different media. This can lead to overly conservative and costly assumptions in assessing the potential risk of exposure to a particular compound in a medium other than the one used in the studies on which toxicity values are based. The oral toxicity values for As were derived from epidemiological studies of As in drinking water (*12, 13*). Studies investigating the absorption of soluble As ingested by humans suggest that close to 100% of soluble inorganic As is absorbed from the gastrointestinal tract (*14*). In contrast to As in drinking water (soluble As), As in soils generally exists as mineral forms or soil–As complexes that will be incompletely solubilized during transit through the gastrointestinal tract. Recent research indicates that As must be dissolved in order to be absorbed (*15*); therefore, As in soil will be less well absorbed than arsenic in drinking water. Therefore, a bioavailability adjustment factor may be necessary to accurately assess potential risks associated with ingestion of soil As by correcting for the difference in absorption between As in soil and in drinking water.

Reduced absorption of arsenic from soils, relative to

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soluble forms, has been demonstrated in rabbits, dogs, microswine, and monkeys. Arsenic bioavailability from Netherlands soils produced only 8.3% absolute As bioavailability in dogs, when compared to intravenous administration of soluble As (*16*). The soil tested in this study was described as bog ore, with arsenic bound to clay surfaces within it, specifically iron and aluminum oxides. Soil samples affected by smelter emissions were used in studies of New Zealand White rabbits and *Cynomolgus* monkeys, resulting in 48 and 20% As bioavailability, respectively, relative to soluble As (*17, 15*), based on urinary As data. House dust studied in the *Cynomolgus* monkey model resulted in 28% relative As bioavailability (*15*). Recent studies of As bioavailability from mining and smelting wastes in a microswine model also indicate reduced As bioavailability relative to soluble As. These studies indicate that As adsorbed to organic material or clay surfaces in soils, or present as As mineral phases, results in limited As bioavailability in animal models. Because As bioavailability appears to be limited by As form and solubility, the PBET was also developed for As bioavailability estimation. The PBET provides a tool for screening site-specific exposure to As in the absence of As bioavailability data from an animal model. The bioavailability adjustment determined from the PBET can be incorporated into an As risk assessment by use of a bioavailability adjustment factor (ranging from 0 to 1) to adjust soil As exposure estimates so that they are expressed in the same terms as water As exposure estimates.

For the purpose of this paper, the absolute bioavailability of Pb and As is defined as that fraction of ingested Pb and As that is absorbed into systemic circulation. The term "relative bioavailability" is used to describe the bioavailability of Pb and As in mine waste or soil relative to that of Pb and As dissolved in water. Because the bioavailability of Pb and As dissolved in water has been determined in humans, the measurement of relative bioavailability in animal models allows correction of these experimental values back to humans. For example, the bioavailability of Pb in the diet of children (e.g., soluble Pb) is approximately 50% (*1*). If relative Pb bioavailability from a particular soil was determined to be 20% in an appropriate animal model, then this value could be corrected for the known uptake of soluble Pb in children (correction factor of 0.5) to arrive at an estimated 10% absolute Pb bioavailability for this substrate in children. This extrapolation from the animal model to children does not require that the animal mimic or be equivalent to children, but rather that Pb from the test material behave proportionally the same relative to soluble Pb in children and the animal model. Similarly, because the bioavailability of As dissolved in water has been determined in humans, the measurement of relative As bioavailability in animal models provides the most relevant data for correction back to a human model. Finally, the term "bioaccessibility" is used to define the fraction of total Pb and As that dissolves in the stomach and is available for absorption during transit through the small intestine. The bioaccessibility of Pb and As provides a measure of solubility in the gastrointestinal tract. The fraction of bioavailable Pb and As will be less than the fraction of bioaccessible Pb and As, due to incomplete uptake of solubilized Pb and As in the small intestine.

The PBET was designed around pediatric GI tract parameters for a child 2–3 years old, believed to be at the greatest risk to metal exposure from accidental soil ingestion. This approach was taken to develop a test based on the biological model of interest (e.g., humans, specifically, children) based on the premise that replicating the conditions in the model of interest would produce the most relevant data. Because bioavailability of the test materials could not be measured directly in children, the PBET could not be validated against this particular model. Therefore, animal models were relied upon for comparison to the PBET results, based on the premise that data from appropriate animal models can be extrapolated to humans for the purpose of exposure assessment. Thus, the validation of the PBET is specific to the animal models used, and the usefulness of the test in predicting human exposure is based on extrapolation of these animal data to humans.

It should be noted that the PBET is a screening-level test and does not mimic the entire physiological process controlling uptake of Pb and As. It has not been designed to simulate transport of Pb and As across the intestinal epithelium. As a result, the test cannot evaluate the dose dependency of absorption. *In vivo* studies indicate that saturation of uptake mechanisms results in dose-dependent uptake of Pb (*6, 18, 19*), causing uptake to decrease at higher Pb doses; this phenomenon has not been observed for As at environmental dose levels (*17*). Because the PBET tests only for Pb solubility constraints, it will tend to overestimate Pb bioavailability if dose-dependent uptake causes a significant reduction in Pb uptake. Pb and As absorption in the small intestine may also create a disequilibrium in the small intestinal fluid, which results in additional dissolution of Pb and As (i.e., the small intestine provides a sink for Pb and As); this eventuality has not been evaluated in the PBET. In addition, the PBET, as described herein, does not account for the presence of food in the gastrointestinal tract. Although nutritional status is known to effect Pb and As uptake (*20*), the PBET has been used to mimic fasting conditions, which produce the most soluble Pb and As, and, hence, the most conservative condition. Despite these limitations, which are the topic of ongoing research, the PBET appears to produce data that correlate well with measures of Pb and As bioavailability in animal models.

This paper provides data for seven Pb and three As substrates that were evaluated using both the PBET and animal models, compares the PBET results to those from the animal bioavailability studies, and suggests a screening-level method for extrapolating PBET data to evaluations of human exposure to Pb and As in soil.

Test Materials

Substrates evaluated for Pb bioaccessibility in the PBET included two composite mine waste materials from Butte, MT (BMW-I and BMW-II, Table 1); two composite residential soil samples from the vicinity of historical zinc and lead smelters in Bartlesville, OK (BVS) and the Salt Lake City, UT (SCS) areas, respectively; two composite tailings samples from the Copperton tailings, UT (CT-1 and CT-2); and a composite stream channel sample from the Bingham Creek channel, UT (CT-3). The Bingham Creek channel sample contains Pb that is probably related to historical mining and milling operations conducted in the area. These substrates were tested for Pb bioavailability using dosed-feed oral bioavailability studies in Sprague-Dawley rats (*6, 8, 21, 22*), allowing comparison of the PBET results to bioavailability data from a rat model.

Arsenic bioaccessibility was evaluated in two composite residential soil samples (ARS-I and ARS-II, Table 2) and

TABLE 1

Lead Test Material Composition

sample origin	Butte mine waste no. 1	Butte mine waste no. 2	Bartlesville soil	Salt Lake City soil	Copperton tailings no. 1	Copperton tailings no. 2	Bingham Creek Channel
sample identifier	BMW-I	BMW-II	BVS	SCS	CT-1	CT-2	CT-3
lead concn (mg/kg)	3940	3908	1388	2090	7220	6890	10 230
pH	3.6	3.7	7.0	7.5	2.4	2.8	4.9
total organic carbon (%)	2.6	4.1	12.8	NA[b]	0.6	1.8	2.9
particle size (GMS ± GSD)	23 ± 4	42 ± 44	23 ± 4	NA	38 ± 3	23 ± 5	21 ± 5
mineralogic analysis	% Pb Mass Distribution in Mineral Phases						
phase							
anglesite	29	53	11	17	62	50	40
galena	19	24	4		6	6	1
manganese–lead oxide	13		47	3		1	8
lead phosphate	26	8	10	30		1	3
iron-lead oxide		4	11	10			4
iron-lead sulfate	8	7	4	6	32	21	3
cerussite	5			9		21	28
slag			5				
metal-lead oxide[a]			5	15			4
lead oxide		3		4			9
lead-organic carbon			1				
elemental lead			2	6			
no. of particles counted	302	160	94	142	136	303	174

[a] Metals in metal–lead oxide are primarily Zn, Cu, As, Ba, and Cr. [b] NA = not available.

TABLE 2

Arsenic Test Material Composition

sample origin	Anaconda residential soil no. I	Anaconda residential soil no. II	Anaconda house dust no. I
sample identifier	ARS-I	ARS-II	AHD-I
arsenic concn (mg/kg)	3900	410	170
pH	6.6	7.8	7.6
total organic carbon (%)	7.4	12	42
particle size (GMS ± GSD)	19 ± 23	25 ± 4	31 ± 3
mineralogic analysis	% As mass distribution in mineral phases		
metal–arsenic oxide[a]	51	46	58
iron–arsenic oxide	35	17	9
metal–arsenic sulfide[b]	1	7	11
arsenic phosphate	1	7	6
slag	7	7	8
iron–arsenic sulfate	3	5	1
metal–arsenic silicate[c]	2	11	7
no. of particles counted	306	587	207

[a] Metals in metal–arsenic oxide are primarily Cu, Zn, Fe, and Al in varying proportions. [b] Metal–arsenic sulfides are a combination of enargite (Cu_3AsS_4), arsenopyrite (FeAsS), and complex solid solutions containing Cu, Te, Pb, Bi, or other metals. [c] Metals in metal–arsenic silicate are primarily Fe and Al in varying proportions.

one composite house dust sample (AHD-I) from the vicinity of a historical copper smelter in Anaconda, MT, while As bioavailability from these three samples was determined in either New Zealand White rabbits or *Cynomolgus* monkeys (*17*, *15*, respectively).

Methods

Selection of PBET Parameters. Rationale for the selection of PBET parameters for gastric and small intestinal pH values, soil mass, and fluid volume, stomach mixing and emptying rate, and small intestinal transit time is described below. The rationale for selection of stomach and small intestinal fluid composition, titration of reaction fluid pH on entering the small intestinal phase, and the method for collection of *in vitro* extract samples are discussed in a previous publication (*10*). In cases where only limited information was available to support selection of a test parameter, a conservative value was selected to maintain the overall conservative nature of the test.

Gastric and Small Intestinal pH. Because pediatric gastric pH is quite variable among individuals, and depends strongly on nutritional status, selecting an appropriate value is a difficult task. Research on pediatric gastric pH using both *in vivo* (ref 23, pH electrode emplaced in lower esophagus, n = 154) and *in vitro* (ref 24, aspiration of stomach fluid followed by pH measurement, n = 105) measurements of pH resulted in mean fasting pH values of 1.7–1.8. Both studies recorded fasting pH ranges from 1 to 4. Following ingestion of food, pediatric gastric pH values rise to >4 (*23*) and subsequently return to basal values within 2 h as food is emptied from the stomach. This behavior is consistent with adults, whose mean fasting gastric pH of approximately 2.0 (*25*) increases to 4–5 following ingestion of a meal (*26*). Gastric pH values

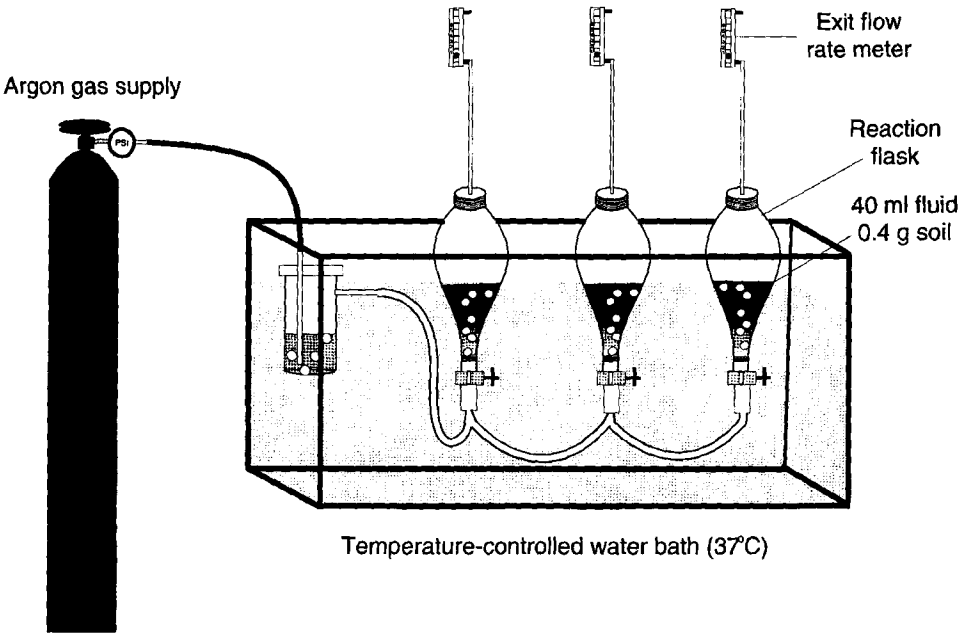

FIGURE 1. Schematic of PBET experimental system.

selected for use in the PBET to represent fasting, "average," and fed states were 1.3, 2.5, and 4.0. The fasting gastric pH value of 1.3 is consistent with an earlier version of the *in vitro* test system and is based on fasting gastric pH measured in rabbits (*10*). The "average" gastric pH value of 2.5 was selected to provide an intermediate pH for testing in the PBET and represents a nutritional status intermediate between fasting and fed states. The gastric pH value of 4.0 is consistent with recent ingestion of food.

A small intestinal pH value of 7.0 was selected for use in the PBET, consistent with measured small intestinal pH values in humans (*27*).

Soil Mass and Fluid Volume. The mass of material used in the reaction vessel was selected after considering EPA's estimate of the mass of soil ingested by a 2- to 3-year-old child (estimated at 0.135 g/day, ref 1) and the minimum feasible soil sample size. A soil mass of 0.4 g was chosen as a minimum value that would ensure a homogeneous split of soil for each test. The volume of fluid in the reaction vessel was maintained at 40 mL, so the solid-to-fluid volume ratio was kept constant, at 1:160 (assuming a density of 1.6 g/cm^3 for the test soil). Soil-to-fluid ratios in the range of 1:5 to 1:25 have been observed to affect dissolution of metals in extraction procedures of this type (*28*), most likely due to diffusion-limited dissolution kinetics, and with this in mind, the soil-to-fluid ratio was selected such that this parameter would not control the test results. Because insufficient data were available for fasting children to support any particular solid-to-fluid volume, a fluid volume of 40 mL was selected arbitrarily to represent a fasting child.

Stomach Mixing. Mixing in the stomach is accomplished by peristalsis, wherein peristaltic constrictor rings force the stomach contents toward the pylorus; the majority of the material cannot pass through the relatively small pylorus into the duodenum, so it is squirted backward through the peristaltic ring toward the body of the stomach (*29*). This mechanism provides for thorough mixing of the stomach contents. Mixing in the PBET was achieved by placing the fluid in a 250-mL polyethylene separatory funnel with a 70-μm frit seated in the bottom, and passing argon (1.0 L/min) through the reaction mixture (Figure 1). Prior to introduction into the separatory funnel, the argon was hydrated and brought to 37 °C by passing through a temperature-controlled water trap. This experimental setup allows control of the mixing rate by adjusting the argon flow and provides turbulent mixing of the reaction mixture as the soil particles are suspended in the test fluid. It is possible that this mixing mechanism may be overly aggressive, thereby overestimating mixing in the child's stomach, an eventuality that will be evaluated in future studies.

