Appendix B

Bench Scale Treatability Study

Omaha Lead Site

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Final
Bench-Scale Treatability Study

Omaha Lead Site
Omaha, Nebraska

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Acronymns

ABA	Absolute Bioavailability
ASTM	American Society for Testing Materials
bgs	Below Ground Surface
BVSPC	Black & Veatch Special Projects Corp.
$Ca(OH)_2$	Calcium Hydroxide (Hydrated Lime)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (aka Superfund)
EMPA	Electron Microprobe Analysis
EPA	United States Environmental Protection Agency
IEUBK	Integrated Exposure Uptake Biokinetic
IVBA	*In Vitro* Bioaccessibility
LEGS	Laboratory for Environmental and Geological Studies
mg/kg	milligram per kilogram = ppm
NPL	National Priorities List
OLS	Omaha Lead Site
Pb	Lead
ppm	parts per million = mg/kg
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RBA	Relative Bioavailability
RBALP	Relative Bioavailability Leaching Procedure
RD	Remedial Design
RI/FS	Remedial Investigation/ Feasability Study
ROD	Record of Decision
SOP	Standard Operating Procedure
SPLP	Synthetic Precipitation Leaching Procedure
SU	Standard Units
TSP	Triple Super Phosphate

Glossary

ABA	Absolute Bioavailability – The amount of substance entering the blood via a particular biological pathway relative to the absolute amount that has been ingested.
AES	Architect-Engineer Services Contract between EPA Region 7 and Black & Veatch Special Projects Corp.
ASTM	American Society for Testing Materials – An organization that develops and publishes voluntary technical standards for a wide range of materials, products, systems, and services.
bgs	Below Ground Surface- An acronym that denotes a measurment or distance below the surface of the ground.
BVSPC	Black & Veatch Special Projects Corp. – The contractor under the EPA Architect-Engineer Services Contract who is serving as a consultant to EPA on the Omaha Lead Site.
$Ca(OH)_2$	Calcium Hydroxide (Hydrated Lime) – Lime is used to raise the pH of the soil following application of the phosphate amendment to the soil.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (aka Superfund) - The legislative authority that funds and carries out EPA solid waste emergency and long-term removal and remedial activities. These activities authorized by CERCLA include establishing the National Priorities List, investigating sites for inclusion on the list, determining their priority, and conducting and/or supervising cleanup and other remedial actions.
EMPA	Electron Microprobe Analysis – An analytical technique that is used to establish the composition of small areas on specimens by bombarding the specimen with a beam of accelerated electrons.
EPA	United States Environmental Protection Agency

FSP	Field Sampling Plan – The document that specifies the procedurres that will be followed during the field sampling activities, including the number of samples collected and the sampling methodology.
In-vitro	Testing or action outside an organism (e.g. inside a test tube or culture dish.)
In-vivo	Testing or action inside an organism.
LEGS	Laboratory for Environmental and Geological Studies – The organization within the University of Colorado that performed the bench scale study and performed the chemical and physical testing of the soil during the treatability study.
mg/kg	milligram per kilogram = parts per million – A unit measure of the concentration of a substance, i.e., milligrams of lead per kilogram of soil.
MSDS	Material Safety Data Sheet - A compilation of information required under the OSHA Communication Standard on the identity of hazardous chemicals, health, and physical hazards, exposure limits, and precautions.
NPL	National Priorities List - EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. The Omaha Lead Site is on the NPL.
OLS	Omaha Lead Site – The Omaha NPL site. The OLS is comprised of individual residential properties that exceed the EPA action level for lead and are eligible for Superfund response.
Pb	Lead – The primary contaminant of concern at the Omaha Lead Site.
ppm	parts per million = mg/kg – Units commonly used to express contamination levels, as in establishing the maximum permissible amount of a contaminant in water, land, or air.

QA/QC	Quality Assurance - A system of procedures, checks, audits, and corrective actions to ensure that all EPA research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.
QAPP	Quality Assurance Project Plan – A plan prepared for the Omaha Lead Site that discusses the QA/QC procedures that will be implemented at the site.
RA	Remedial Action - The actual construction or implementation phase of a Superfund site cleanup that follows remedial design.
RBA	Relative Bioavailability - The ratio of the absorption of lead in soil to the absorption of a lead standard (lead acetate).
RBALP	Relative Bioavailability Leaching Procedure - A test that measures the fraction of a chemical solubilized from a soil sample under simulated gastrointestinal conditions. The in-vitro tests consist of an aqueous fluid, into which the contaminant is introduced. The solution than solubilizes the media under simulated gastric conditions. Once this procedure is complete, the solution is analyzed for lead and/or arsenic concentrations. The mass of the lead and/or arsenic found in the filtered extract is compared to the mass introduced into the test. The fraction liberated into the aqueous phase is defined as the bioavailable fraction of lead or arsenic in that media.
RD	Remedial Design - A phase of remedial action that follows the remedial investigation/feasibility study and includes development of engineering drawings and specifications for a site cleanup.
RI/FS	Remedial Investigation/ Feasability Study - An in-depth study designed to gather data needed to determine the nature and extent of contamination at a Superfund site; establish site cleanup criteria; identify preliminary alternatives for remedial action; and support technical and cost analyses of alternatives. The remedial investigation is usually done with the feasibility study. Together they are usually referred to as the "RI/FS".

ROD	Record of Decision - A public document that selects and explains which cleanup alternative(s) will be implemented at National Priorities List sites.
SOP	Standard Operating Procedure – A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps and that is officially approved as the method for performing certain routine or repetitive tasks.
TSP	Triple Super Phosphate - A fertilizer produced by the action of concentrated phosphoric acid on ground phosphate rock. TSP was one of the chemical amendments used in the treatability study.

Executive Summary

The objective of this treatability study is to evaluate the influence of phosphate treatment on lead-contaminated Omaha Lead Site (OLS) soils. The information generated during this study will be used by EPA to evaluate and compare remedial alternatives in the final remedy selection process for the OLS. Studies conducted at other Superfund sites contaminated with similar forms of lead have concluded that the application of certain phosphate-based compounds (referred to as soil amendments) can result in the conversion of lead in soils to relatively insoluble minerals with reduced bioavailability. After treatment, lead remains present in the soil, but is transformed into a form that is less toxic.

It was estimated in the Final Remedial Investigation Report that approximately 8,552 OLS residential properties exhibit lead concentrations between 400 and 800 parts per million (ppm). If determined to be technically feasible, the amendment treatment of lead-contaminated soil at OLS residential properties exhibiting moderate lead levels (between 400 ppm and 800 ppm) could provide benefits over the excavation and replacement of soils at many OLS properties and provide protection of human health and the environment.

Prior to developing and implementing a field program, multiple amendment treatment scenarios were tested in the laboratory (bench scale) in an effort to limit the field program to the two or three most promising treatments. An extensive list of laboratory tests, including analytical chemistry and electron microprobe analyses, were performed on soil samples collected at various points in time during the study. The data from this group of laboratory tests, which are collectively referred to as "soil characterization testing," and "bench-scale testing" will allow EPA to evaluate potential chemical and physical changes in test soils in response to amendment addition.

An *In Vitro* test method, relative bioavailability leaching procedure (RBALP), was utilized to evaluate changes in soil lead bioaccessibility in response to amendment treatment. The RBALP is referred to as bioaccessibility testing to distinguish it from *in vivo* bioavailability studies which involve animal feeding studies. The RBALP is used because *in vivo* testing is more costly to perform than the RBALP test and requires a longer period of time to perform the testing. In addition to the RBALP, the synthetic precipitation leaching procedure (SPLP) (EPA Method 1312) was used to evaluate the potential leachability of lead, arsenic and phosphate and lead speciation was conducted on the untreated and treated soils.

EPA has gained experience at other Superfund sites with similar types of contamination, and has performed side-by-side comparison testing of *In Vitro* bioaccessibility and *in vivo* bioavailability test methods. RBALP performed at pH 1.5

correlates well with *in vivo* relative bioavailability (RBA) in untreated soils as evidenced by the close agreement of the two methods on the same soils in a previous swine study for the OLS. RBALP performed at pH 2.5 significantly underestimates the RBA when compared to *in vivo* results at the OLS. No test methods have been validated to measure bioaccessibility in phosphate treated soil. Although RBALP has not been validated for phosphate treated soils at pH 1.5 or pH 2.5, the procedure may provide an indication of the potential effectiveness in reducing the RBA of lead-contaminated soils.