Stomach Emptying Rate. The human stomach empties in an exponential fashion, with the fastest emptying rate occurring immediately after a meal is ingested. In adults, approximately 80% of stomach emptying occurs during the first hour after ingestion of a meal, with complete emptying occurring within 2 h (*30*). A recent study using epigastric impedance to measure stomach emptying in healthy children found a half-emptying time ($t_{1/2}$) of 13.5 min for orange squash (n = 45) and 17.0 min for orange squash with 1.25 percent fat content [n = 12 (*31*)]. Since four consecutive $t_{1/2}$ intervals result in approximately 94% emptying, these data suggest that a child's stomach empties in 54–68 min for these two meal types. On the basis of these observations, a stomach incubation time of 1 h was selected for the PBET, despite the fact that a stomach emptying time of 1 h is based on the presence of food while the other PBET parameters are based on a fasting individual. Stomach emptying times in the absence of food are expected to be more rapid than 1 h, as described below.

Small Intestinal Transit Time. As a result of peristaltic waves that move chyme (semifluid digested food material) along the small intestine, 3–5 h is required for passage of chyme from the top of the small intestine to the entrance to the large intestine in adults (*29*). Studies of orocoecal transit time (from ingestion to the ileocecal valve at the entrance to the large intestine) in healthy children (n = 7) after ingestion of a semisolid meal resulted in an average orocoecal transit time of 4.5 h (*32*). Subtracting a 1-h stomach transit time from the above value results in a

pediatric small intestinal transit time of 3.5 h. It should be noted that orocoecal transit times following ingestion of a fluid meal are considerably shorter: approximately 60 min (*32, 33*). On the basis of these data, a 4-h small intestinal transit time was selected for the PBET.

Sample Preparation. All samples were oven dried (24 h at 50 °C) and sieved to <250 μm. Lead and As concentrations in the test materials were measured by digestion [method 3050 (*34*)] and GFAA [methods 7420 and 7060, respectively (*34*)]. Sample pH was measured using the soil slurry method [method 9045 (*34*)]. Total organic carbon (TOC) was measured by weight loss on ignition at 430 °C. Particle size distribution was measured using the electrozone method (Particle Data Laboratories, Elmhurst, IL). Lead and As mineralogies were evaluated using an electron microprobe by the method of ref 2 to identify Pb- and As-bearing phases. Lead and As mass distribution among phases in each sample was calculated by correcting the percent occurrence data by the Pb or As concentration and specific gravity of each phase and normalizing the resultant data to 100%.

PBET Procedure. Gastric solution for the PBET was prepared by adjusting 1 L of DI water to the selected pH with 12 N HCl and adding 1.25 g of pepsin (activity of 800–2500 units/mg), 0.50 g of citrate (Fisher Chemical Co.), 0.50 g of malate (Aldrich Chemical Co.), 420 μL of lactic acid (synthetic syrup), and 500 μL of acetic acid (Fisher Chemical Co.). All chemicals were from Sigma Chemical Co. unless otherwise noted. Forty mL of stomach solution was combined with 0.4 g of test material in a 250-mL polyethylene separatory funnel. The funnel was submerged approximately half-way in a temperature-controlled water bath maintained at 37 °C (Figure 1). The substrate/stomach solution mixture was allowed to stand (no agitation) for 10 min, after which argon gas was purged through the reaction vessel at 1 L/min to provide mixing, as described in the section on Stomach Mixing. The pH was checked after 5 min, and every 10 min thereafter, and the pH was adjusted with HCl as necessary. Samples (2 mL each) were collected at 20, 40, and 60 min and centrifuged at approximately 2100*g* for 25 min, and the liquid fraction was decanted. The 2-mL sample volume was replaced with gastric solution to maintain a 40-mL volume in the reaction flask. After 1 h, the reaction was titrated to pH 7 by adding a 5-in.-long dialysis bag (8000 MWCO, Spectra/Por cellulose ester tubing) containing approximately 1 g of $NaHCO_3$ and 2 mL of DI water. The exact amount of $NaHCO_3$ was determined by calculating the amount of HCl added to each vessel and the amount of $NaHCO_3$ necessary to neutralize it. The dialysis bag was removed when the reaction vessel reached pH 7, and 70 mg of bile salts (porcine) and 20 mg of pancreatin (porcine) were added. Samples (2 mL) were obtained from the small intestinal incubation at 1 and 3 h after the reaction flask reached equilibrium at pH 7. Lead and As concentrations in the extracts were determined by ICP [method 6010 (*34*)].

The bioaccessibility of Pb from sample BMW-I was determined using the PBET in triplicate at gastric pH values of 1.3, 2.5, and 4.0. Sample BVS was evaluated at gastric pH values of 1.3 and 3.0, and all of the other Pb substrates were analyzed at gastric pH values of 1.3 and 2.5. Both samples ARS-I and ARS-II were evaluated at gastric pH values of 1.3 and 2.5, and sample AHD-I was evaluated at a pH of 2.5. Soluble Pb and As spikes (spiked at 5 mg/L) were performed at pH values of 1.3 and 2.5 to evaluate recovery of soluble Pb and As (no soil present) from the test system. Pb and As bioaccessibility (%) was calculated as the fraction present in the fluid phase divided by total Pb or As in the reaction vessel, times 100.

Results

Lead concentrations in the seven substrates tested ranged from 1388 to 10 230 mg/kg (Table 1), providing an order-of-magnitude range in the Pb concentrations tested. Arsenic concentrations ranged from 170 to 3900 mg/kg (Table 2). Sample pH values reflected sample provenance, with tailings and mine-waste materials producing acidic pH values (range of 2.4–4.9) and residential soils and house dust producing near-neutral pH values (range of 6.6–7.8). TOC varied, as expected, based on the origin of the test materials. The tailings-derived materials exhibited TOC values of 0.6–2.9%, the Butte mine-waste materials contained 2.6–4.1% TOC, and the residential soils from Bartlesville and Anaconda ranged from 7.4 to 12.8% TOC (Tables 1 and 2). The Anaconda house dust contained 42% TOC, consistent with house dusts containing a sizable component of exfoliated skin cells, hair, food particles, mites, and insect parts (*35*). Volume-based particle size distribution was determined to provide the geometric mean size (GMS) and geometric standard deviation (GSD) of the test substances. The GMS ranged from 19 to 42 μm for the test substances, indicating that particles were within the size fraction (<100 μm) that adheres to children's hands and may be ingested (*36*).

Pb and As Mineralogy. Results from the electron microprobe analyses (Table 1) indicate that the Pb mass distribution in the mineral phases of samples BMW-I and BMW-II, from Butte, are dominated by galena (PbS), its oxidation product anglesite ($PbSO_4$), and lead phosphates of variable composition. The occurrence of anglesite and galena is consistent with a mining waste provenance, as is the observation that Pb particles in BMW samples were frequently encapsulated (or included) in sulfide (pyrite) or silicate (quartz, feldspar) minerals. In contrast, sample BVS, from Bartlesville, was dominated by soil alteration phases (manganese–lead oxide, iron–lead oxide, and lead phosphate); Pb phases resulting from natural soil weathering processes. This observation is consistent with the average of 66% of mineral-phase Pb attributed to soil Pb alteration phases in Bartlesville soils (*21*). In addition, Pb particles in Bartlesville soils were generally not included within other mineral phases (i.e., they were present as liberated particles), rendering them available for dissolution. Similarly, sample SCS contained primarily soil alteration Pb phases, with the addition of metal–lead oxides (metal = As, Zn, and Cu) and cerussite (Table 1) to the Pb phases occurring in sample BVS. The tailings material samples (CT-1 and CT-2) exhibited a lead mineralogy consistent with a surficial tailings environment, comprising galena, anglesite, and an iron–lead sulfate with a chemistry representative of lead jarosite [$PbFe_6(SO_4)_4(OH)_{12}$]. Cerussite ($PbCO_3$), which was observed in one of the samples, was a primary mineral phase in the orebody from which the tailings were derived. Lead solubility from the tailings materials will be controlled by the limited solubility of anglesite in gastric fluid (*3*) and by the rinding of anglesite and cerussite particles by Pb jarosite, which is stable in acidic solutions [pH < 4, (*37*)]. The sample composed of tailings mixed with stream channel material (CT-3) contained a Pb mineralogy similar to the two tailings samples (CT-1 and CT-2), with the addition of

TABLE 3

Comparison of Pb PBET Results (% Bioaccessibility) and Pb Bioavailability Data

time[a] (h)	BMW-I pH 1.3[b]	BMW-I pH 2.5[b]	BMW-I pH 4.0[b]	BMW-II pH 1.3[d]	BMW-II pH 2.5[d]	BVS pH 1.3[c]	BVS pH 3.0[d]	SCS pH 1.3[c]	SCS pH 2.5[b]
0.33 stomach	7.0 ± 2.0	2.7 ± 1.6	1.1 ± 0.6	22	6	68	22	72	11 ± 4
0.66 phase	8.3 ± 2.0	3.1 ± 2.1	1.1 ± 0.8	31	10	70	25	75	20 ± 2
1.0	9.5 ± 0.4	3.8 ± 1.6	1.3 ± 0.6	35	13	69	26	83	22 ± 6
2.2 small	3.6 ± 2.7	0.94 ± 1.2	0.84 ± 0.2						
3.2 intestine	2.0 ± 0.4	1.4 ± 0.6	0.60 ± 0.2	4	5	16	13	27	8 ± 2
4.2 phase	1.0 ± 1.4	0.94 ± 0.2	0.48 ± 0.2	4	3	12	11	25	7 ± 0
rel Pb bioaccessibility (%) based on stomach data[e]	9.5	3.8	1.3	35	13	70	26	83	22
rel Pb bioaccessibility (%) based on small intestinal data[f]	4.6	2.7		8.3	9.8	29	29	54	18
relative Pb bioavailability in rats[g] (%)		9.3		22.5		35		41	

time[a] (h)	CT-1 pH 1.3[d]	CT-1 pH 2.5[d]	CT-2 pH 1.3[d]	CT-2 pH 2.5[d]	CT-3 pH 1.3[d]	CT-3 pH 2.5[d]	soluble Pb spike pH 1.3[c]	soluble Pb spike pH 2.5[c]
0.33 stomach	12	6.8	8	4	39	22	95	96
0.66 phase	14	8	9	6	42	24	99	98
1.0	16	8	10	6	49	24	108	104
2.2 small								
3.2 intestine	1.2	0.3	0.7	0.7	5	7	53	41
4.2 phase	1.7	0.2	0.4	1.0	8	7	43	41
rel Pb bioaccessibility (%) based on stomach data[e]	16	8	10	6	49	24	48	41
relative Pb bioaccessibility based on small intestinal data[f]	3.0	0.6	1.1	2.1	14	17		
rel Pb bioavailability in rats[g](%)	14.7		8.7		36			

[a] Time from start of PBET assay. [b] Average ±95% upper confidence limit (1.96σ) on triplicate PBET results. [c] Average of duplicate PBET results. [d] Single PBET test. [e] Relative Pb bioaccessibility values based on stomach data are maximum solubilized Pb in the stomach phase, corrected for maximum recovery of soluble Pb spike in the stomach phase. [f] Relative Pb bioaccessibility (%) based on small intestinal data are average solubilized Pb in the small intestinal phase, corrected for the average recovery of soluble Pb spike in the small intestinal phase. [g] Values presented are relative Pb bioavailability in rats, based on blood-Pb data from dosed-feed studies in Sprague-Dawley rats.

soil Pb alteration phases (e.g., ferromanganese lead oxides, lead phosphate, and metal–lead silicate, Table 1). The presence of more soluble Pb phases (e.g., lead oxide, cerussite, and lead silicates) in the stream channel sample suggests that it will yield a greater fraction of bioaccessible Pb than the two tailings material samples. It should be noted that surface-adsorbed Pb (not detectable by electron microprobe) also constitutes a fraction of the bulk Pb pool that will probably be readily desorbed and more bioaccessible in the acidic gastric environment than the mineralogic phases.

Arsenic mass distribution was similar in samples ARS-I, ARS-II, and AHD-1 and consisted primarily of metal–As oxides (metal = Cu, Zn, Fe, and Al in varying proportions) and iron–arsenic oxides, with minor As contribution from slag, metal–arsenic silicate, As phosphate, metal–arsenic sulfides, and iron–arsenic sulfate (Table 2). As with Pb, surface-adsorbed As most likely constitutes a fraction of the bulk As pool in soil, and is generally adsorbed to hydrous iron and aluminum oxides.

PBET Results for Pb. Triplicate PBET analyses of sample BMW-I at three pH values indicated reproducible results, with reproducibility generally better in the gastric than the small intestinal portion of the test, based on upper 95% confidence limits on the triplicate analyses (Table 3). Results indicate that Pb dissolution in the gastric environment is strongly pH dependent, with an average 57% decrease in soluble Pb when gastric pH was raised from 1.3 to 2.5 (3.0 for BVS) for the seven samples tested. Increasing stomach pH from 2.5 to 4.0 for BMW-I resulted in a further 66% decrease in stomach-solubilized Pb for sample BMW-I (Table 3). On entering the small intestinal phase, solubilized Pb decreased by 74 ± 18%, consistent with extensive adsorption and precipitation reactions removing Pb from solution as the pH increased. It should be noted that solubilized Pb in the test is operationally defined as that portion of Pb remaining in solution after relatively low-speed centrifugation (2500g for 25 min). Solubilized Pb in the small intestinal phase remained generally constant or decreased slightly as the incubation time increased for all seven test substrates. Soluble Pb spikes were approximately 100% recovered in the stomach phase of the test, independent of pH, with recoveries of approximately 48 and 41% in the small intestinal phase when gastric pH values were 1.3 and 2.5, respectively (Table 2).

Comparison of the PBET Pb bioaccessibility values for the seven substrates indicates that the model is sensitive to changes in substrates, with tailings and mine waste producing less bioaccessible Pb than the Pb-bearing soils. These results are consistent with Pb solubility expectations for the various substrates based on the Pb mineralogy data. Galena, anglesite, and lead jarosite contained less bioaccessible Pb than did Pb phases such as lead oxide, cerussite, manganese–lead oxide, and metal–lead oxide. Lead bioaccessibility also varied with pH and TOC of the test material. Acidic pH of the test material results in decreased Pb bioaccessibility, most likely due to formation of soil alteration Pb phases such as anglesite and lead jarosite that are stable in the acidic gastric environment. Neutral soil pH results in soil alteration phases such as cerussite

TABLE 4

Comparison of As PBET Results (% Bioaccessibility) and As Bioavailability Data

	ARS-I		ARS-II		AHD-I	soluble As spike	
time[a] (h)	pH 1.3[b]	pH 2.5[c]	pH 1.3[b]	pH 2.5[c]	pH 2.5[c]	pH 1.3[c]	pH 2.5[d]
0.33 stomach	45	33	43	38			83 ± 4
0.66 phase	49	41	48	44	29	102	93 ± 11
1.0	55	40	49	45	34	103	90 ± 16
2.2 small	50	34	44	30	36	96	99 ± 20
3.2 intestinal phase	50	30	44	32	32	98	95 ± 17
rel As bioaccessibility[e] (%)	50	32	44	31	34		
rel As bioavailability (%) in animal models[f]	48 (rabbits)		20 (monkeys)		28 (monkeys)		

[a] Time from start of PBET assay. [b] Single PBET tests. [c] Averages of duplicate PBET results. [d] Average ±95% upper confidence limit (1.96σ) on five PBET runs. [e] Relative As bioaccessibility (%) calculated as average soluble As mass in small intestinal simulation divided by total As mass in the reaction vessel, corrected for recovery of soluble As spike in small intestinal simulation. [f] Values presented are As bioavailability from soil (dosed in capsules to fasting animals) based on recovery of urinary arsenic relative to recovery of As from sodium arsenate dosed by gavage (*14, 15*). Bioavailability of sodium arsenate (administered by gavage) was 50 and 68% in rabbits and monkeys, respectively, compared to intravenous sodium arsenate.

and ferromanganese lead oxides that appear to have greater solubility in the gastric environment. In addition, organic carbon may provide a sorption surface for soil Pb that will be readily desorbed in the gastric environment, causing elevated soil TOC to result in a greater fraction of bioaccessible Pb, consistent with the observed results (Tables 1 and 3).

Comparison of PBET Results for Pb to Animal Studies. Dosed-feed Pb bioavailability studies in Sprague-Dawley rats were performed such that Pb-bearing soil blended in feed could be compared to lead acetate (a soluble Pb salt) blended in feed, yielding the Pb bioavailability from soil relative to Pb acetate. In addition, lead acetate blended in feed was compared to an intravenous injection of lead acetate (100% bioavailability) to determine the absolute bioavailability of lead acetate (*38*). All of the Pb bioavailability data reported herein are based on measurements of blood Pb in rats.

As previously discussed, for the purpose of developing a bioavailability parameter for exposure assessment, measures of relative bioavailability (i.e., bioavailability of Pb from the test material relative to the bioavailability of Pb in water) are more useful than absolute bioavailability. Measures of relative bioavailability were developed in the Sprague-Dawley rat model for test substrates BVS (*21*), SCS (*7*), and BMW-II (*6*), whereas measures of absolute Pb bioavailability were developed for the other Pb substrates (*22*). However, absolute Pb bioavailability may be corrected to obtain relative bioavailability values, based on the use of a correction for the 15% bioavailability of lead acetate in a dosed-feed Sprague-Dawley rat bioavailability study (*38*). For example, material BMW produced 1.4% absolute Pb bioavailability (*22*), which when corrected for the bioavailability of lead acetate (1.4/0.15), yields an estimate of 9.3% relative Pb bioavailability. Relative Pb bioavailability estimates for all seven test substrates are presented in Table 3.

The PBET data were treated in a similar manner (bioaccessibility of Pb from the test substrate was corrected for the recovery of a soluble Pb spike) to arrive at relative bioaccessibility values for both the stomach and small intestinal phase data (Table 3). The recovery of the soluble Pb spike in the stomach phase (100% at both pH 1.3 and 2.5) was used to correct the stomach phase bioaccessibility values, and the recoveries of the soluble Pb spike in the small intestinal phase (48 and 41% at pH values of 1.3 and 2.5, respectively) were used to correct the small intestinal phase bioaccessibility.

Relative Pb bioaccessibility (X axis) and relative Pb bioavailability (Y axis) values were compared using a linear regression model. At a simulated stomach pH of 2.5, this model yields an r^2 of 0.93 ($n = 7$), based on bioaccessibility calculated from the stomach phase data, and an r^2 of 0.76, based on the small intestinal phase data. The difficulty in achieving a good correlation based on small intestinal phase data is most likely due to the complex nonequilibrium chemical system for Pb in the small intestinal phase (described in ref 3), causing poor reproducibility of the test system and variability in the fraction of Pb that was precipitated or adsorbed during the small intestinal simulation. Although use of the small intestinal phase data would be preferable as a measure of Pb bioaccessibility, the correlation between *in vitro* and *in vivo* results was considerably greater for the stomach phase data. In addition, the correlation between stomach phase relative Pb bioaccessibility and relative Pb bioavailability values was equally good at stomach pH values of 1.3 and 2.5 ($r^2 = 0.93$ in both cases). Although identical r^2 values at pH levels of 1.3 and 2.5 may be coincidental (with only seven observations, it is not possible to establish the significance of this finding), these data suggest that extractability of Pb varies consistently as a function of pH over the range from 1.3 to 2.5 for the seven materials tested.

For the purpose of estimating relative Pb bioavailability in Sprague-Dawley rats based on PBET data, a simulated stomach pH of 2.5 was selected as the most appropriate value, because the linear regression for the pH 2.5 data yielded a y intercept closer to 0 (3.2 for pH 2.5 versus 6.8 for pH 1.3) and a slope closer to 1 (1.4 for pH 2.5 and 0.44 for pH 1.3). These data suggest that the stomach pH of 2.5 more closely resembles the conditions found in the Sprague-Dawley rat during a dosed-feed Pb bioavailability study than the pH value of 1.3.

PBET Results for Arsenic. In contrast to Pb, As dissolution did not exhibit a strong pH dependency, with dissolved As from ARS-I and ARS-II (stomach phase) decreasing by only 25 and 8%, respectively, as system pH was raised from 1.3 to 2.5 (Table 4). These data suggest that stomach pH is less important in controlling As bioaccessibility than it is for Pb. On titration to pH 7, solubilized As decreased by only 20 ± 10%, compared to 60 ± 14% for Pb, consistent with the lack of adsorption and

precipitation reactions involving As at neutral pH conditions (*39*).

Arsenic bioaccessibility (%) derived from the PBET (Table 4) was calculated by averaging the two small intestinal values (duplicate measurements ensured that the small intestinal simulation had reached equilibrium As concentration). These values represent the fraction of As from the test material that is dissolved in the small intestinal fluid and is therefore bioaccessible. Subsequently, dissolved As from the test material was divided by the fraction of soluble As recovered from the soluble As spike, yielding As bioaccessibility relative to a soluble As source (i.e., As in drinking water). Because As recovery from the soluble As spike was close to 100% for both pH 1.3 and 2.5 (Table 4), the spike recovery was assumed to be 100% for the purpose of correcting the PBET data. Relative arsenic bioaccessibility estimated by this method for ARS-I was 50 and 32% at pH values of 1.3 and 2.5, respectively, and 44 and 31%, respectively, for ARS-II (Table 4). House dust (AHD-I) relative arsenic bioaccessibility estimated by this method was 34% (stomach pH of 2.5). These data confirm the difference in As solubility between residential soils and house dusts and soluble As forms, with the soil and house dust As being approximately 3 times less bioaccessible than soluble As at a stomach pH of 2.5.

Comparison of PBET Results for As to Animal Studies. Because fasting stomach pH in rabbits is approximately 1.3 (*10*), it is most appropriate to use pH 1.3 PBET data for comparison to an As bioavailability study in fasted rabbits (soil ARS-I). For the purpose of establishing relative As bioavailability from ARS-I, the absolute As bioavailability in rabbits (24%) was corrected for the bioavailability of soluble As in rabbits (50%), yielding a relative bioavailability of 48% (*17*). Application of a similar calculation to the PBET data for ARS-I at a stomach pH of 1.3 yields a relative As bioaccessibility of 57%, comparable to the rabbit data (48%).

Relative As bioavailability was evaluated for materials ARS-II and AHD-I in *Cynomolgus* monkeys, because this animal model has greater physiological and anatomical similarity to humans than does the rabbit. For the purpose of establishing relative As bioavailability from ARS-II, the absolute As bioavailability in fasted monkeys (14%) was corrected for absorption of soluble As (68%), yielding a relative As bioavailability of 20% (*38*). A similar calculation for house dust, which produced 19% absolute bioavailability, yielded a relative As bioavailability of 28% (Table 4). By a similar calculation, the PBET relative As bioaccessibilities from ARS-II were 44 and 31% at pH values of 1.3 and 2.5, respectively, and 34% from AHD-I at a pH of 2.5 (Table 4). No stomach pH data were found in the literature for *Cynomolgus* monkeys. Monkeys of the species *Macaca mulatta*, the most closely related species to *Cynomolgus* monkeys (*Macaca fascicularis*), have a fasting stomach pH of 1.8 to 2.0. Therefore, data from the pH 2.5 PBET were likely to be most comparable to the As bioavailability study results in monkeys. Indeed, comparison of these data indicate that the PBET results using a stomach pH of 2.5 provide a conservative estimate of relative As bioavailability for ARS-II and AHD-I in monkeys (the PBET overestimates monkey results by 4–11%).

Discussion

This study demonstrates that the PBET is useful in evaluating the geochemical and physiological factors controlling the bioaccessibility of Pb and As in the gastrointestinal tract. Lead bioaccessibility was observed to be more dependent on stomach pH than was As. When the acidic stomach environment is neutralized, Pb is largely removed from solution by precipitation and adsorption reactions, while As is not.

PBET data were consistent with lead speciation results. Sample BMW-I and BMW-II, which contained primarily less soluble Pb phases (e.g., galena, anglesite, and lead phosphate; Table 1) and a greater degree of Pb phase encapsulation, resulted in minimal Pb bioaccessibility. The Pb-bearing soil samples (BVS and SCS), which contained more soluble Pb phases (metal–lead oxide, lead oxide, cerussite), produced greater fractions of bioaccessible Pb. In addition, the samples derived from tailings materials (CT-1 and CT-2) also produced limited Pb bioaccessibility, due to the presence of anglesite and lead jarosite, which have limited solubility in the acidic gastric environment. Arsenic speciation results indicated that the soil samples ARS-I and ARS-II contained similar As mineralogy, consistent with the nearly identical As bioaccessibility observed for these samples during PBET evaluation. Because mineralogy and bioaccessibility results for ARS-I and ARS-II are nearly identical, differences between rabbit and monkey study results are most likely due to differences between the animal models, rather than between the substrates tested.

The PBET model provided consistent results across a wide pH range and was sensitive to different types of Pb-bearing materials, as reflected in the ability of the test to accurately predict different Pb bioavailability values measured in a Sprague-Dawley rat model. Application of the PBET data at a stomach pH of 2.5 in a linear regression model (relative Pb bioaccessibility on *Y* axis) yielded results that predicted relative Pb bioavailability in rats ($r^2 = 0.93$, $n = 7$). On the basis of this linear correlation, with a y intercept of 3.2 and slope of 1.4, the PBET data can be used to estimate relative Pb bioavailability in the Sprague-Dawley rat model.

Relative Pb bioavailability from the Sprague-Dawley rat model can be used to estimate absolute Pb bioavailability in children, based on the premise that Pb bioavailability from the test substance relative to soluble Pb is similar in both the rat and child models. Interpretation of the data in this manner does not require the assumption that the rat is equivalent to the child, but only that the two Pb forms behave proportionally in the two models. Because only 50% of Pb in the diet (assumed to be soluble Pb) is absorbed by children (*1*), the relative Pb bioavailability from the rat model can be applied to the child by applying a correction factor (0.50) to the relative Pb bioavailability estimate, to arrive at an absolute Pb bioavailability. The absolute Pb bioavailability estimate generated in this fashion can be compared to the EPA default assumption of 30% absolute Pb bioavailability from soil to determine whether a Pb bioavailability correction for soil is warranted.

Results of the PBET indicate good predictive ability for As bioavailability from soil, producing data that are consistent with results from rabbit and monkey As bioavailability studies. Application of the PBET at a stomach pH of 2.5, followed by correction for As bioaccessibility from a soluble As form, results in relative As bioaccessibility data that provide a conservative predictor of relative As bioavailability in monkeys (4–11% overprediction), the animal model likely to best predict As bioavailability in humans. Because the PBET overpredicts As bioavailability

in animal models, a bioavailability study using monkeys is recommended for situations where the accuracy of As bioavailability values is a primary consideration. However, the PBET has been used to develop As bioavailability adjustments ranging from 10 to 25% for soils and house dusts in Oklahoma and Michigan, and these results have been accepted by state regulatory agencies for the purpose of site-specific exposure assessment.

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An inter-laboratory trial of the unified BARGE bioaccessibility method for arsenic, cadmium and lead in soil

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ABSTRACT

The Bioaccessibility Research Group of Europe (BARGE) has carried out an inter-laboratory trial of a proposed harmonised *in vitro* physiologically based ingestion bioaccessibility procedure for soils, called the Unified BARGE Method (UBM). The UBM includes an initial saliva phase and simulated stomach and intestine compartments. The trial involved the participation of seven laboratories (five European and two North American) providing bioaccessibility data for As (11 samples), Cd (9 samples) and Pb (13 samples) using soils with *in vivo* relative bioavailability data measured using a swine model. The results of the study were compared with benchmark criteria for assessing the suitability of the UBM to provide data for human health risk assessments. Mine waste and slag soils containing high concentrations of As caused problems of poor repeatability and reproducibility which were alleviated when the samples were run at lower soil to solution ratios. The study showed that the UBM met the benchmark criteria for both the stomach and stomach & intestine phase for As. For Cd, three out of four criteria were met for the stomach phase but only one for the stomach & intestine phase. For Pb two, out of four criteria were met for the stomach phase and none for the stomach & intestine phase. However, the study recommends tighter control of pH in the stomach phase extraction to improve between-laboratory variability, more reproducible *in vivo* validation data and that a follow up inter-laboratory trial should be carried out.

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1. Introduction

The Bioaccessibility Research Group of Europe (BARGE, http://www.bgs.ac.uk/barge/home.html) is a European network bringing together international institutes and research groups to study human bioaccessibility of priority contaminants in soils via the gastrointestinal (GI) tract. The key contaminants included in this work are arsenic (As), lead (Pb) and cadmium (Cd) as they are potentially harmful to human health (ATSDR, 2007a, 2007b, 2008) and the most common elements undergoing bioaccessibility research (Smith et al.; Ruby et al., 1993, 1996; Albores et al., 2000; Oomen et al., 2002; Marschner et al., 2006; Chan et al., 2007; Datta et al., 2007; Drexler and Brattin, 2007; Finzgar et al., 2007; Hansen et al., 2007; Juhasz et al., 2007a, 2007b; Ljung et al., 2007; Sarkar et al., 2007; Subacz et al., 2007; Turner and Ip, 2007; Van de Wiele et al., 2007; Beak et al., 2008; Moseley et al., 2008; Girouard and Zagury, 2009; Morman et al., 2009; Nagar et al., 2009; Poggio et al., 2009; Smith et al., 2009; Zhang et al., 2009; Demetriades et al., 2010; Juhasz et al., 2010). These contaminants are associated with a legacy of industrial activities (Gasser et al., 1996; Razo et al., 2006; Rieuwerts et al., 2006; Basta et al., 2007; Laird et al., 2007; Morrison and Gulson, 2007; Bosso and Enzweiler, 2008; Bosso et al., 2008; Romero et al., 2008; Caboche et al., 2010; Meunier et al., 2010; Roussel et al., 2010) and natural background geology (Fendorf et al., 2004; Koch et al., 2005; Nathanail et al., 2005; Palumbo-Roe et al., 2005; Wragg, 2005; Cave et al., 2007; Juhasz et al., 2007b; Wragg et al., 2007), which are of concern to a number of the countries participating in BARGE.