Bioaccessibility testing results, together with the soil characterization data generated during this treatability study, are intended to provide the information required to evaluate the effectiveness of phosphate treatment on OLS soils. Although the information obtained from the treatability study will be useful to evaluate future remedial action alternatives at the OLS, the information from the study is not conclusive because of the following limitations of the study.

- It is difficult to perform *in-vivo* testing on soils with lead concentrations between 400 ppm and 800 ppm, which are the soils that are most likely to be treated with the phosphate amendment at the OLS.
- The i*n vitro* RBALP testing procedure used to estimate the relative bioaccessibility of lead in the soils has not been validated for use on phosphate amended soils.
- The bench scale treatability will only estimate the short term reduction in the RBA of lead in soils. There is no conclusive data indicating phosphate treatment results in long-term reduction in the RBA of lead in soils.

Duplicate matrices of soils were assembled containing controls and the phosphate amendments phosphoric acid (PA), phosphate rock (PR), and triple-super phosphate (TSP), both with and without amorphous iron. The matrices were run in triplicate using 2, 7, and 14 day reaction periods. The effectiveness of the amendments were evaluated based on the relative change *in vitro* bioaccessibility (IVBA) as measured using the RBALP i*n vitro* procedure, with extraction fluids at pH 1.5 and 2.5.

Virtually all of the phosphate amendments showed some reduction in IVBA however, the 14-day, 1.5% PA (1.5 PA) (with iron) was the most reductive. All of the amendments behaved equally as well on the three soil-types, producing an increased presence of some phosphate form.

The measured effectiveness of the amendment techniques varied between the pH 1.5 and pH 2.5 i*n vitro* results. The pH 1.5 data presented in Table 4-1, which has the strongest correlation with *in vivo* RBA, shows limited reduction in IVBA, ranging from 15 percent to 26 percent reduction for the three soil types tested. The RBALP at pH 2.5

showed more significant reduction in IVBA, ranging from 61 percent to 80 percent; however the RBALP at pH 2.5 did not show good correlation with *in vivo* results on the same test soils and has not been validated by *in vivo* studies.

One sample from each of the three soil types treated with 1.5 PA plus iron was speciated. The speciation indicated that the treatment procedure was forming a phosphate product. The speciation indicated the formation of a potentially more soluble primary or secondary orthophosphate rather than the more insoluble chloropyromorphite. These orthophosphates would be more bioaccessable than the lead phases in the untreated soils and support the limited decrease in IVBA observed in the treated soils. All of the phosphate amendments increased the solubility and potential release of phosphorus and arsenic.

1.0 Introduction

Black & Veatch Special Projects Corp. (BVSPC) has been tasked by EPA Region 7 to perform this treatability study for the Omaha Lead site (OLS) under Task Order 091 of EPA Contract No. EP-S7-05-06.

The OLS includes contaminated surface soils (generally between 0 to 6 inches below ground surface (bgs) present at residential properties, child-care facilities, and other residential-type properties in the city of Omaha, Nebraska, which were contaminated as a result of historic air emissions from lead smelting and refining operations. The OLS Focus Area encompasses approximately 27 square miles, centered on downtown Omaha, where two former lead processing facilities were located. The site includes only residential and residential-type properties and all non-residential properties are excluded from the OLS focus area, including commercial properties in the central business district.

The United States Environmental Protection Agency (EPA) began sampling residential yards and properties used for licensed child-care services in March 1999. The original boundaries of the OLS Focus Area were established at the time the Site was listed on the EPA National Priorities List (NPL). During the Remedial Investigation in 2004 (RI, Ref. 2), the OLS Focus Area was expanded to include an area south of L Street to the Sarpy County line (Harrison Street), an area north of Ames Avenue to Redick Avenue, and an area to the west of 45th Street. The focus area now extends north to Read Street and west to 56th Street (See Figure 1-1).

Between March 1999 and February 2009, surface soil samples were collected from over 37,000 residential properties. The December 2004 Interim Record of Decision (ROD, Ref. 1) identified response actions to be taken while the final ROD was developed, including excavation and replacement of contaminated soils at the most highly contaminated residential properties with surface soil lead concentrations exceeding 800 ppm. In addition, childcare facilities and properties where children with elevated blood lead levels reside are eligible for remediation if one or more mid-yard soil sample exceeds 400 mg/kg. If a property is eligible for remediation, all soils that test greater than 400 mg/kg are removed, including drip-zone soils.

This treatability study will evaluate the effectiveness of phosphate treatment on the bioaccessibility of lead-contaminated OLS soils. Studies conducted at other Superfund sites contaminated by lead smelting operations have concluded that the application of certain phosphate-based compounds can result in the conversion of lead in surface soils to relatively insoluble minerals with reduced bioavailability (Refs. 3, 4, and 5.

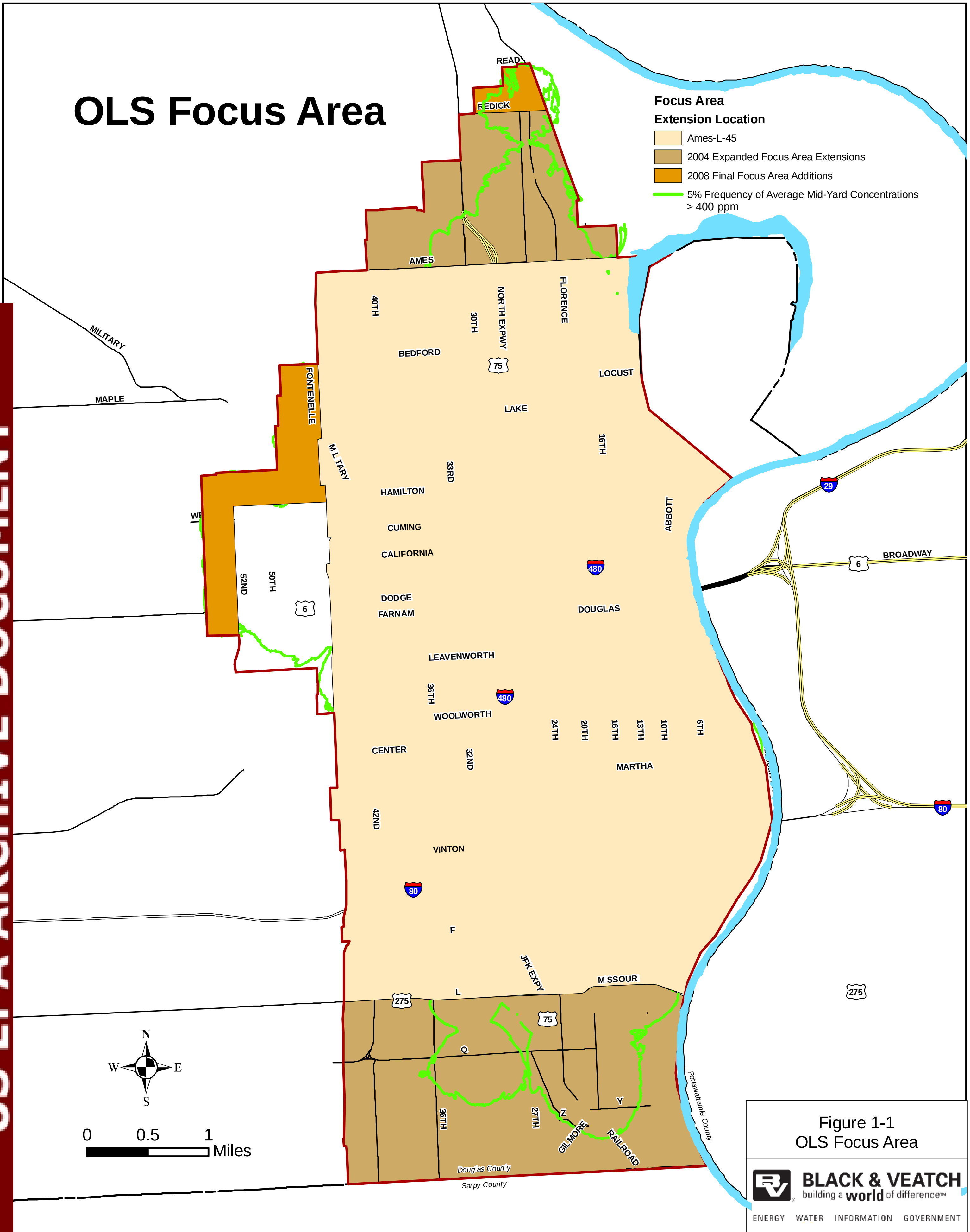

Figure 1-1
OLS Focus Area

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Created By: Kyle Gallagher 09/08/08 Project No.: 044746

Earlier studies involving phosphate-based compounds in this area (Refs. 25 and 26) indicated very low solubilities for many lead-phosphates (Ksp !27 to !66), particularly chloropyromorphite [$Pb_5(PO_4)_3Cl$]. The transformation of soluble Pb mineralogical forms into chloropyromorthite continues to be the primary focus of many soil amendment studies. Sources of phosphorous used in the previous studies included phosphoric acid (PA) (H_3PO_4), triple-super phosphate (TSP), phosphate rock (PR) (a phosphorous-rich natural sediment), and/or hydroxyapatite (HA). Studies have combined one or more of these phosphorous sources with or without the addition of lime, iron, and/or manganese in an attempt to enhance amendment qualities. Most phosphate amendments are formulated to contain between 0.5 and 1.0 percent phosphorous by weight. The sources for phosphorous used in this study include PA, TSP, or PR.

PA, also called orthophosphoric acid, is an odorless, clear, viscous liquid, having a typical pH 1.5. It is a highly corrosive acid, which is incompatible with powdered metals, strong bases, and iron containing compounds. Due to its incompatibility with iron compounds, PA is often used to remove iron-oxide (rust) stains from stainless steel. PA is found commercially in detergents, cleaners, insecticides, fertilizers and cattle feed additives. In the bench scale treatability study, 85% PA (Mallinckrodt Chemicals 2796-45), which has a heavy metal contamination of less than 10 ppm, was used.

TSP ($Ca(H_2PO_4)_2$), also called monocalcium phosphate, is an off-white, granular solid. It is typically produced by reacting phosphate rock with sulfuric acid. This product was historically a very popular item used as a basic fertilizer, or mineral supplement in foods and feed; however, it has since been prohibited by most U.S. certifications. When combined with nitrate-based fertilizers it can create a highly volatile environment. Further, the phosphoric derivatives have a tendency to bind to iron, aluminum, calcium, magnesium, and sodium, essentially "tying-up" essential nutrients. Hi-Yield® *Triple Super Phosphate*, which has 45% available phosphate was used in the treatability study. Wet chemical analyses of this product indicated a lead concentration of 6 ppm.

PR, ($Ca_{10}F_2(PO_4)_5$), also called Kap rock, or fluoroapatite, is a tan, black, gray, or white solid with an "earthy" odor. PR is the only naturally occurring resource of phosphate. PR rock beds are formed near oceans and are often contaminated with other minerals such as magnesium, fluoride and silica. It is mainly used in the production of fertilizers, feed, and industrial products. Whitney Farms™ *Granulated Rock Phosphate*, which contains 3% available phosphoric acid, was used in the treatability study. Wet chemical analyses of this product indicated a lead concentration of 50 ppm.

The previous studies using PA, TSP, or PR have produced mixed results and, to date, phosphate amendments have not been used to treat soils at any large, lead contaminated sites. One study, (Ref. 30) using a phosphate amendment and a post treatment analyses period of five years was far less successful, with a reduction in IVBA (*in vitro*) of only 40%. In addition, (Ref. 30) showed a gradual increase in soil IVBA (3 to 65%) over the five year test period.

In addition, a number of potentially significant problems associated with phosphate amendments have been recognized, including both phyto- and earthworm toxicity (Refs. 27, 28, and 29). Both of these toxicities are primarily associated with very high applications of phosphorous and/or decreased soil pH. Additionally, treatment of soil with a phosphate amendment creates an additional risk of eutrophication of nearby waterways from surface water runoff.

Results from the soil characterization and bench-scale treatment studies described in this report may be used to design subsequent field studies for the treatability study. The scope and objectives of this portion of the treatability study correlate with the December 2004 Interim Record of Decision (ROD). The following paragraph is from the Interim ROD:

> *The treatability study consists of an initial bench scale test to determine the effect that the treatment technology has on the bioavailability of lead in site soils under laboratory conditions. If initial findings are positive, the second phase of the study involves actual field testing and additional bioavailability studies.*

1.1 Study Objectives

The overall objective of this treatability study is to provide data to help support a decision regarding the use of phosphate-based soil amendments at the OLS to treat lead-contaminated soils. As stated in the Interim ROD (EPA, 2004), "it is particularly important that the treatment process itself does not create a hazard to children or residents living at or near the affected properties. The end-products of the treatment process must also not pose an unacceptable short- or long-term risk to residents at or near treated properties. This treatability study must successfully demonstrate that unacceptable risks are not created at any time during the treatment process or thereafter." Specific objectives for this portion of the study include the following:

- In response to amendment treatment, evaluate changes over time (2-14 days) in chemical and physical characteristics of the treated soils, including lead speciation and mineralogy.
- Evaluate the influence of phosphate treatment on the bioaccessibility of lead contamination in mid-yard and drip zone OLS soils.

- Provide data that could be used to evaluate issues related to potential remediation costs and public acceptance of the remedy.

Although the information obtained from the treatability study will be useful to evaluate future remedial action alternatives at the OLS, the information from the study is not conclusive because of the following limitations of the study.

- It is more difficult to perform *in-vivo* testing on soils with lead concentrations between 400 ppm and 800 ppm, which are the soils that are most likely to be treated with the phosphate amendment at the OLS.
- The i*n vitro* testing procedure (Relative Bioavailability Leaching Procedure) used to estimate the relative bioavailability of lead in the soils has not been validated for use on phosphate amended soils.
- The bench scale treatability will only estimate the short term reduction in the relative bioavailability (RBA) of lead in soils. There is no conclusive data indicating phosphate treatment results in long-term reduction in the RBA of lead in soils.

1.2 Rationale for Types of Soil to be Tested

Three types of soils were subjected to amendment treatment in this study:

Test Soil	Soil Id.	Lab Id.	Average Lead Concentrations
A	93205	Soil A	Mid-yard soil between 400 & 800 ppm
B	93206	Soil B	Mid-yard soil greater than 1,000 ppm
C	93207	Soil C	Drip Zone soil greater than 1,000 ppm

The rationale for testing the 3 types of soil is as follows:

- Test Soil No. A has moderate lead concentrations between 400 and 800 ppm which is the potential treatment range discussed in the Interim ROD. For example, if an amendment treatment is found to be capable of lowering the bioavailability of lead by 50 percent, risks associated with elevated lead levels in soil may be reduced to acceptable levels. Bioaccessibility testing can be conducted on soils with lead concentrations below 1,000 ppm, but *in vivo* bioavailability testing is more suitable for soils with lead concentrations greater than 1,000 mg/kg.

- Test Soil No. B is a mid-yard soil with an average lead concentration exceeding 1,000 ppm. If the soil characterization and bioaccessibility testing results indicate that amendment treatment appears to be effective, EPA could elect to perform an *in vivo* bioavailability study in order to corroborate the bioaccessibility results and to strengthen the correlation between the i*n vitro* and *in vivo* results.
- Test Soil No. C is a drip zone soil with an average lead concentration greater than 1,000 ppm. By definition, the drip zone may be impacted by lead paint. EPA believes that it is of interest to evaluate the influence of phosphate treatment on drip zone soils because the information will be important when the remedial alternatives are evaluated in preparation for the Final ROD.

1.3 Preparation of Soil Used for Treatability Study

Soil used for the bench scale treatability study was prepared in accordance with the Treatability Study Work Plan (Ref. 20). Soil for the treatability study was collected from residential yards in OLS Focus Area. Candidate properties were identified based upon the lead concentrations in the yards. Soil screening at the properties involved collecting samples with a 2-inch diameter core barrel slide-hammer sampling device. Three soil types were prepared:

- Mid-yard soil with average lead levels between 400 and 800 parts per million (ppm);
- Mid-yard soil with average lead levels greater than 1,000 ppm; and
- Drip Zone soils with average lead concentrations greater than 1,000 ppm.