The accurate determination of bioaccessibility has the potential to make a significant impact on current risk assessment practice. BARGE has been involved in comparing and evaluating the physico-chemical processes within the many models and systems that have been developed over the years to measure bioaccessibility and contaminant

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exposure e.g. (Oomen et al., 2002; Basta et al., 2007; Cave et al., 2007; Chan et al., 2007; Gal et al., 2007; Gron et al., 2007; Ljung et al., 2007; Nathanail and Smith, 2007; Palumbo-Roe and Klinck, 2007; Subacz et al., 2007; Van de Wiele et al., 2007; Wragg et al., 2007; Wragg and Klinck, 2007). A priority objective is to provide robust and defensible data on bioaccessibility that can be used in human health risk assessments and policy making.

The concepts of bioaccessibility and oral bioavailability are fundamentally important for quantifying the risks that are associated with oral exposure to environmental contaminants. Bioaccessibility refers to the fraction of a contaminant that is released from soil into solution by digestive juices. It represents the maximum amount of contaminant that is available for intestinal absorption. In general, only a fraction of these bioaccessible contaminants can be absorbed by the intestinal epithelium. Inorganic contaminants are subsequently transported to the liver via the portal vein for biotransformation. The fraction of parent compound that reaches the systemic circulation is referred to as the bioavailable fraction. Given the fact that bioaccessibility is one of the principal factors limiting the bioavailable fraction, it is an important parameter to measure for risk assessment purposes.

Bioavailability data from actual human soil feeding tests is scarce (Maddaloni et al., 1998; Stanek et al., 2010) and although *in vivo* animal studies have been carried out, these are, in general costly, time consuming, have ethical constraints and there is usually only a limited amount of soil available (Freeman et al., 1992, 1993, 1995; Ruby et al.,

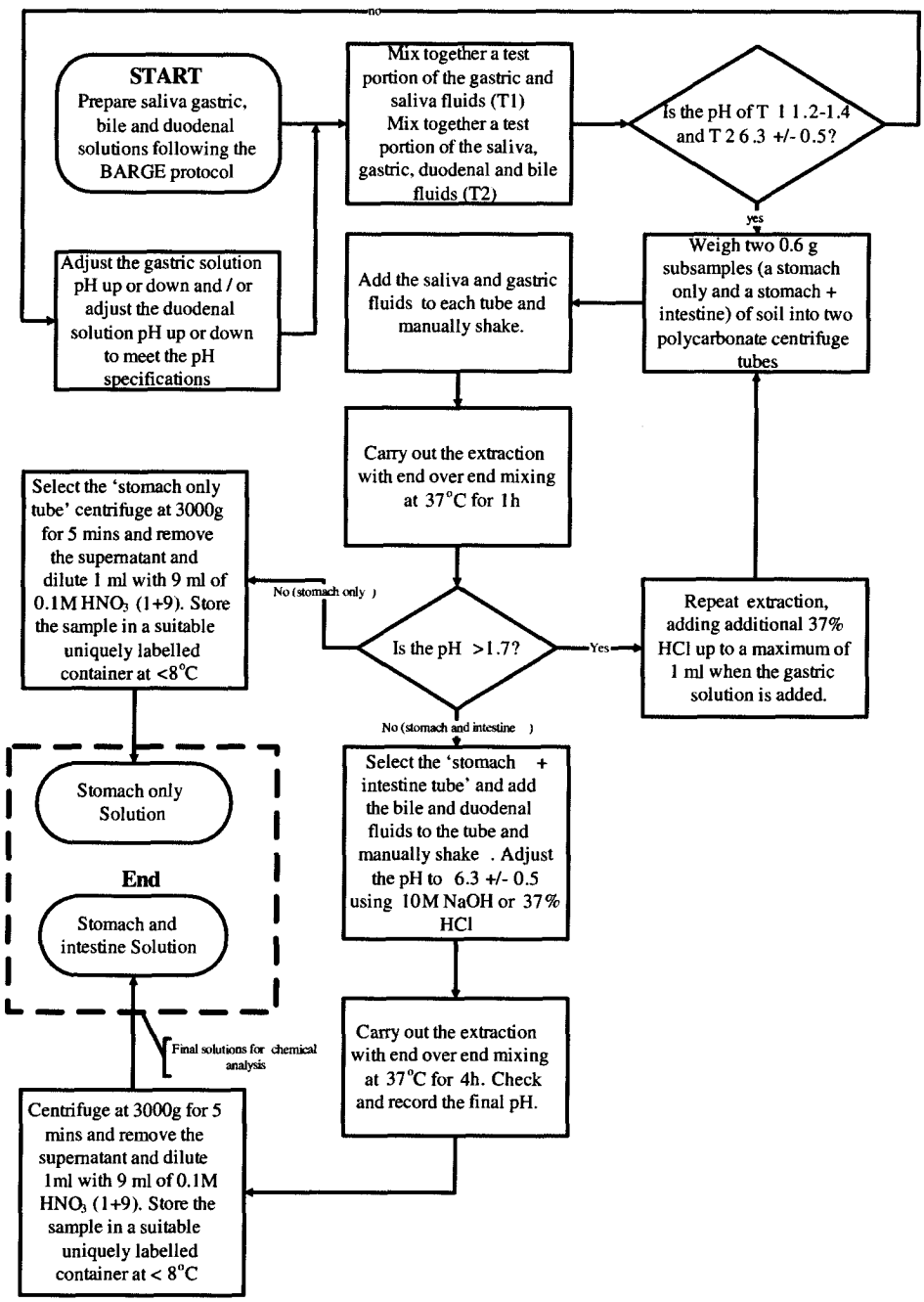

Fig. 1. Schematic of the UBM (full details of how the method was used in the inter-laboratory study are given in Sections 3.2 and 4.4).

1993; Golub et al., 1999; Rodriguez et al., 1999; Ellickson et al., 2001; Schroder et al., 2003, 2004; Marschner et al., 2006; Makris et al., 2008; Bannon et al., 2009; Nagar et al., 2009) and Juhasz et al. (2007a, 2008, 2009a, 2009b). An alternative is the application of *in vitro* models that simulate the GI tract. These screening methods can be used to measure the bioaccessible contaminant fraction, as bioaccessibility is an important parameter prior to bioavailability. A number of *in vitro* bioaccessibility tests for mimicking human ingestion have been reported in the literature and have been comprehensively reviewed (Wragg and Cave, 2003; Dean and Ma, 2007). Of these, there are four batch extraction methods which are most commonly used: the physiologically based extraction test (PBET) originally developed by Ruby et al. (1996); the *in vitro* gastrointestinal method (IVG) (Rodriguez et al., 1999); the Dutch National Institute for Public Health and the Environment method (RIVM) (Versantvoort et al., 2004) which is mainly used in Europe; and the relative bioaccessibility leaching procedure (RBALP) which was developed specifically for Pb in soils (Drexler and Brattin, 2007). The PBET, IVG, and RIVM methods use extraction media that closely mimic the chemical environment of the human gastrointestinal system i.e. they are physiologically based, whereas the RBALP uses physiologically relevant pH of the stomach but uses a glycine buffer as the extraction medium.

As a result of research carried out by BARGE and other research groups it was clear that the different bioaccessibility tests showed similar trends when used on the same soil samples, but the different operating conditions for each test produced widely ranging bioaccessibility values between the methods (Oomen et al., 2002; Saikat et al., 2007; Van de Wiele et al., 2007; Juhasz et al., 2009a, 2009b). For example, in a study of five different methods on three test soils (Oomen et al., 2002) a wide range of bioaccessibility values were found: for As 6–95%, 1–19%, and 10–59%; for Cd 7–92%, 5–92%, and 6–99%; and for Pb 4–91%, 1–56%, and 3–90%. This made comparison of data difficult to carry out in a subjective manner causing regulators and risk assessors some concern (Environment Agency, 2005a, 2005b, 2007; Richardson, 2008; Scheckel et al., 2009; Latawiec et al., 2010). To overcome this problem, BARGE undertook a joint decision to progress the development of a harmonised *in vitro* bioaccessibility method.

The main criteria for the test were:

i) It should be physiologically based, mimicking the human GI physico-chemical environment in the stomach and small intestine. This should not only help to obtain good agreement with *in vivo* data but would also enhance public understanding of the test;

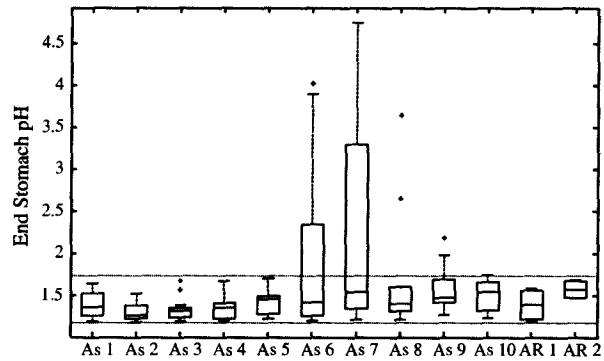

Fig. 3. pH tolerance data for the 'stomach' phase of the UBM for the As soils under investigation. The dashed horizontal lines indicate the pH tolerance at the end of the stomach phase extraction.

ii) It should represent a conservative case;
iii) There should be one set of conditions for all potentially harmful elements (PHE) being studied;
iv) It must be demonstrated that the test is a good analogue of *in vivo* conditions; and
v) The test must be able to produce repeatable and reproducible results within and between testing laboratories.

The chosen method was that previously published by researchers at the Dutch Institute of Public Health, the RIVM (Oomen, 2000; Oomen et al., 2002), as this was considered to be the most suitable static or batch method available, and therefore more likely to be adopted by testing laboratories. The RIVM methodology has also gained acceptance by regulators in both the Netherlands and Denmark. Modifications were made to the RIVM methodology to ensure adequate conservatism, that the *in vitro* test was robust and applicable to the different soil types found in a range of different countries.

2. Method performance and benchmarks

The evaluation of the UBM was undertaken by means of an international inter-laboratory exercise. For the method to be 'fit for

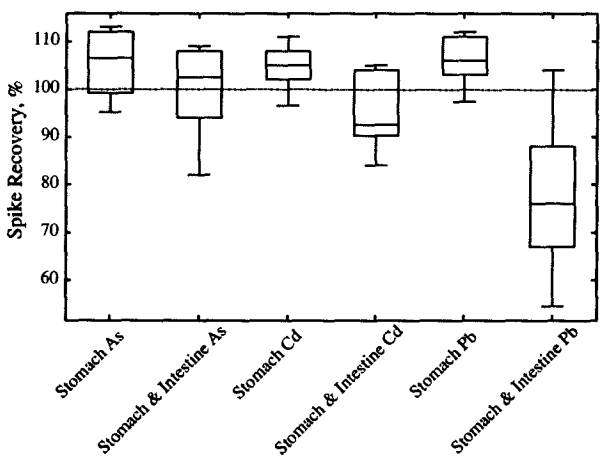

Fig. 2. Box and whisker plot summarising the percentage recoveries of As, Cd and Pb in the spiked stomach and stomach & intestine phase solutions at the standard soil: solution ratio (1:100 g ml^{-1}).

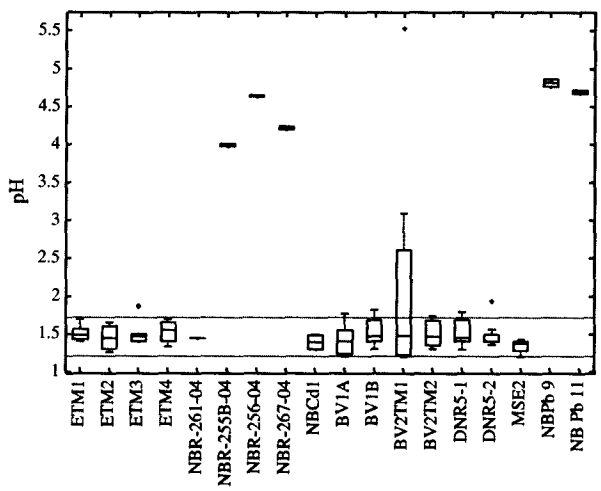

Fig. 4. pH tolerance data for the 'stomach' phase of the UBM for the Cd and Pb soils under investigation. The dashed lines indicate the pH tolerance at the end of the stomach phase extraction.

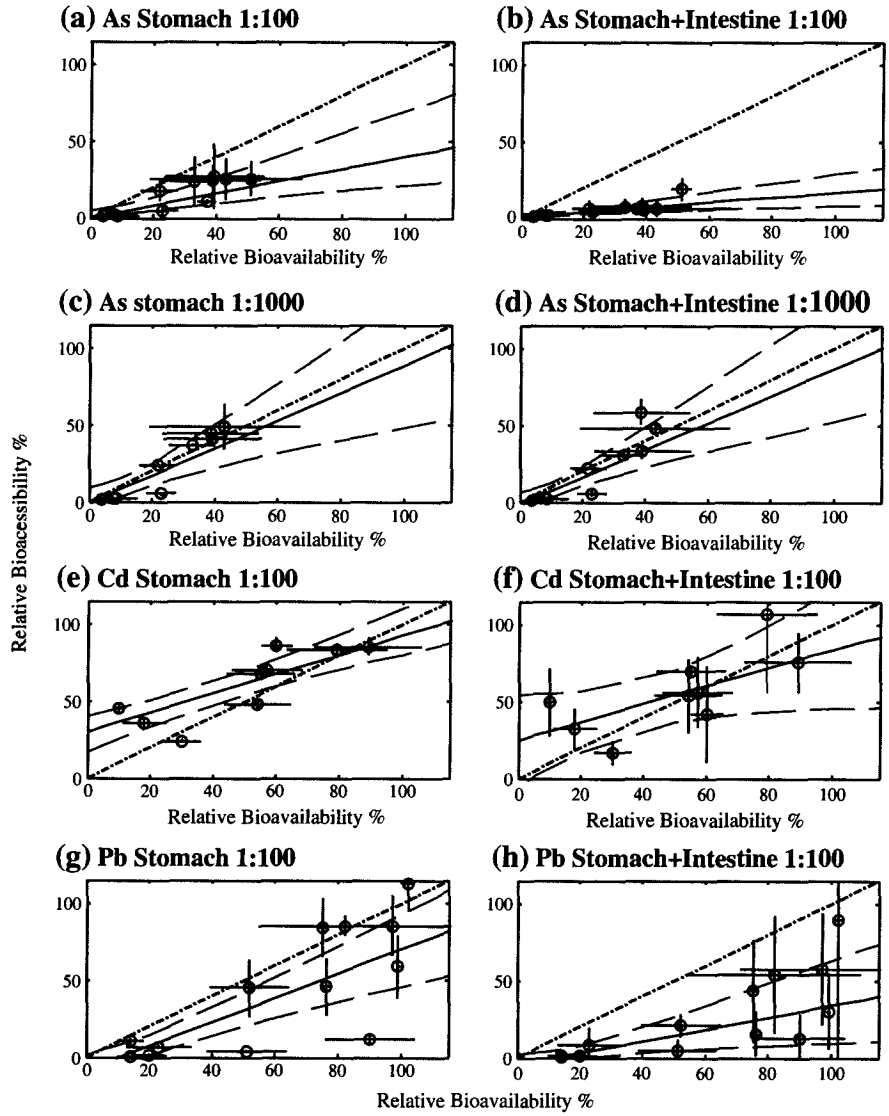

Fig. 5. Relative bioaccessibility vs *in vivo* relative bioavailability for As Cd and Pb in the stomach and stomach and intestine compartments and associated soil:solution ratios. The solid black line shows the median straight line fit, the dotted line shows the line of equivalence and the dashed lines represent the 90% confidence region.

purpose' the bioaccessibility would need to pass quantitative tests on how well the test could be validated by an *in vivo* result and how reliably the test could be carried out (repeatability and reproducibility). A validation study of a simple one compartment bioaccessibility test (not physiologically based) for Pb has recently been carried out (Drexler and Brattin, 2007) and shows some very impressive statistical performance figures for both validation and reliability.