Soil was excavated from six of the candidate properties and transported to the OLS staging area and separated into three piles according to the lead concentration in the soil. The soil piles were thoroughly mixed and grab samples were collected from different locations in the piles of soil to confirm average lead levels in the soil. Soil from these piles was sent to the Laboratory for Environmental and Geological Studies (LEGS) at the University of Colorado for testing in the bench scale treatability study. Average lead concentrations in the bulk soils from the three soil piles were 568 ppm, 1,247 ppm, and 1,418 ppm, respectively (Ref. 20, Appendix C).

The LEGS was responsible for sample preparation as discussed in the Treatability Study Work Plan. Soils were air-dried in a controlled environment prior to sieving. Soils were then sieved with a #10 stainless steel sieve to provide bulk samples (particle size < 2 mm) for standard soil analyses and speciation testing. The bulk samples were sieved a second time using a #60 stainless steel sieve to provide fine samples (particle size < 250μ) for *in vitro* studies.

All non disposable equipment used for sample preparation was decontaminated before the tools and equipment were used or re-used. Stainless steel splitters or sieves were washed in RBS 35® detergent, triple rinsed in deionized (Type II) water, and air dried.

Following sample preparation, LEGS sent split samples to the EPA Region 7 laboratory for Quality assurance (QA) metals analyses.

2.0 Characterization Testing

2.1 Soil Characterization

The purpose of soil characterization testing is to assess amendment-soil interactions and quantify changes in physical and chemical characteristics of test soils over time. The tests performed on untreated soils will provide "control" information against which subsequent characterization testing results will be compared in order to understand changes in response to amendment addition.

Soil characterization testing and analyses was performed by the University of Colorado LEGS. Characterization testing included the following parameters: metals, soil pH, acidity, particle size distribution, soil classification, phosphorus, nitrogen, total organic carbon, cation exchange capacity, and lead mineral speciation using an electron microprobe. Speciation testing is intended to provide the following information: lead mineral phase, matrix association, particle size (longest dimension), frequency of occurrence, and relative metal mass using electron microprobe (EMPA) techniques. A principal objective of EMPA analyses is to evaluate changes in lead mineral speciation through the duration of the study.

2.1.1 Fundamental Chemical Characteristics

The chemical characteristics of the three test soils are provided in Table 2-1. Each parameter was run in duplicate (n=2) unless otherwise noted following the methods listed in Appendix A (Table 1A). All raw data and QA/QC are provided in accompanying electronic spreadsheets. A more extensive suite of metals was analyzed for each test soil on splits sent to EPA Region VII lab.

Table 2-1
Average Fundamental Chemical Characteristics of Test Soils

Soil ID	Lab ID	Total Pb*	pH	Acidity	Total P	Extractable P	SPLP P	CEC	TOC	N
		mg/kg		Meq/100g	mg/kg	mg/kg	mg/kg	cmol/kg	%	%
93205	Soil A	752	7.2	65.4	1233	12.7	0.92	20.4	3.748	0.247
93206	Soil B	1100	7.4	70.2	1447	13.4	0.69	21.0	5.072	0.260
93207	Soil C	2230	7.7	80.1	1005	6.4	0.32	20.4	2.532	0.154

*Average lead concentration using analytical methods 3050 and 6010B. Concentrations vary from previously cited lead concentrations in bulk samples (BVSPC XRF results) because only a portion of the bulk sample was analyzed and different methods were used for analysis of soils.

2.1.2 Particle-Size, Texture, and Soil Classification

Soil texture refers to the relative proportion of sand, silt and clay size particles in a sample of soil. Clay size particles are the smallest being less than .002 mm in size. Silt is a medium size particle falling between .002 and .05 mm in size. The largest particle is sand with diameters between 0.05 for fine sand to 2.0 mm for very coarse sand. Soil scientists group soil textures into soil texture classes. A soil texture triangle is used to classify the texture class. Soil texture effects many other properties like structure, chemistry, and most notably, soil porosity, and permeability. Texture influences plant growth by its direct effect on soil aeration, water infiltration, and cation exchange capacity (CEC). Infiltration and permeability are rapid in sandy soils, very slow in clay soils, and intermediate in loam soils.

The three soils from the treatability study have been tested to determine their particle-size distribution, texture, and soil classification following the methods referenced in Appendix A (Table 1A). In addition, a number of related soil properties are provided. These results can be found in Table 2-2 and Figure 2-1. A single large (~125 g) sample was used for these analyses. All measurements and calculations can be found in electronic spreadsheets (Appendix E).

Table 2-2
Test Soil Particle-Size Analyses and Related Soil Properties

Parameter	Soil A (93205)	Soil B (93206)	Soil C (93207)
% Sand (.05-2.0mm)	47.7%	47.4%	23.5%
% Silt (.002-.05 mm)	51.7%	44.9%	72.6%
% Clay (<.002 mm)	0.6%	7.7%	3.9%
Classification	Silty Loam	Loam	Silty Loam
Wilting Point (cm^3 H_2O/cm^3 Soil)	0.074	0.087	0.090
Field Capacity (cm^3 H_2O/cm^3 Soil)	0.24	0.23	0.29
Available Water (in. H_2O/ ft. Soil)	2.0	1.73	2.45
Bulk Density (mg/m^3)	1.15	1.20	1.15
Porosity	56%	55%	56%

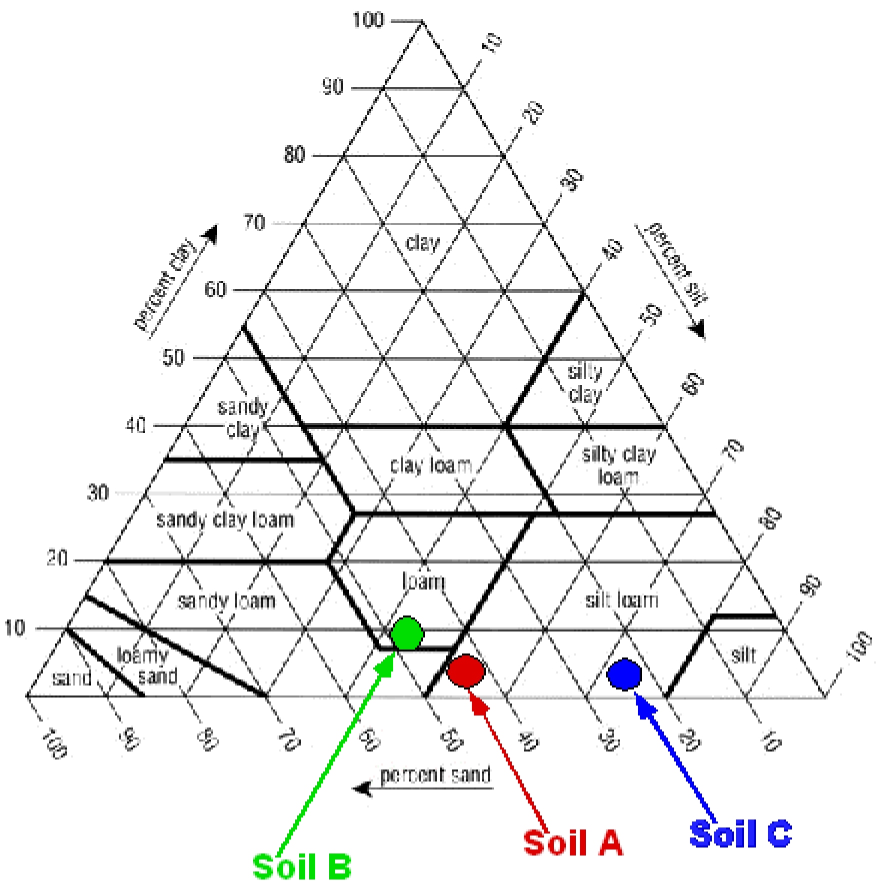


Figure 2-1 - Soil Textural Classes for the Three OLS Test Soils

2.1.3 Mineralogy-X-ray Diffraction

Clay mineral analyses were based on the standard method (Ref. 16). A detailed description of the methodology and results can be found in Appendix F. The bulk XRD analyses of all three soils are dominated (Figures 2-2 through 2-4) by quartz (SiO_2), plagioclase ($Na,CaAlSi_3O_8$), and microcline ($KAlSi_3O_8$). Soil B additionally contained a significant amount of hematite (Fe_2O_3). Further analyses of the soils clay fraction (Figures 2-5 and 2-6) indicate that all three soils are dominated by the presence of the minerals illite, kaolinite, and smectite.

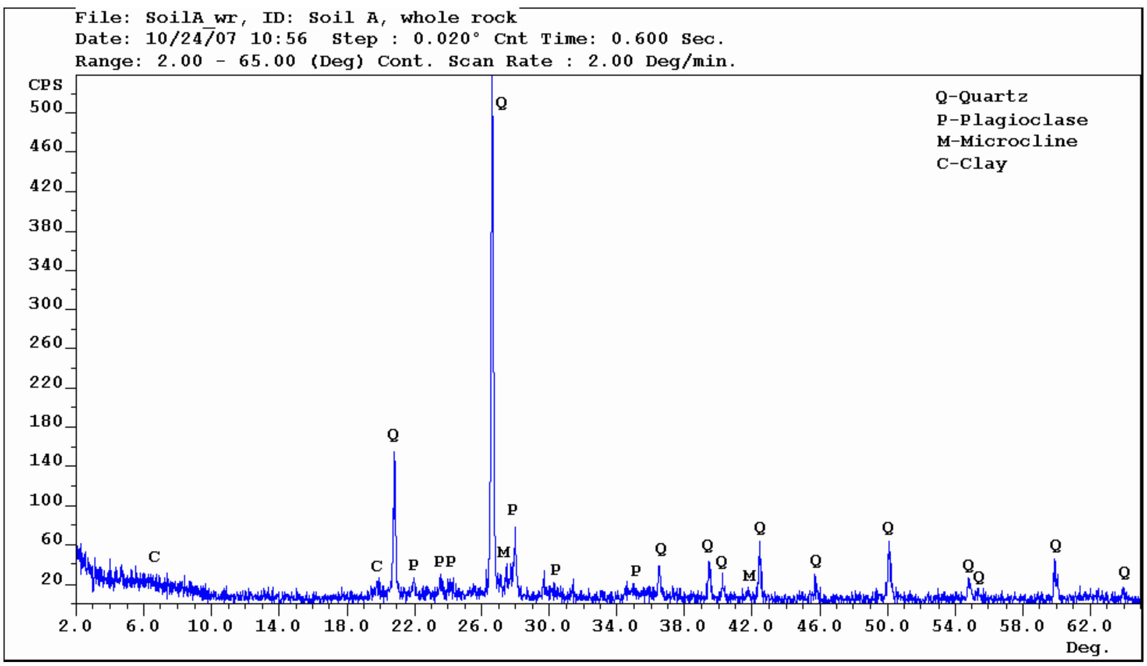


Figure 2-2 - Whole-Rock XRD Spectra for OLS Test Soils A

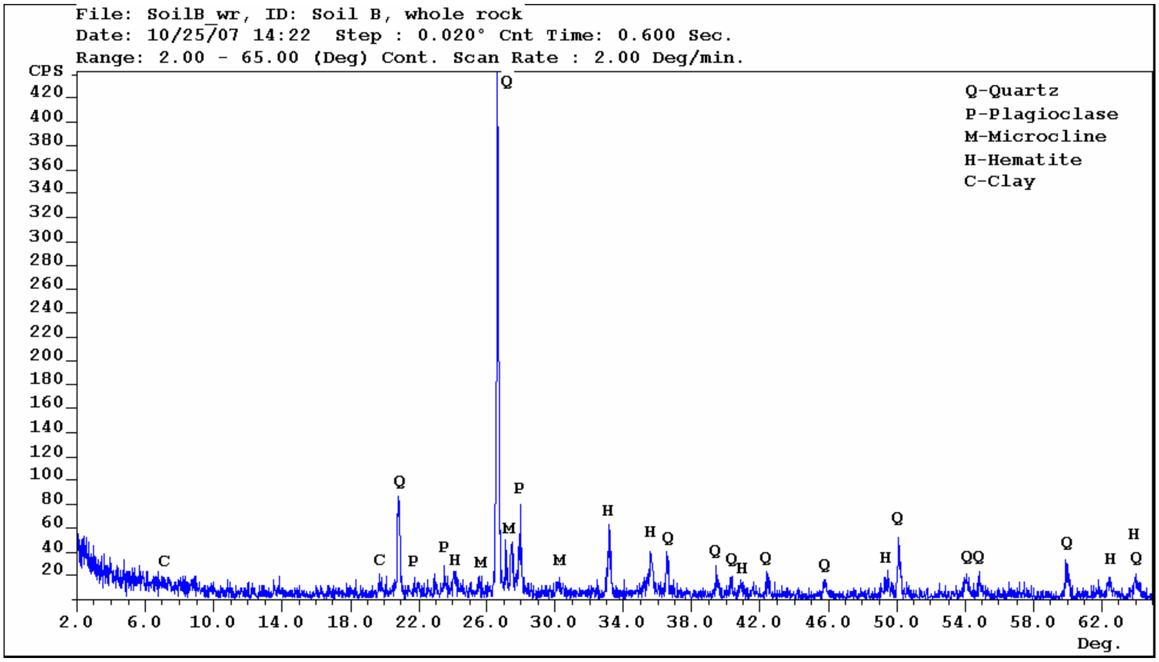


Figure 2-3 - Whole-Rock XRD Spectra for OLS Test Soils B

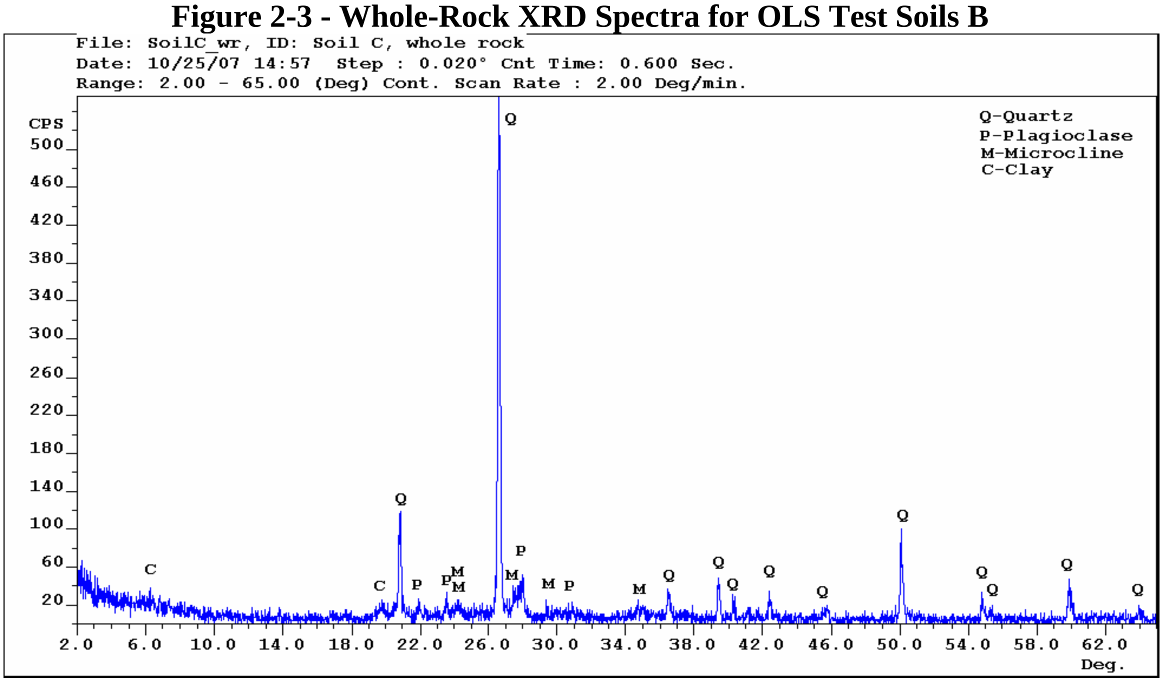


Figure 2-4 - Whole-Rock XRD Spectra for OLS Test Soils C

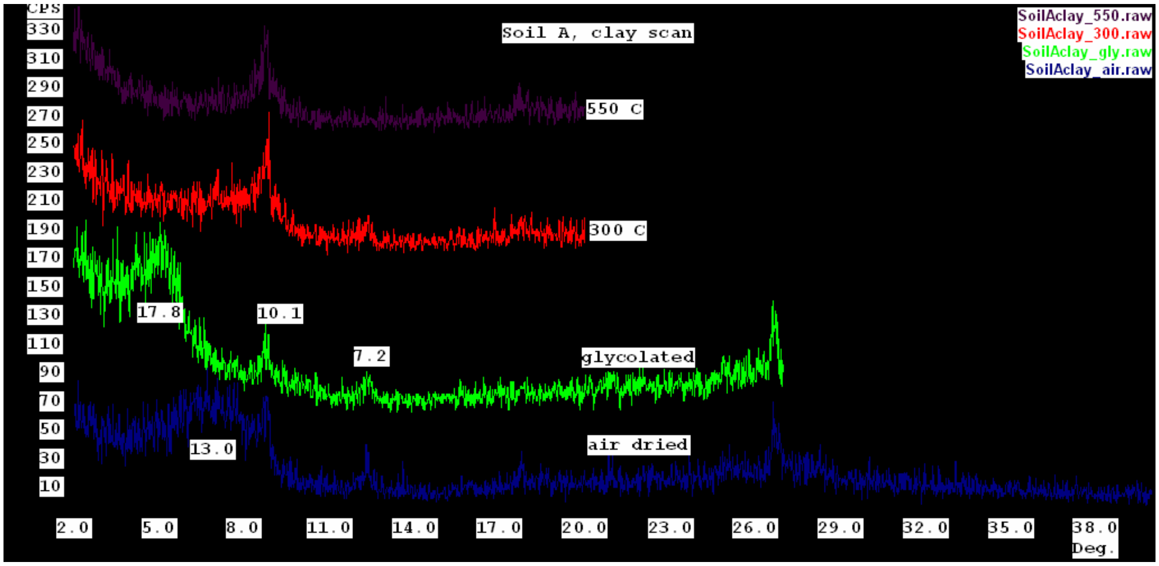


Figure 2-5 - Clay Fraction XRD Spectra for OLS Test Soils A

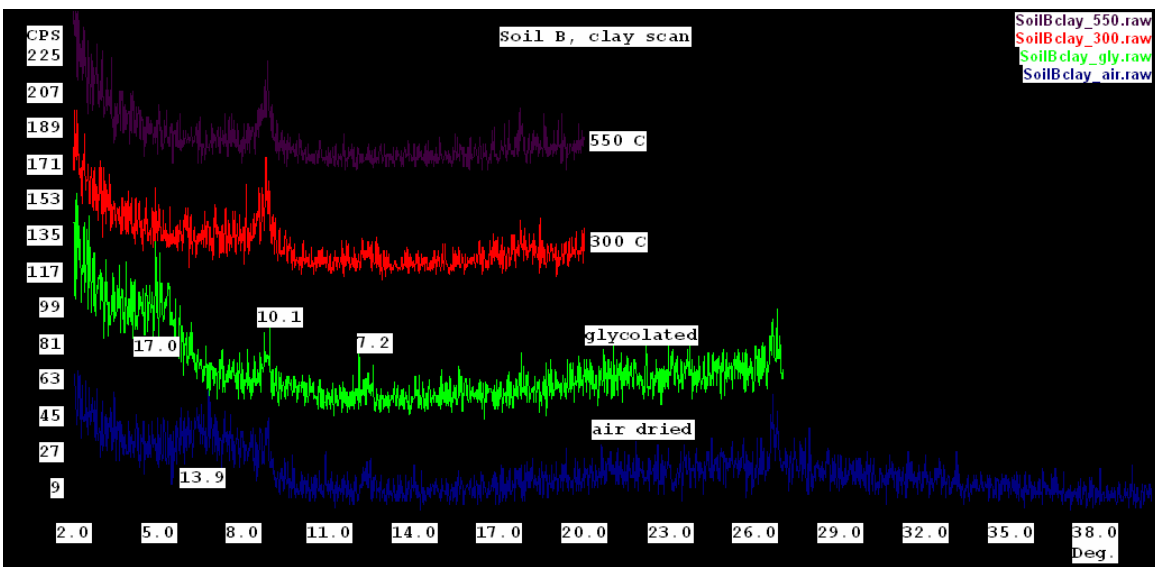


Figure 2-6. Clay Fraction XRD Spectra for OLS Test Soils B.

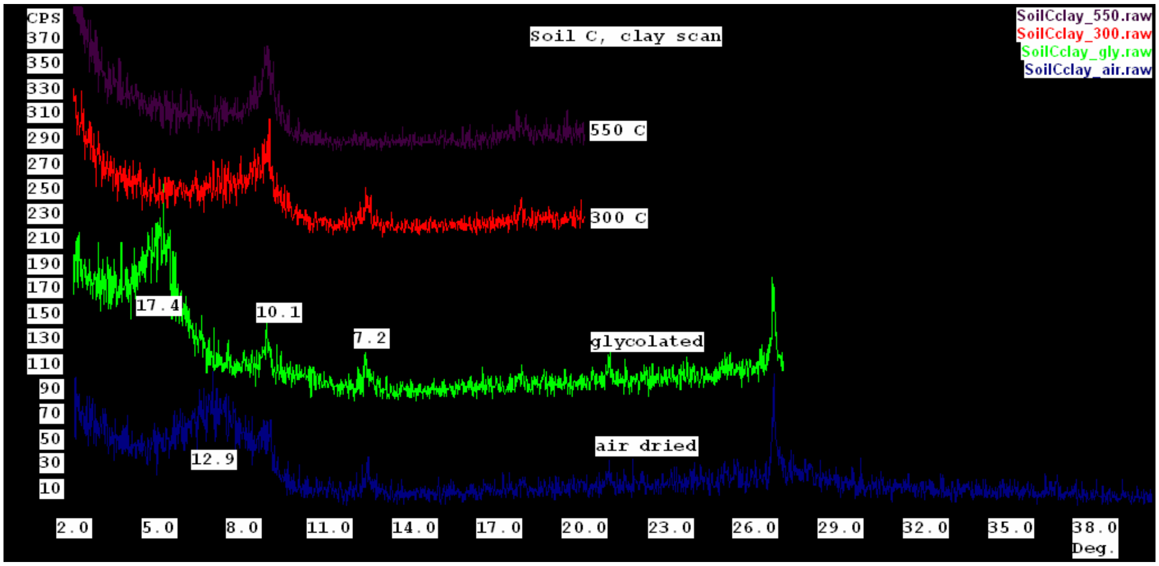


Figure 2-7 - Clay Fraction XRD Spectra for OLS Test Soils C

2.1.4 Speciation- EMPA

Lead speciation on the <2mm fraction for each of the OLS soils was conducted following the LEGS method (Appendix B) at the University of Colorado. A single split was taken for each soil. Data are summarized in Tables 2-3 to 2-5 and Figures 2-8 to 2-10, while a complete particle-by-particle data set is provided in an electronic spreadsheet contained in Appendix E.

In general, the dominant lead forms in the three test soils are: cerussite ($PbCO_3$), anglesite ($PbSO_4$), and a lead phosphate. Lead forms identified in the treatability study soils are generally consistent with those found in a previous apportionment study at the OLS; i.e., soils containing large relative masses of cerussite, anglesite, or lead phosphate were found in the apportionment study. These lead forms are consistent with results from the i*n vitro* bioassay work described later in this report.

Table 2-3

OLS Test Soil A Speciation Results.