Although there is not much literature on acceptability criteria for *in vitro/in vivo* validation of bioaccessibility tests in soil, there is an equivalent *in vitro/in vivo* correlation test (IVIVC) used widely in the pharmaceutical industry. The IVIVC test is a tool designed to correlate *in vitro* and *in vivo* drug release (Emami, 2006). The bioavailability of the administered drug, measured by the fraction of the drug absorbed into the human body (equivalent to the animal testing data for metal uptake from soil) is correlated to the *in vitro* bioaccessibility measured by a dissolution test (equivalent to the UBM bioaccessibility test for soil). The US Federal Drug Administration has set out guidelines for the acceptability of results (Anon, 1997) which include:

i) A linear relationship with slope of unity, if possible, is preferred, to show that the *in vitro* dissolution is representative *in vivo* absorption;
ii) The relative standard deviation (RSD) for the *in vitro* measurement of a single sample should be less than 10% (repeatability);
iii) The prediction error of the *in vivo* absorption from the *in vitro* dissolution test should not exceed 15% for each formulation (sample).

This provides a basis for setting up performance criteria for the soil bioaccessibility validation. Pharmaceutical formulations are, however, far more homogeneous and less complex than soil samples and

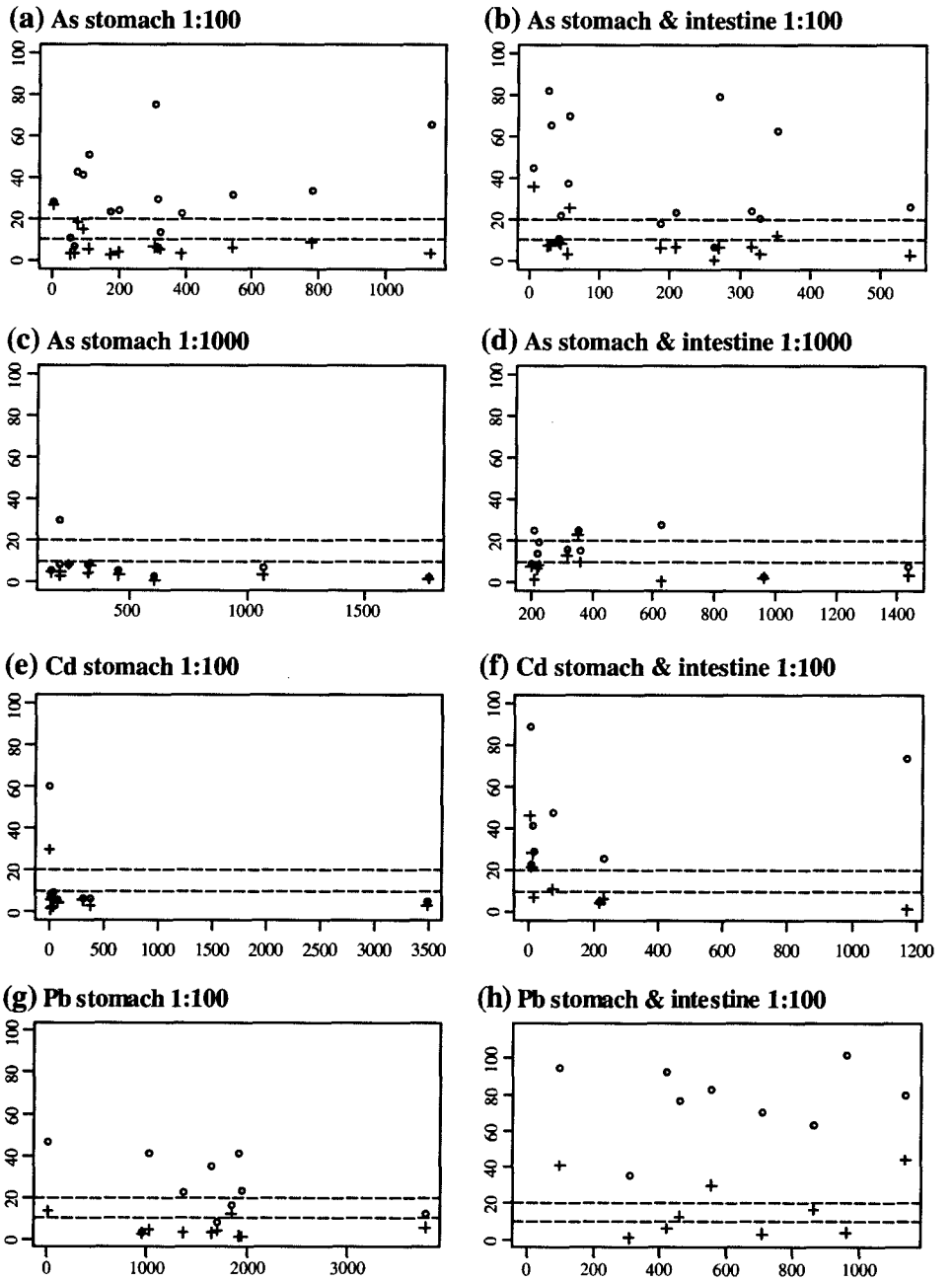

Fig. 6. Summary plots of the relative standard deviation (RSD) for As, Cd and Pb for the between-laboratory (o) and within-laboratory (+) bioaccessibility measurements in the stomach and intestine compartments at associated soil:solution ratios. The x-axis represents the bioaccessible value in mg kg^{-1} and the y axis represents the RSD as a percentage. Dashed horizontal lines show 10% and 20% RSD.

therefore these criteria may be too stringent for soil testing. It is necessary to go to the literature to look at the repeatability of inter-laboratory trials on soil testing. Drexler's soil bioaccessibility inter-laboratory trial (2007) reported a repeatability of 4% and reproducibility of 6% (measured as the percent RSD). There are not many other inter-laboratory studies for bioaccessibility testing available; however, there are instances of laboratory trials on soils where PHEs are extracted using different reagents to determine their solid phase distribution and speciation, which is similar to the UBM bioaccessibility test. In the inter-laboratory trial for the European Community Bureau of Reference (BCR) sequential extraction test on a lake sediment (Quevauviller, 2002) the between-laboratory repeatability for Cd was 15, 13 and 75% RSD for three extraction steps and for Pb 19, 5.4 and 29% RSD (As was not determined). Another inter-laboratory trial on soils (Nagourney et al., 2008) used a standard extraction test to determine the Cr^{VI} content of a reference soil giving an inter-laboratory RSD of ~20%. This clearly shows that between-laboratory repeatability in soil extraction studies of PHEs can be highly variable.

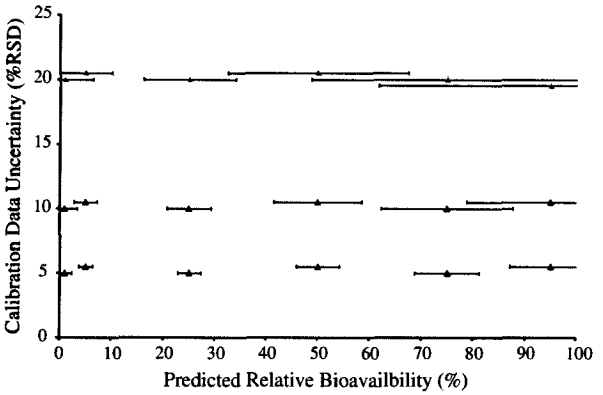

Fig. 7. Effect of increasing uncertainty in the bioaccessibility and bioavailability calibration data on the predicted bioavailability. Y axis data have had small shift introduced to so that overlap of error bars can be clearly viewed.

Using the combined information from IVIVC and from soil extraction literature the following soil bioaccessibility testing validation criteria (benchmark criteria) are proposed:

i) There should be a linear relationship between the relative bioaccessibility and the relative bioavailability where relative bioavailability/bioaccessibility refers to the bioavailable/bioaccessible fraction of the contaminant in the soil relative to the bioavailability/bioaccessibility of a soluble salt of the contaminant. A slope of unity, if possible, is preferred, to show that the *in vitro* bioaccessibility is representative of the bioavailability study; the linear relation should be demonstrated by a very strong correlation coefficient ($r>0.8$ or $r^2>0.6$) and a slope >0.8 and <1.2
ii) The within-laboratory repeatability should be $\leq 10\%$ RSD
iii) The between-laboratory reproducibility should be $\leq 20\%$ RSD

3. Materials and methods

3.1. Samples under investigation

The materials under investigation included slag materials, soils, river sediments and house dusts containing *in vivo* data for As, Cd and Pb. A number of the donated soils had previously been studied in bioaccessibility investigations and the resulting data reported in the peer reviewed literature (Rodriguez et al., 1999, 2003; Schroder et al., 2003, 2004; Basta et al., 2007). Where information on the source of the material, contaminants and subsequent testing data was not readily available in the literature, it was provided by the donor of the individual samples. In addition to *in vivo* tested soils as a primary source of contaminated material, the evaluation of the UBM also included the two National Institute of Standards and Technology (NIST) standard reference materials (SRMs), 2710 and 2711, which have been studied by various workers in relation to their bioaccessible contaminant contents (Ellickson et al., 2001; Cave et al., 2003; Schroder et al., 2004). and a soil (BGS 102), containing naturally elevated As concentrations, prepared by the British Geological Survey (BGS) specifically for the purposes of bioaccessibility testing (Wragg, 2009). Table 1 summarises the materials studied in the inter-laboratory trial, including the material type, references to published information and the total and relative bioavailable data available.

Table 1
Summary of materials under investigation with published total and relative bioavailable concentrations. Where relative bioavailability is the bioavailable fraction of the contaminant in the soil relative to the bioavailability of a soluble salt of the contaminant.

Soil	Total As mg kg^{-1}	RBA As %	Total Cd mg kg^{-1}	RBA Cd %	Total Pb mg kg^{-1}	RBA Pb %	Material type
As 1	11300	8.62	n/a	n/a	n/a	n/a	Calcine Soils (Rodriguez et al., 1999; Basta et al., 2007)
As 2	17500	4.07	n/a	n/a	n/a	n/a	As above
As 3	13500	7.88	n/a	n/a	n/a	n/a	As above
As 4	11500	22.8	n/a	n/a	n/a	n/a	As above
As 6	405	38.7	n/a	n/a	n/a	n/a	Iron slag soils (Rodriguez et al., 1999; Basta et al., 2007)
As 7	450	43	n/a	n/a	n/a	n/a	As above
As 8	1180	39.1	n/a	n/a	n/a	n/a	As above
As 9	5020	32.9	n/a	n/a	n/a	n/a	As above
As 10	4650	21.9	n/a	n/a	n/a	n/a	As above
AR 1	676	37	n/a	n/a	n/a	n/a	Aberjona River Sediments
AR 2	313	51	n/a	n/a	n/a	n/a	As above
ETM 1	n/a	n/a	4109	60	n/a	n/a	Pt. Mugu Soil 1B
ETM 2	n/a	n/a	452	89	n/a	n/a	CO-SCS Soil
ETM 3	n/a	n/a	102	79	n/a	n/a	OK-SS Soil
ETM 4	n/a	n/a	46.8	18	n/a	n/a	Dugway Soil #4
NB Cd1	n/a	n/a	465	55.4	n/a	n/a	Nick Basta Cd study sample 1, Blackwell Soil (Schroder et al., 2003, Anon, 2007)
NBR-255B-04	n/a	n/a	188	53.6	4050	90	Nick Basta Pb–Cd studies samples 5 and 4, Jasper Yard soil (Schroder et al., 2003, Anon, 2007)
NBR-256-04	n/a	n/a	29.9	10.4	11700	40	Nick Basta Pb–Cd studies samples 12 and 6, Murray Slag (Schroder et al., 2003, Anon, 2007)
NBR-261-04	n/a	n/a	43	29.9	8530	14	Nick Basta Pb-Cd studies samples 2 and 2, Butte NPL (Schroder et al., 2003, Anon, 2007)
NBR-267-04	n/a	n/a	23.8	56.8	3200	51	Nick Basta Pb-Cd studies samples 13 and 7, Murray Soil (Schroder et al., 2003, Anon, 2007)
NBPb 11	n/a	n/a	n/a	n/a	8170	14	Nick Basta Pb study sample 11, Midvale Slag Soil (Anon, 2007)
NBPb 9	n/a	n/a	n/a	n/a	10600	20	Nick Basta Pb study sample 9, Leadville Slag Soil (Anon, 2007)
B & V 1A	n/a	n/a	n/a	n/a	1650	102	Composite soil
B & V 1B	n/a	n/a	n/a	n/a	1630	75	Composite soil
B & V 2 TM1	n/a	n/a	n/a	n/a	2280	52	House dust
B & V 2 TM2	n/a	n/a	n/a	n/a	2310	97	Composite soil
DNR5 1	n/a	n/a	n/a	n/a	2830	99	0.5% Phosphate-treated soil
DNR5 2	n/a	n/a	n/a	n/a	4230	76	1% Phosphate-treated Soil
MSE2	n/a	n/a	n/a	n/a	2020	82	Soil

3.2. In vitro bioaccessibility method

The *in vitro* UBM, was a physiological GI simulation based on the methodology utilised at the RIVM, previously described by Oomen et al. (2002). The procedure was carried out according to the schematic in Fig. 1 and has been described in full in other publications (Wragg et al., 2009; Roussel et al., 2010). The UBM was carried out at 37 °C (body temperature), at a final soil:solution ratio of 1:100 (g ml^{-1}) with end over end rotation at 30 rpm. The simulation consisted of three stages: the mouth, stomach and small intestinal cavities at a stomach pH of 1.2 and an intestinal pH of 6.3 under fasting conditions, which produced two individual extracts per test sample for analysis. The sample known as 'stomach' phase consisted of an extraction solution removed from the system after simulation of the mouth (utilising simulated salival fluid) followed by the stomach (utilising simulated stomach fluid) compartments. The sample known as 'stomach & intestine' represented the extraction solution removed after simulation of the mouth, stomach and small intestine (utilising simulated saliva, stomach, bile and duodenal fluids) phases of the system. The chemical constituents included in each phase were the same as those previously reported (Oomen et al., 2002), with the exception the duodenal fluid, which contained an increased concentration of sodium hydrogen carbonate (5.607 g l^{-1} compared with 3.388 g l^{-1} in the original methodology). The increased sodium hydrogen carbonate concentration was employed to compensate for the lower, but still physiologically acceptable, stomach pH used in the method (1.2 compared with 1.5 used by the RIVM method). The reason for reducing the pH to 1.2 was based on preliminary studies where calcareous soils were found to cause difficulties in maintaining a low pH in the stomach phase. Reducing the pH to a lower but still physiologically acceptable value of 1.2 helped to alleviate this practical difficulty.