Form	Particle Count Number	Size Mean	Std-Dev	Range low	Range high
total	103	14.65	30.12	1	250
MnOOH	39	16.18	16.19	3	85
FeOOH	25	10.52	10.36	1	50
FeSO4	10	7.2	8.28	3	28
Cerussite	1	6	ND	6	6
Brass	1	1	ND	1	1
Phosphate	20	13.1	33.94	1	150
Anglesite	2	126.5	174.66	3	250
PbMO	1	1	ND	1	1
Clay	3	5	4.36	2	10
Galena	1	5	ND	5	5

Form	(linear) freq	Bio freq	Rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
MnOOH	41.82	41.82	19.43	19.43	9.53
FeOOH	17.43	17.43	2.72	2.72	7.33
FeSO4	4.77	4.77	0.15	0.15	4.12
Cerussite	0.4	0.4	1.45	1.45	1.22
Brass	0.07	0.07	0	0	0.5
Phosphate	17.36	17.36	23.11	23.11	7.32
Anglesite	16.77	16.77	51.32	51.32	7.21
PbMO	0.07	0.07	0.16	0.16	0.5
Clay	0.99	0.99	0.12	0.12	1.92
Galena	0.33	0.33	1.53	1.53	1.11

Column headings: Frequency of occurrence weighed on the longest particle dimension = "**linear freq**", bioaccessable frequency is the frequency of occurrence population less any particle greater than 250 microns or enclosed in another particle = "**Bio freq**", relative lead mass based on frequency of occurrence = "**Rm Pb**", Bioaccessable lead mass is based on bioaccessable frequency of occurrence = "**Biorm Pb**", and counting error at the 95% confidence limit = "**Error-95%**". All factors are more fully defined in SOP, Appendix B.

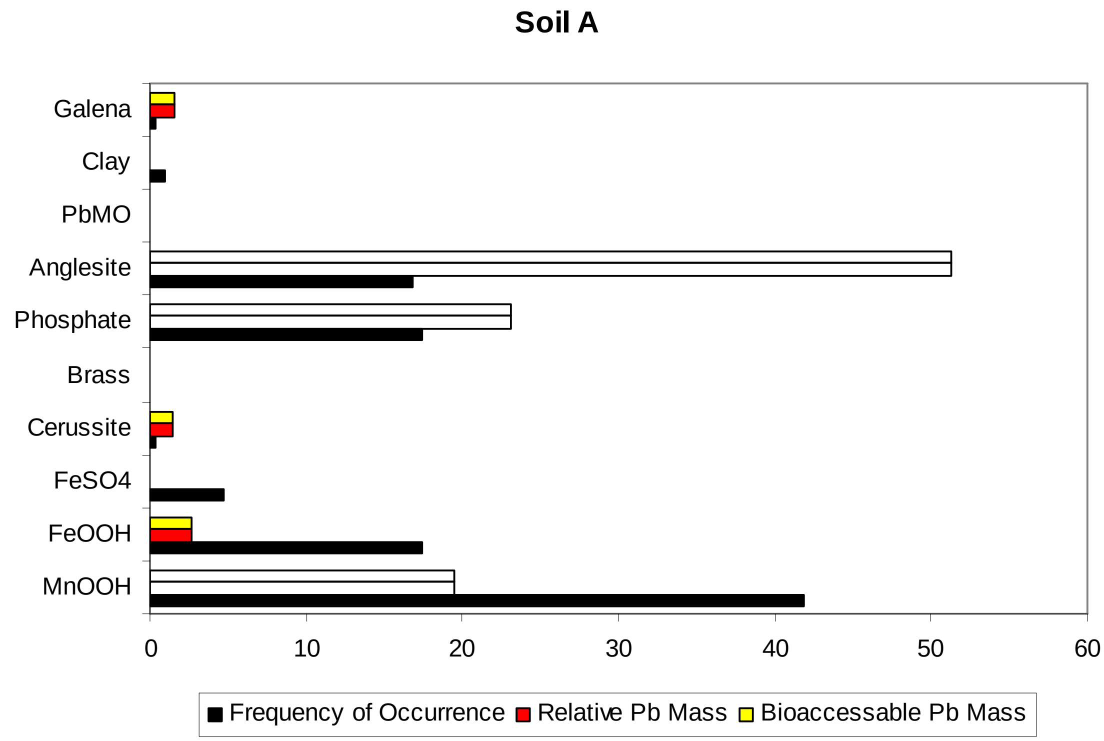


Figure 2-8 - OLS Test Soil A Speciation Results

Table 2-4

OLS Test Soil B Speciation Results.

Form	Particle Count Number	Size Mean	Std-Dev	Range low	Range high
total	135	13.12	62.09	1	690
Cerussite	63	4.71	25.03	1	200
FeOOH	24	19.29	19.53	4	75
Barite	2	5.5	3.54	3	8
Phosphate	21	7.29	9.2	1	43
PbTiO2	1	1	ND	1	1
PbSiO4	9	1.22	0.44	1	2
MnOOH	7	14.71	11.48	1	30
Anglesite	3	4	4.36	1	9
Galena	2	2	1.41	1	3
Brass	1	18	ND	18	18
Clay	1	8	ND	8	8
Paint	1	690	ND	690	690

Form	(linear) freq	Bio freq	Rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
Cerussite	16.77	27.41	66.29	72.08	6.3
FeOOH	26.14	42.87	4.45	4.85	7.41
Barite	0.62	1.02	0	0	1.33
Phosphate	8.64	14.17	13.8	15.06	4.74
PbTiO2	0.06	0.09	0.22	0.24	0.4
PbSiO4	0.62	1.02	0.7	0.77	1.33
MnOOH	5.82	9.54	2.96	3.23	3.95
Anglesite	0.68	1.11	2.25	2.46	1.38
Galena	0.23	0.37	1.13	1.24	0.8
Brass	1.02	1.67	0.01	0.01	1.69
Clay	0.45	0.74	0.06	0.07	1.13
Paint	38.96	0	8.12	0	8.23

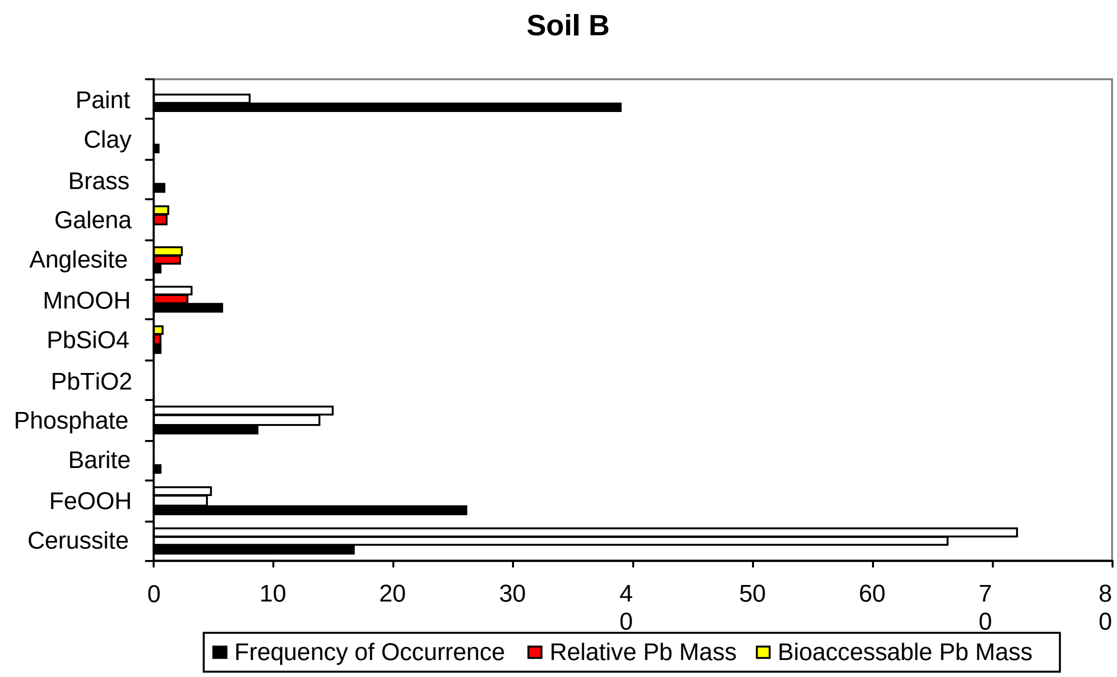


Figure 2-9 - OLS Test Soil B Speciation Results.

Table 2-5
OLS Test Soil C Speciation Results.