In summary, 9.0 ml of salival fluid was added by pipette to 0.6 g of test material for both the 'stomach' and the 'stomach & intestine' extractions; the extraction vessels were capped and shaken manually for 30 s. To each test aliquot, 13.5 ml of gastric fluid was added and the extraction vessels were capped and placed into an extractor and incubated using end-over-end rotation, at 37 ± 2 °C for 1 h. At the end of 1 h both the 'stomach' and 'stomach & intestine' extracts were removed from the incubator and the pH of the suspension measured. If the pH of the suspension was measured at 1.2–1.7, the 'stomach' phase extract was deemed complete and the 'stomach & intestine' extract was taken forward to carry out the intestinal digestion phase. If the pH tolerance was not met and there was sufficient solid material available, the UBM extraction was repeated and the pH was adjusted to between 1.2 and 1.7 using up to 1.0 ml of concentrated HCl (37% or 12 N). If the pH criterion was met, the 'stomach' phase extract was centrifuged at 3000 × *g* for 5 min and a 1.0 ml aliquot preserved by the accurate addition 9.0 ml of 0.1 M HNO_3. To continue the extraction and carry out the 'stomach & intestine' phase, 27.0 ml of duodenal fluid and 9.0 ml of bile fluid were added by pipette, the samples re-capped, manually shaken for 30 s and the pH checked to ensure that it was 6.3 ± 0.5. If the pH criterion was not met, the pH was adjusted by the dropwise addition of 37% HCl, 1 M or 10 M NaOH as required and then replaced in the incubator at 37 °C and rotated for a further 4 h. At the end of the intestinal incubation period, the pH was recorded and the suspensions were centrifuged for 5 min at 3000 × *g*. An aliquot of the supernatant was collected and preserved in the same manner as the 'stomach' phase extractions. Both extraction phases were stored at 1–8 °C. For both the 'stomach' and 'stomach & intestine' phases of the UBM, all contributing laboratories made a record of any additional HCl or NaOH adjustments made to either phase. Because of the small amount of material available for the inter-laboratory trial, it was not possible for all contributing laboratories to carry out repeat extractions because of pH tolerance failures, and therefore some data was reported that was outside the scope of the required tolerances. Two laboratories also carried out the UBM extractions for the As soils at a lower soil to solution ratio of 1:1000 g ml^{-1}. Because the bioaccessible element content of BGS 102 was assumed to be relatively low compared with the *in vivo* validation soils, based on the total element concentration data available, the contributing laboratories provided an additional 10.0 ml aliquot of unpreserved and therefore undiluted 'stomach' and 'stomach & intestine' extract for analysis.

Prior to evaluation of the UBM, a detailed Standard Operating Procedure (SOP) was agreed by all BARGE laboratory participants (the BGS, DHI, INERIS, Ohio State University, RIVM, the Royal Military College of Canada (RMC) and the University of Ghent) (Wragg, 2009). The lead laboratory (BGS) issued instructions to all participating laboratories, which included a list of materials to be investigated and the number of duplicate, blank and spike extractions expected. To ensure standardisation of the procedure and reduction in uncertainty estimates, all equipment and reagents were sourced by each laboratory from the same suppliers. Where a contributing laboratory was unable to obtain the required reagents, the lead laboratory satisfied the requirement by supplying said laboratory. Polypropylene tubes with screw top lids (101 × 16.5 mm, with a capacity of 13 ml) were provided to each laboratory for sample storage and transportation and a simple digestion and analysis that was carried out by the lead laboratory. The lead laboratory carried out digestion of the extracts in order to re-solubilise any analytes sorbed to the surface of the tubes during transit and storage, and to ensure that all samples were of the same acidic matrix for analysis, regardless of minor operational differences applied in the individual laboratories. To each digestion tube 1.0 ml of AristaR grade ® concentrated HNO_3 and 1.0 ml of 70% v/v H_2O_2 were added by auto-pipette and the tubes loosely capped and placed in a temperature controlled hot-block for 3 h at 70 °C. After cooling the samples were capped tightly and stored at 1–8 °C prior to analysis. Full details of the selection criteria for the sample tubes and the digestion procedure have been fully described by Wragg et al. (2009).

3.3. Bioaccessibility extract analysis

The bioaccessible As, Cd and Pb content of each extract provided was determined directly by a Varian/Vista AX CCD simultaneous instrument with dedicated Varian SPS-5 Auto-sampler and PC running the latest version of ICP Expert software supplied by the instrument manufacturer, according to the operating conditions previously described (Cave and Wragg, 2002; Wragg, 2005). Each sample was introduced with 1% caesium chloride (as an ionisation buffer) via a peristaltic pump into a glass concentric slurry nebuliser connected to a cyclonic action spray chamber. Analysis was carried out on ~2.5 ml of the UBM digested 'stomach', 'stomach & intestine' extraction solution. Arsenic, Cd and Pb were determined in the UBM extracts after calibration using a minimum of 5 mixed element standards in a 1% HNO_3 matrix. The inductively coupled plasma-optical emission spectrometer (ICP-OES) was calibrated to concentrations up to 100 mg l^{-1} for As and Pb and 10 mg l^{-1} for Cd and re-calibrated after not more than 125 unknown samples. Two quality control standards, at ~10 and 75% of the calibration range, were analysed after each calibration, after no more than ten unknown solutions during the run and at the end of each run to check for drift. As the bioaccessibility matrix had been diluted to a ratio of 1:10 (g ml^{-1}) with 0.1 M HNO_3 prior to shipping, and digested in mixed HNO_3/H_2O_2 on arrival at the lead laboratory no further matching to the calibration or QC standards was deemed necessary. All reported measurements, as mg l^{-1}, were based on the average of three 10 s replicate measurements. All element concentrations quoted have been converted into mg kg^{-1} extracted from the solid. The analysis of unpreserved BGS 102 was carried out using a Thermo Elemental ExCell quadrupole ICP-MS instrument in combination with a Cetac

ASX-510 autosampler, according to the operating conditions previously described by Watts et al. (2008). The instrument was calibrated at the beginning of each analytical run using standards prepared from certified Claritas PPT® (Spex CertiPreP) multi-element solutions in the range 0 to 50 μg l^{-1}. In addition, 10 μg l^{-1} mixed element standards were inserted at regular intervals throughout the analysis run and used to correct for any drift in instrument sensitivity. Indium and rhenium were added to all solutions via a T-piece connection and used as internal standards to correct for any matrix suppression. Multi-element QC standards, containing As, Cd and Pb, were analysed after no more than every 20 unknown samples. Because of limited sample volume, all of the samples were diluted by a factor of two with 1% HNO_3 prior to analysis.

3.4. Quality control

In order to gain an insight into the within-laboratory repeatability, duplicate UBM extractions of each test material, commonly employed reference materials normally used for their total concentrations, blanks and spikes were requested from each participating laboratory. However, due to time constraints this was not possible for all participating laboratories. The reference material QC samples were either the NIST 2710 or 2711 SRM (or both where possible) and the BGS 102 As bioaccessibility guidance soil (Wragg, 2009). The blank QCs consisted of the individual 'stomach' or 'stomach & intestine' matrix taken through the entire UBM *in vitro* procedure, prior to submission for analysis, to account for As, Cd and Pb contamination from the chemicals and the extraction equipment in use. The spike QCs were individual 100 mg l^{-1} spiking solutions of As, Cd and Pb, provided by the lead laboratory, with instructions for the preparation of a mixed spiking solution for extraction in order that each analyte was present in solution, in each phase ('stomach' or 'stomach & intestine') at 0.1 mg l^{-1}, after sample preservation. The spiking solutions were extracted with no test material present to check the percentage (%) recovery of the extraction method, i.e. that no analyte was adsorbed to the extraction tubes or lost during the extraction procedure.

3.5. Statistical data analysis

The analytical performance characteristics of the bioaccessibility measurement (repeatability and reproducibility) were determined in the collaborative study using the procedure described in ISO Standard 5725-2 (ISO. 5725-2, 1994). Outlier testing using Grubbs' test (Grubbs, 1950) and Cochran's test (Snedecor and Cochran, 1980) was carried out in the R statistical programming language using the outliers package (R Development Core Team, 2007) and the outlier removal rules specified in ISO Standard 5725-2 were applied. Repeatability and reproducibility calculations were carried out in MS Excel™. In addition to the ISO 5725-2 statistical calculations, the *in vivo* relative bioavailability data is plotted against the relative bioaccessibility data to show the relationship between the *in vivo* and the *in vitro* measurements. Linear regression analysis was carried out using Theils method (Theil, 1950; Glaister, 2005) that makes no assumption about the errors on the x and y axes and is robust to outliers. Confidence limits on the regression line were calculated using ten thousand Monte Carlo simulations using the uncertainties on the relative bioaccessible and relative bioavailable data. The procedure was implemented in the MATLAB programming language.

4. Results

The mean relative bioaccessibilities and associated relative standard deviations for As, Cd and Pb for each sample in each compartment (along with the additional data for the lower soil to solution ratio for As) are given in Tables 2 and 3.

Table 2
Summary data for mean and standard deviation for the relative bioaccessibilities of As in the test samples using the UBM *in vitro* method. Where "st" is the stomach compartment and "st + int" is the stomach followed by intestinal compartment.

Sample name	Number of data points	Relative bioaccessibility (%)	Standard deviation (%)	Soil:solution ratio (g ml^{-1})	Compartment
As 1	7	1.6	0.4	0.01	st
As 2	7	1.2	0.3	0.01	st
As 3	7	2.5	0.7	0.01	st
As 4	7	5.0	1.6	0.01	st
As 6	7	24.3	10.0	0.01	st
As 7	7	25.7	13.1	0.01	st
As 8	7	27.3	20.4	0.01	st
As 9	6	23.8	15.6	0.01	st
As 10	7	17.7	6.0	0.01	st
AR 1	2	10.7	0.7	0.01	st
AR 2	2	25.8	11.0	0.01	st
As 1	7	1.8	0.3	0.01	st + int
As 2	7	1.3	0.3	0.01	st + int
As 3	7	2.6	0.6	0.01	st + int
As 4	7	5.1	1.3	0.01	st + int
As 6	7	8.3	5.4	0.01	st + int
As 7	7	6.6	5.4	0.01	st + int
As 8	7	5.3	3.7	0.01	st + int
As 9	6	7.7	4.8	0.01	st + int
As 10	7	6.3	5.0	0.01	st + int
AR 1	2	6.7	0.7	0.01	st + int
AR 2	2	19.2	7.2	0.01	st + int
As 1	7	1.9	0.2	0.001	st
As 2	7	1.4	0.1	0.001	st
As 3	7	2.6	0.2	0.001	st
As 4	7	5.5	0.2	0.001	st
As 6	7	44.3	2.5	0.001	st
As 7	7	48.9	14.6	0.001	st
As 8	7	40.7	2.3	0.001	st
As 9	6	37.1	0.8	0.001	st
As 10	7	24.1	1.6	0.001	st
As 1	7	2.0	0.5	0.001	st + int
As 2	7	1.4	0.3	0.001	st + int
As 3	7	2.9	0.7	0.001	st + int
As 4	7	5.9	1.7	0.001	st + int
As 6	7	58.4	8.2	0.001	st + int
As 7	7	48.1	4.3	0.001	st + int
As 8	7	33.3	5.1	0.001	st + int
As 9	6	31.1	2.5	0.001	st + int
As 10	7	22.5	0.6	0.001	st + int

4.1. Quality control

Each participating laboratory supplied a minimum of three blank extraction samples from each of the UBM phases, under the standard (1:100 g ml^{-1}) extraction conditions. For the 'stomach phase' extractions, all data for As was returned at below the limit of quantification (<6.75 mg kg^{-1}); however, for Cd, one data point for one laboratory was within 2 times the reporting limit (<0.90 mg kg^{-1}) and, for Pb a second laboratory returned two blank sample values within 3 times the reporting limit (<0.225 mg kg^{-1}). For the 'stomach & intestine phase' all of the blank extraction samples returned values less than the reporting limit for As (<17.6 mg kg^{-1}), Cd (<2.34 mg kg^{-1}) and Pb (<5.85 mg kg^{-1}). Where ICP-AES values for test sample extractions were returned below the reporting limit or the increased soil to solution ratio of 1:1000 (g ml^{-1}) was employed, the samples were analysed by ICP-MS because of its increased sensitivity and lower reporting limits. The data from the extraction blanks provides a good indication that the reagents or equipment used in the UBM methodology did not contribute As, Cd or Pb to the sample data.

Six of the seven participating laboratories provided a minimum of two mixed element spike extracts for each phase of the UBM, under the standard (1:100 g ml^{-1}) extraction conditions, for analysis. One laboratory was unable to provide any spike extracts. Fig. 2, a box and whisker plot, summarises the range of mean percentage As, Cd and Pb

Table 3
Summary data for mean and standard deviation for the relative bioaccessibilities of Cd and Pb in the test samples using the UBM *in vitro* method (soil: solution ratio of 0.01 g ml^{-1} for all samples). Where "st" is the stomach compartment and "st + int" is the stomach followed by intestinal compartment.

Sample name	Element	Number of data points	Relative bioaccessibility (%)	Standard deviation (%)	Compartment
ETM 1	Cd	6	86.4	4.5	st
ETM 2	Cd	6	85.6	5.7	st
ETM 3	Cd	6	83.2	4.8	st
ETM 4	Cd	7	36.0	3.0	st
NB Cd 1	Cd	3	67.8	4.3	st
NBR-255B-04	Cd	1	48.4	3.0	st
NBR-256-04	Cd	1	45.6	2.8	st
NBR-261-04	Cd	1	24.2	1.5	st
NBR-267-04	Cd	1	70.7	4.0	st
ETM 1	Cd	6	41.9	31.0	st + int
ETM 2	Cd	6	75.5	19.5	st + int
ETM 3	Cd	6	107.2	51.3	st + int
ETM 4	Cd	7	32.1	13.3	st + int
NB Cd 1	Cd	3	69.9	3.4	st + int
NBR-255B-04	Cd	1	53.7	24.0	st + int
NBR-256-04	Cd	1	49.5	22.1	st + int
NBR-261-04	Cd	1	17.1	7.6	st + int
NBR-267-04	Cd	1	55.9	22.8	st + int
B & V 1A	Pb	6	112.8	18.5	st
B & V 1B	Pb	7	84.5	19.0	st
B & V 2TM1	Pb	7	45.2	18.7	st
B & V 2TM2	Pb	7	85.5	19.8	st
DNR5-1	Pb	7	59.0	20.6	st
DNR5-2	Pb	7	46.0	18.8	st
MSE 2	Pb	6	85.4	6.6	st
NB Pb 11	Pb	1	0.6	0.1	st
NB Pb 9	Pb	1	0.9	0.2	st
NBR-255B-04	Pb	1	11.6	2.7	st
NBR-256-04	Pb	1	6.9	1.6	st
NBR-261-04	Pb	1	10.3	2.4	st
NBR-267-04	Pb	1	3.2	0.7	st
B & V 1A	Pb	6	89.5	91.3	st + int
B & V 1B	Pb	7	43.4	33.3	st + int
B & V 2TM1	Pb	7	20.8	7.3	st + int
B & V 2TM2	Pb	7	57.6	36.4	st + int
DNR5-1	Pb	7	30.1	24.9	st + int
DNR5-2	Pb	7	15.4	14.2	st + int
MSE 2	Pb	6	54.0	38.1	st + int
NB Pb 11	Pb	1	1.2	1.5	st + int
NB Pb 9	Pb	1	1.2	1.6	st + int
NBR-255B-04	Pb	1	12.3	16.1	st + int
NBR-256-04	Pb	1	8.8	11.4	st + int
NBR-261-04	Pb	1	0.1	0.1	st + int
NBR-267-04	Pb	1	4.6	6.0	st + int

spike recovery values in each of the two UBM phases for the participating laboratories. Fig. 2 shows that, for the 'stomach' phase of the extraction, the As, Cd and Pb recovery was 105 ± 10%, and that there was a wider spread in the data for the 'stomach & intestine' phase extractions. For As and Cd in the 'stomach & intestine' phase, Fig. 2 indicates an increased spread in the % recovery of ~80–110%, compared with the 'stomach' phase, although both the median As and Cd recoveries of ~100 and 90% respectively are considered acceptable. The percentage spike recovery for Pb in the 'stomach & intestine' phase ranges from ~55 to 105% (Fig. 2), with a median value of ~75%. The behaviour of Pb and Cd is strongly pH dependent, with higher solubility in acidic conditions and complexation by pepsin or chemical precipitation of metals in an increased pH environment such as the gastro-intestinal compartment (Ellickson et al., 2001; Gron and Andersen, 2003). This is not observed in the case of elements that form anions in solution and is consistent with previous studies for As (Oomen et al., 2006). For the extractions carried out at the decreased soil:solution ratio, As spike recoveries of 100 and 99% for the 'stomach' and 'stomach & intestine' phases respectively were returned.

Table 4
Summary data for the bioaccessible fraction of the Quality Control samples from each of the participating laboratories. The mean value is in mg kg^{-1}, the relative standard deviations (RSD) are expressed as %, "st" is the stomach compartment and "st + int" is the stomach followed by intestinal compartment.

Measurement	NIST 2710	NIST 2711	BGS 102	Element	Compartment	S:L g ml^{-1}
Overall mean	323	55.1	4.52	As	st	0.01
Repeatability RSD	5.53	3.23	26.7	As	st	0.01
Reproducibility RSD	13.8	11.0	28.2	As	st	0.01
Overall mean	335	–	–	As	st	0.001
Repeatability RSD	7.80	–	–	As	st	0.001
Reproducibility RSD	9.14	–	–	As	st	0.001
Overall mean	264	45.6	5.38	As	st + int	0.01
Repeatability RSD	0.63	8.55	35.7	As	st + int	0.01
Reproducibility RSD	6.89	22.0	44.5	As	st + int	0.01
Overall mean	316	–	–	As	st + int	0.001
Repeatability RSD	13.3	–	–	As	st + int	0.001
Reproducibility RSD	16.0	–	–	As	st + int	0.001
Overall mean	14.8	33.8	0.281	Cd	st	0.01
Repeatability RSD	5.83	2.58	29.9	Cd	st	0.01
Reproducibility RSD	7.36	9.24	60.3	Cd	st	0.01
Overall mean	7.86	16.2	0.593	Cd	st + int	0.01
Repeatability RSD	21.7	7.20	46.5	Cd	st + int	0.01
Reproducibility RSD	23.0	29.20	89.0	Cd	st + int	0.01
Overall mean	3785	958	12.8	Pb	st	0.01
Repeatability RSD	5.54	2.73	13.3	Pb	st	0.01
Reproducibility RSD	12.4	2.96	46.8	Pb	st	0.01
Overall mean	1138	101	3.11	Pb	st + int	0.01
Repeatability RSD	44.2	40.8	139	Pb	st + int	0.01
Reproducibility RSD	80.0	94.6	141	Pb	st + int	0.01

Table 4 gives a summary of the mean bioaccessible values for each element in each compartment for the quality control reference soils along with the within-laboratory repeatability and the overall between-laboratory reproducibility expressed as the relative standard deviation. This data cannot be used to check accuracy as there are no certified bioaccessible values, but they serve to give an idea of the uncertainty in the results both within and between laboratories for milled and well homogenised soils. BGS102 data tends to have higher within and between-laboratory variability compared with the two NIST soils. This is probably due to the relatively low concentrations of bioaccessible As, Cd and Pb in this soil. After a dilution of 100 in the extraction stage, and a further dilution of 10 in the preservation stage the As, Cd and Pb concentrations in solution are likely to be at or approaching detection limits for the ICP-AES instrument used for the analysis of the extracts. For NIST 2710 and NIST 2711, the bioaccessible concentrations of As, Cd and Pb are significantly higher than BGS 102 so variability from being close to detection limits should not be a problem. The variability of results for the NIST soils is inconsistent, from being very good (~3% RSD for Cd and Pb and in NIST 2711 in the stomach phase) to poor (94.6% in NIST 2711 for Pb in the stomach phase). Some of the reasons for these differences are discussed in more detail in Sections 4.5–4.7 but this exercise suggests that the variability is method related and not down to sample heterogeneity.

4.2. Total element data

The total As, Cd and Pb concentrations in the test samples were obtained from previously published data using USEPA method 3050 (Schroder et al., 2003, 2004; Basta et al., 2007) given in Table 1. However, the BGS laboratories undertook trial digestions of the As samples, which when subjected to a mixed acid digestion (HF, HNO_3 and $HClO_4$) explosive ejections of sample and reagents from the reaction tube were observed. This indicated that the mixed acid digest employed was not suitable for these samples but served to illustrate the unusual geochemistry of these materials, thought to be due to the presence of high concentrations of elemental sulphur.

4.3. pH tolerances

The UBM protocol (Fig. 1) requires that the pH of the individual extracts are checked at the end of the 'stomach' and 'stomach & intestine' phases and the start of the 'stomach & intestine' extraction phase to ensure that acceptable pH values are achieved. Figs. 3 and 4 summarise the distribution of the pH data obtained for the end of the 'stomach' phase of the UBM, as a box and whisker plot. Fig. 3 shows that the end 'stomach' phase pH tolerance criteria (1.2 to 1.7) for the As soils was met by the contributing laboratories for the majority of the test samples. However, for samples As 6 and 7 a wide range of pH values were observed, ~1.2 to 4.0 and 4.7 respectively. Outliers (denoted as solid black crosses), outside of the pH tolerance were observed for sample As 8 (~pH 2.75 and 3.5), similarly for sample As 9 (pH 2.25) in addition to the maximum value for this sample (~2.0). A similar trend was observed for pH measurements made in both compartments during the 'stomach & intestine' extract for the As soils (data not shown), where samples As 6 and 7 were outside of the required pH tolerances. For the materials contaminated with Cd and Pb (Fig. 4), samples NBR-255B-04, NBR-256-04, NBR-267-04, NBPb9 and NBPb11 all had end 'stomach' phase pH's in the range c. 4.0–5.0, sample BV2TM1 ranged between 1.2 and 3.25 and the maximum pH's of samples BV1A, BV1B and DNR5-1 was 1.8, for both the 'stomach' and 'stomach & intestine' extractions. As there was a limited mass of NBR-255B-04, NBR-256-04, NBR-267-04, NBPb9 and NBPb11, these samples were only extracted by one laboratory.

4.4. Validation and reliability of the test

The relative bioavailability data obtained from the *in vivo* studies for the three elements have been obtained by taking the ratio of the amount absorbed from the soil to the amount absorbed from a completely soluble salt of the element. In order to make a meaningful comparison the absolute bioaccessibility as measured by the UBM *in vitro* test (amount of element extracted from the soil expressed as a percentage of the total element in the soil) was converted to a relative bioaccessibility by dividing the absolute bioaccessibility of the contaminant in the soil by the absolute bioaccessibility of the completely soluble salt. The bioaccessibility of the same salts used in the *in vivo* studies (As in Na-arsenate, Cd in Cd-chloride and Pb in Pb-acetate) was measured using the same UBM procedure used for the soils. In the gastric phase, the absolute bioaccessibility values were $99 \pm 2\%$ and $98 \pm 3\%$ for Pb in Pb-acetate and Cd in Cd-chloride, respectively. For As in Na-arsenate bioaccessibility was $95 \pm 3\%$. This showed that all three elements were either indistinguishable or within 2% of being 100% bioaccessible for the reference compounds in this compartment. In contrast, in the intestinal phase Pb and Cd had reduced absolute bioaccessibility giving values of $66 \pm 3\%$ and $68 \pm 3\%$ respectively; however, the As bioaccessibility remained high at $92 \pm 4\%$. The reasons for this are related to the solubility and stability of Cd and Pb in the higher pH solutions as discussed earlier (Ellickson et al., 2001; Gron and Andersen, 2003).

Table 5 gives the values of the assessment criteria (defined at the end of Section 2) for each element and each of the simulated GI compartments. The grey highlighted values indicate where the required benchmark value was achieved. Fig. 5 shows plots of the % relative bioavailable values versus the % relative bioaccessible values, showing error bars on both axes along with the Theil line of best fit, the 90% confidence interval for the line and the line of equivalence. Fig. 6 summarises the within and between-laboratory RSD values.

Table 5
Summary of method assessment criteria, grey highlights pass the benchmark criteria.

Element	Liquid to solid ratio (ml g^{-1})	Compartment	r^2	r	slope	Median within RSD	Median between RSD
As	100	st	0.77	0.88	0.40	5.70	29.47
As	100	st + int	0.63	0.80	0.16	6.92	25.94
As	1000	st	0.91	0.95	0.89	3.83	7.43
As	1000	st + int	0.83	0.91	0.88	7.26	15.72
Cd	100	st	0.69	0.83	0.63	3.90	7.00
Cd	100	st + int	0.51	0.71	0.57	9.16	35.32
Pb	100	st	0.61	0.78	0.78	3.59	22.78
Pb	100	st + int	0.57	0.76	0.38	14.62	81.39
Units						%	%
Criteria			≥ 0.6	≥ 0.77	≥ 0.8	≤ 10	≤ 20

4.5. Arsenic

Table 5 shows that correlation between *in vitro* and *in vivo* data is strong for both compartments, but the slope of the lines are low. Fig. 5 shows that there are some very large uncertainty bars for some samples on both the bioavailable and bioaccessible data. Table 5 and Figs. 5(a),(b), and 6(a),(b) show that although the within-laboratory repeatability meets the benchmark criteria, the between-laboratory data for both compartments does not. Fig. 3 shows that samples As 6 and As 7 deviated significantly from the target pH range compared with the other samples which may have caused poor reproducibility. Fig. 5(a), however, does not show that these samples have higher bioaccessibility uncertainties. Leaving sample As 6 and As 7 out of the calculations for benchmark data for Table 5 did not have any significant effect on the assessment criteria and the data for these two points were therefore retained. In a previous study (Basta et al., 2007) using soils As 1 to As 10 (Table 1) to test a different *in vitro* bioaccessibility method (the IVG method) the soils As 1 to As 4 are identified as being contaminated with a calcine waste material and samples As 6 to As 10 oxidised waste material (slag) generated from the roasting and/or smelting of arsenopyrite ore. Examination of Fig. 5 (a and b) and Table 2 clearly shows that the slag samples, that have the lower total As and higher bioaccessibilities have much poorer reproducibility (high average standard deviation ~12% relative bioaccessibility) compared with the calcine samples (average standard deviation ~0.8% bioaccessibility) suggesting that this is caused by the geochemistry of these samples. Additional geochemical data on these samples (Rodriguez et al., 2003) shows that the calciner samples have relatively acid soil pH (2.6–3.1) and low Ca concentrations (11.7–18 g kg^{-1}) compared with the slag soils (soil pH 7.1–7.4 and Ca concentrations of 60.7–121 g kg^{-1}). The samples with the highest Ca concentrations (As 6 and As 7, 121 and 96.4 g kg^{-1} respectively) are the samples with the poorly controlled pH tolerance for the 'stomach' phase of the UBM (Fig. 3). This suggests that the poorer between-laboratory reproducibility on the iron slag samples is a function of their high buffering capacity highlighting the need for tighter control limits on the 'stomach' phase. Comparing the absolute % bioaccessibilities, obtained by the UBM with the IVG previous study (a method that uses a soil to solution ratio of 1:150, a stomach pH of 1.8 for 1 h and an intestinal ph of 5.5 for 1 h) shows that there is very good agreement between the two data sets. For the 'stomach' compartment (a simple linear regression with the UBM on the x-axis

and IVG on the y axis gives rsquare = 0.99, slope = 1.15 and intercept-2.2). For the 'stomach & intestine' compartment, however, agreement is poor (rsquare = 0.38, slope = 2.3, intercept = −2.6) this is probably due to the lower pH (5.5) and shorter reaction time used in the IVG method.

In summary, the data for the 1:100 g ml^{-1} soil:solution ratio for these test materials appear to show poor reproducibility for the slag samples and low relative bioaccessibility values as compared with the relative bioavailability (Fig. 5(a) and (b) but the stomach compartment data show close agreement with an independent bioaccessibility test. Additional extractions at the lower soil to solution ratio (1:1000 g ml^{-1}) were carried out on nine of the original samples (the two Aberjona river samples were not extracted at this lower soil to solution ratio due to lack of material). At the lower ratio there was much improved agreement with relative bioavailability. The r-square values in Table 5 for this ratio indicate a strong correlation with relative bioavailable As, with the slopes of the lines meeting the benchmark criteria. Fig. 5(c) and (d) shows the uncertainties on the bioaccessibility values to be much reduced compared with the 1:100 g ml^{-1} solid to liquid ratio, although only two laboratories have contributed data for the high dilution conditions. Table 5 and Fig. 6(c) and (d) show that the within-laboratory repeatability meets the benchmark criteria for both the 'stomach' and 'stomach & intestine' compartments. Under these conditions these results would indicate that the UBM method would be fit for purpose.

4.6. Cadmium

For Cd there are comparative data (Schroder et al., 2003) for five of the soils (Nb Cd1, NBR-255B-04, NBR-256-04, NBR-261-04, NBR-267-04) using the IVG bioaccessibility method discussed in Section 4.5. In a similar manner to As, for the 'stomach' compartment there is a strong 1:1 relationship with the UBM data (a simple linear regression with the UBM on the x-axis and OSU-IVG on the y axis gives rsquare = 0.86, slope = 0.97 and intercept = −0.4). For the 'stomach & intestine' compartment both methods give lower values than their equivalent 'stomach compartments' (*t*-test p-value <0.005) and there is a strong correlation between the UBM and the OSU-IVG although the latter gives, on average, lower values than the former (a simple linear regression with the UBM on the x-axis and OSU-IVG on the y axis gives rsquare = 0.71, slope = 0.59 and intercept = 4.3).

Table 5 shows a strong correlation of relative bioaccessible Cd with relative bioavailable Cd in the stomach compartment but the slope of the line is 0.63 which does not meet the benchmark criteria although this value is in agreement with the slope of the bioaccessibility vs relative bioavailability plot (0.60) using the OSU-IVG method (Schroder et al., 2003). Fig. 5 shows the error bars on the on the relative bioaccessibility values to be less than the relative bioavailability error bars. Table 5 and Fig. 5(e) show that the within and between-laboratory repeatability meet the benchmark criteria for the 'stomach' compartment. For the 'stomach & intestine' compartment, however, Table 5 and Figs. 5(f) and 6(f) show that the slope, r-square, repeatability and reproducibility are degraded, so that all but the within-laboratory RSD fail the benchmark criteria. Under these conditions these results would indicate that, apart from the preferred slope of >0.8, the UBM method would be fit for purpose for the 'stomach' phase but not the 'stomach & intestine' phase. The decreased slope of the regression line and the poorer reproducibility in the 'stomach & intestine' phase is probably related to the higher pH in this compartment. Cadmium solubility decreases at high pH (Cotton et al., 1999), the spike recovery (Fig. 2) shows that Cd is lost to precipitation at pH 6.3 and complexation by pepsin in the gastro-intestinal compartment (Ellickson et al., 2001; Gron and Andersen, 2003), and similarly Cd extracted from the soil – at pH 1.2 will undergo the same processes in the 'stomach & intestine' phase. In addition, the soil also provides a sink for sorption at the higher pH conditions which is dependent on individual soil properties. These include the amount of organic matter, clays and Al and Fe oxides present in the soil. All of these can act as sites for specific adsorption at neutral to alkaline pH (Cave et al., 2011). All of these effects result in a lower slope and poorer reproducibility.

4.7. Lead

Table 5 shows that the slope of the line for the 'stomach' compartment is only just below the benchmark criteria (0.78 compared with a target of 0.8) and the correlation with bioavailable Pb is within the criterion. Examination of Fig. 5(g) and (h) and Table 3 shows two groupings in the data, a set of 6 samples with relative bioaccessibilities of 10% or less and a set of 6 samples with relative bioaccessibilities 40% or greater. The former group of 6 samples are those that were only available to one laboratory and only have very low relative bioaccessibilities compared with their relative bioavailabilities. Fig. 4 shows that pH at the end of the 'stomach' phase was much higher than specified in the procedure and this may account for the low bioaccessibility values in these samples. This hypothesis is also supported by comparison of the absolute bioaccessibility values from this study with the absolute bioaccessibility values obtained for these six soils using the IVG method (Schroder et al., 2004), which, unlike As and Cd, has poor correlation and very low values compared with the IVG stomach compartment. A simple linear regression with the UBM on the x-axis and IVG on the y axis gives rsquare = 0.19, slope = 2.3 and intercept = 14.2. There are no literature bioaccessibility data for comparison of the samples with relative bioaccessibilities >40% that were extracted by all participating laboratories. These samples, however, have relative bioaccessibilities which are more comparable to the relative bioavailability data (Fig. 5(g)). Fig. 6(g) and Table 5 show that the within-laboratory repeatabilities for the stomach compartments are well within the benchmark criteria but the between-laboratory reproducibility is poor.

Table 5 and Figs. 5(h) and 6(h) show that none of the benchmark criteria are met for the 'stomach & intestine' compartment. The groupings observed in the 'stomach' compartment data are also seen in the 'stomach & intestine' compartment although less pronounced. The poor reproducibility and low slope at the higher pH of the 'stomach & intestine' are likely to be due the same effects described for Cd.

5. Discussion

For As, the low inter-laboratory RSDs and the high between-laboratory RSDs suggest that the small differences between the way the test is applied to these soils has a large effect on the results obtained. These soils have a complex physico-chemical composition and contain very high concentrations of As (Table 1) arising from the mining slag which forms a major part of their mass, which appears to contribute to the reproducibility problems observed in the inter-laboratory trial. This can also be seen in the very high uncertainty in the *in vivo* measurements (Fig. 5(a) to (d)). Variability in bioaccessible As can be reduced by careful control of *in vitro* pH which has been shown to greatly affect the measured metal bioaccessibility (Oomen et al., 2002; Yang et al., 2003; Waisberg et al., 2004; Tang et al., 2006, 2007, 2008). However, pH cannot be controlled during *in vivo* dosing trials used to calculate the relative bioavailability of As in soil. Although the higher dilution test (soil to liquid ratio 1:1000 g ml^{-1}) was only carried out at two laboratories the soils produce results which meet the benchmark criteria. Possible reasons why the higher dilution gives better results are:

i) The higher dilution removes the problem of As oversaturation which may be the cause of the low slope and poorer reproducibility at low dilution;

ii) At the higher dilution matrix effects (dissolution of concomitant chemical species from the sample, which adversely affect the chemical analysis) from the mine waste material are reduced.

The drawback with using the 1:1000 g ml^{-1} soil to liquid ratio is that the small amount of sample may cause reproducibility problems if the test soil is inhomogeneous and, if soils with lower contamination concentrations are tested, the higher dilution may bring the concentrations of the analyte near to or below the method detection limit.

In practical terms, contaminated materials that are relevant to human exposure scenarios where bioaccessibility measurements will have a significant effect on the risk assessment are soils with contaminants close to human health guideline values and not very highly contaminated mine wastes and slags similar to those assessed in this study. When considering these soils, concentration of As will be far lower and the matrix effects much reduced and the problems encountered here are likely to be much reduced. However, it is recognised that mine waste contaminated soils are important in human health risk assessments and that in these cases it may be more appropriate to use the 1:1000 g ml^{-1} soil to liquid ratio.

For Cd, the method meets all but the slope criteria for the specified benchmarks for the 'stomach' phase (Table 5). The low slope and poor repeatability/reproducibility observed in the 'stomach & intestine' phase suggests that the Cd is precipitated out of solution at high pH causing the poor performance.

The Pb data in the 'stomach' compartment for the samples extracted by all the laboratories shows reasonable agreement with the *in vivo* data but all of these soils have high relative bioavailable values (>50%). The relative bioaccessibility data from the samples with lower relative bioavailabilities is questionable because of the 'stomach' phase tolerances not being met on these samples. Table 5 shows Pb in the 'stomach' phase fits the rsquare and within-laboratory RSD criteria, and is only just outside the slope criteria (0.78, should be $\geq$0.8) and the between-laboratory RSD criteria (22.78, should be $\leq$20). For the 'stomach & intestine' phase none of the criteria are met which, like Cd, suggests that precipitation at high pH causes the poor performance.

This study suggests that pH control is a critical factor for obtaining between-laboratory reproducibility. Using tighter pH tolerance on the stomach phase (1.20 $\pm$ 0.05), Caboche (2009) has shown that the UBM correlates well with *in vivo* swine data for As, Cd and Pb on 15 soils with different contamination histories (r-square values >0.89 and slopes not significantly different from 1). In this study, the repeatability of the average relative bioaccessible measurements for the 15 soils for the 'stomach' and the 'stomach & intestine' compartments were c.8% and 10% RSD for As, c.6 and 7% for Cd and c.5% and 5% for Pb. Using the UBM with a stomach phase at pH 1.5 $\pm$ 0.05 on smelter contaminated agricultural topsoils (Pelfrene et al., 2011), repeatabilities for the 'stomach' and the 'stomach & intestine' compartments of 1.5 and 2.2% RSD for Cd and 1.2 and 2.2% RSD for Pb were demonstrated on 4 selected soils. These soils had absolute bioaccessible Cd values in the range of 0.8–24.7 mg kg^{-1} and Pb absolute bioaccessible values in the range of 84–1880 mg kg^{-1}. Although not a true reproducibility study, the same authors demonstrated between operator repeatabilities for the 'stomach' and the 'stomach & intestine' compartments of 3.4% and 15.2% RSD for Cd and 11.0% and 6.5% RSD for Pb using the same subset of soils. Without tighter pH control (stomach pH 1.2–1.4), a study of urban soils contaminated from Pb, Zn smelters (Roussel et al., 2010) showed repeatabilities for the UBM method for the 'stomach' and the 'stomach & intestine' compartments of 6.3% and 13.8% RSD for Cd and 12.0% and 17.4% RSD for Pb for the NIST 2710 standard reference material (n = 25). Whilst these studies are not directly comparable, there is some evidence that the studies (Caboche, 2009; Pelfrene et al., 2011) with tighter controls on the stomach pH have better repeatabilities than the study (Roussel et al., 2010)with wider pH limits (<10% compared with 6–17% RSD) thus supporting the findings of this study. The between operator study (Pelfrene et al., 2011), although not strictly comparable to a between-laboratory comparison, shows RSD values <20%, again suggesting that the benchmark criteria of <20% RSD should be obtainable with careful control on the method.

The overall purpose of a bioaccessibility test is to provide information for risk assessors on the amount of PHE will be taken into the body via the ingestion route. A validation study comparing *in vitro* and *in vivo* data is, in effect, calibrating the bioaccessibility against bioavailability data so that the more easily obtained bioaccessibility values can be used to predict bioavailability. There are a number of uncertainties in relating a bioaccessible value to the amount of PHE absorbed by a human subject. If we assume the swine gastrointestinal model is a good surrogate for humans (Miller and Ullrey, 1987; Moughan et al., 1992) and that there is a linear relationship between bioaccessibility and bioavailability (Schroder et al., 2003, 2004; Drexler and Brattin, 2007; Juhasz et al., 2007a) then the data from this and similar studies can be used to provide information on the reliability of the data provided to the risk assessor. A simulation was set up using relative bioavailability data on a set of theoretical soils covering the range of 1 to 90% (1, 5, 25, 50, 75 and 90%) with theoretical relative bioaccessibility data on the same soil samples. The simulation used a linear model with slope of unity and intercept of zero where bioavailability is to be predicted from bioaccessibility. The uncertainties are normally distributed on both parameters ranging from 5% to 20% RSD. A Monte Carlo simulation was set up to estimate the uncertainties on the predicted bioavailability. The linear models for the slope and intercept were created using Theils method (Theil, 1950; Glaister, 2005) that accommodates errors on both the x and y axes. The results are shown in Fig. 7 with error bars indicating 95% confidence intervals. At 5% RSD uncertainty on the bioaccessibility and bioavailability data used for the calibration all of the five bioavailability predictions (1, 5, 25, 75and 90% relative bioavailability) are all clearly distinguishable. At 10% RSD uncertainty the two highest and lowest predicted values have overlapping error bars but the intermediate bioavailability values are still clearly distinguishable. For 20% RSD uncertainty the overlap between the predicted values increases again but it is still possible to distinguish between 5%, 25% and 75% predicted bioavailability. In this study a reproducibility target of 20% has been set; however, Fig. 6 shows that the majority of within-laboratory RSD (method repeatability) are better than 10% and therefore with more careful specification of the test (particularly pH control) it should be possible to approach 10% RSD reproducibility. This simulation clearly shows that 20% reproducibility is the maximum tolerable in order to provide useful data for risk assessment.

The simulation also requires that the *in vivo* bioavailability data should also be better than 20% RSD which may be more difficult to control. Fig. 5 shows that the uncertainties on the bioavailability data are in many cases much higher than the bioaccessibility values and therefore improved *in vivo* data is also required to provide robust validation. The uncertainty simulation clearly shows that improvements in the reproducibility of both the in-vivo and in-vitro measurements are required to give risk assessors more confidence in the use of bioaccessibility data.

6. Conclusion

In terms of meeting the five main criteria for the bioaccessibility test (listed in Section 1), the UBM is physiologically based with one set of extraction reagents used for the three elements considered in this study. The As bioaccessibility measurements, however, required a lower solid to liquid ratio than for Cd and Pb. It is envisaged that this will not be necessary for contaminated soils with As concentrations that are more relevant to human exposure scenarios. The correlations

between the *in vivo* data and the *in vitro* data suggest that the UBM is a good analogue of *in vivo* conditions although there is a need to improve the repeatability and reproducibility of the method before this can be clearly demonstrated. The test uses fasted conditions (low stomach pH with no food present) and is therefore likely to give conservative (high bioaccessible values) results, which has been confirmed by an independent study (Caboche, 2009) using a comparison against an in-vivo swine model.. The UBM method does, however, agree well with the IVG *in vitro* test for As and Cd in the stomach compartments where data for the same soils are available. The IVG method has been validated against swine data for As, Cd and Pb (Schroder et al., 2003, 2004; Basta et al., 2007).

This study and others (Roussel et al., 2010; Caboche, 2009; Pelfrene et al., 2011) that use the UBM have highlighted a number of specific aspects of the UBM test that need to be addressed. There needs to be a review of the practical procedures used in the *in vitro* test to improve the between-laboratory repeatability. Previous studies have shown the importance of pH of the 'stomach' compartment on the final bioaccessibility result (Oomen et al., 2002). It is possible that the pH tolerance for the UBM is too wide. This is probably one of the main sources of between-laboratory variability in this study.

For As, it appears that the method will meet the benchmark criteria for both 'stomach' and 'stomach & intestine' compartments if soils with lower As concentrations (tens to hundreds of mg kg^{-1}) and with a less complex physico-chemical make up are used. For Cd and Pb it seems possible that the method will work for the 'stomach' phase but not for the 'stomach & intestine' phase; A further follow up study/ inter-laboratory trial using test soils with contaminant concentrations more relevant to bioaccessibility testing (e.g. up to 5 times soil guideline values) is required; The As soils provided by Professor Basta have a complex physico-chemical composition, which appears to contribute to the reproducibility problems observed in the inter-laboratory trial; A more rigorous *in vivo* validation using fasted conditions of the UBM is required; It is not unusual for the first inter-laboratory trial of a new operationally defined procedure for extracting metals from soils to have some initial problems e.g. Quevauviller (2002), which is indeed the case for the UBM method. However, the data indicate that, in general, this *in vitro* test provides bioaccessibility data which is comparable data to *in vivo* bioavailability data. The study has highlighted areas of the test which require further refinement but it is our view that with further development this procedure provides a basis for a standardised bioaccessibility test for PHEs in soils.

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