Form	Particle Count Number	Size Mean	Std-Dev	Range low	Range high
total	110	2.24	3.22	1	20
Cerussite	38	1.76	1.63	1	8
Phosphate	12	2.25	0.87	2	5
PbTiO2	25	1.04	0.2	1	2
Anglesite	2	8	0	8	8
MnOOH	3	18.33	2.08	16	20
PbMO	1	4	ND	4	4
PbSiO4	25	1.12	0.33	1	2
Clay	1	2	ND	2	2
Barite	1	10	ND	10	10
FeSO4	1	7	ND	7	7
FeOOH	1	4	ND	4	4

Form	(linear) freq	Bio freq	Rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
Cerussite	27.24	27.24	49.76	49.76	8.32
Phosphate	10.98	10.98	7.6	7.6	5.84
PbTiO2	10.57	10.57	19.23	19.23	5.75
Anglesite	6.5	6.5	10	10	4.61
MnOOH	22.36	22.36	5.26	5.26	7.79
PbMO	1.63	1.63	1.99	1.99	2.36
PbSiO4	11.38	11.38	5.94	5.94	5.94
Clay	0.81	0.81	0.05	0.05	1.68
Barite	4.07	4.07	0	0	3.69
FeSO4	2.85	2.85	0.05	0.05	3.11
FeOOH	1.63	1.63	0.13	0.13	2.36

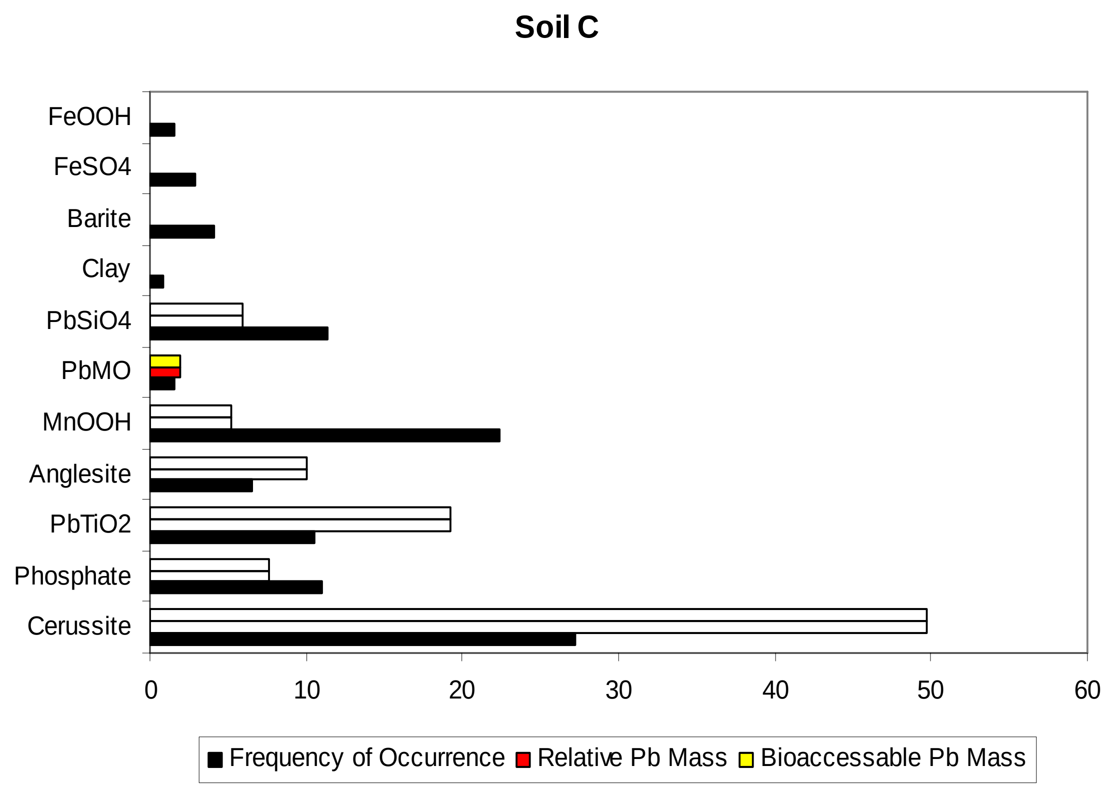


Figure 2-10 - OLS Test Soil C Speciation Results

2.2 Bioaccessibility Testing

An i*n vitro* procedure known as the "Relative Bioavailability Leaching Procedure" (RBALP) (Refs. 6 and 7) was utilized for this treatability study. The RBALP, which was developed by LEGS, has been used to estimate soil lead i*n vitro* bioaccessibility (IVBA) (Refs. 8, 9, 10, and 11). Bioaccessibility testing, which is an i*n vitro* test, was described in Section 2.2 of the Treatability Study Work Plan (Ref. 20).

A method of estimating bioavailability involves i*n vitro* testing which is, by definition, conducted "in laboratory glassware." The i*n vitro* method is referred to as *bioaccessibility* testing to distinguish it from *in vivo* bioavailability testing which involves animal feeding studies. The i*n vitro* method is significantly less resource intensive, can be performed more rapidly (weeks instead of months required for the *in-vivo* test method), does not require the sacrifice of animals, and the results have been shown to correlate well with the results of *in vivo* bioavailability studies (Ref. 10).

Unlike the *in vivo* procedure, which favors soils with at least 1,000 ppm lead, the RBALP can be applied to soils with lead concentrations in the target treatment range for this project (400 to 800 ppm). For detailed information on bioaccessibility testing objectives, methods and procedures, including a discussion of how the *in vivo* and i*n vitro* testing results are correlated mathematically, see Appendix C (RBALP Standard Operating Procedure).

Baseline bioaccessibility data for the OLS test soils are summarized in Tables 2-6 and 2-7. Data for both lead and arsenic are provided and represent an average of six replicate (n=6) analyses. Both the standard i*n vitro* pH of 1.5 was reported in addition to data for a pH of 2.5 in order to compare results with literature values from other amendment studies. Only one detailed field study has been conducted using phosphate amendments with supporting *in vitro* and *in vivo* data. Soils from Joplin, Missouri, comprised primarily of $PbCO_3$ and $PbSO_4$, (two fairly soluble forms of lead), have been studied over a time period of up to three years (Refs. 3, 4, and 5). A reduction in IVBA and RBA-rat, (based on *in vitro* and *in vivo* data, respectively) range from 2-70%. In this study, a better comparison between (RBA-rat) results was occasionally found when the *in vitro* (IVBA) procedure was run at pH 2.2.

Also, it is important to note that all *in vitro* data is based on a sieved (<250 μ) split of the sample, as this is the particle size that is considered bioaccessable by the EPA. Complete data package with raw data, calculations and QA/QC are provided in accompanying electronic spreadsheets in Appendix E.

Table 2-6

In Vitro Lead Bioaccessibility of OLS Test Soils

	<250µ Total Pb*	**IVBA-Pb pH 1.5**	**IVBA-Pb pH 2.5**
	mg/kg	%	%
Soil A	831 +/- 20	80 +/- 3	41 +/- 3
Soil B	1406 +/- 93	86 +/- 3	49 +/- 4
Soil C	2284 +/- 130	88 +/- 6	61 +/- 4

* Soil sample sieved at 60 mesh (250 µm)

Table 2-7

In Vitro Arsenic Bioaccessibility of OLS Test Soils

	<250µ Total As*	**IVBA-As pH 1.5**	**IVBA-As pH 2.5**
	mg/kg	%	%
Soil A	37 +/- 0.5	35 +/- 3	25 +/- 2
Soil B	43 +/- 0.8	37 +/- 4	24 +/- 2
Soil C	15 +/- 0.3	33 +/- 8	16 +/- 2

* Soil sample sieved at 60 mesh (250 µm)

3.0 Laboratory Bench Testing

Several forms of phosphate have been researched for the treatment of lead-contaminated soil including phosphate rock, triple super phosphate, and phosphoric acid. Previous studies have generally found that the bioavailability of lead is reduced by the application of phosphate amendments. Lead phosphate minerals are generally very stable with very low solubility and are expected to exhibit low bioavailability. Phosphoric acid has been evaluated in treatability studies and bench scale tests and has been shown to reduce lead bioavailability at other sites (Ref. 3, 4, and 5). Other types of amendments, including sulfate compounds and biosolids, have also yielded promising research results.

This treatability study will focus on documenting bioaccessibility changes in OLS soils resulting from phosphate amendments. One of the amendment schemes was similar to the treatment process developed for the Jasper County, Missouri, Superfund site, which utilized phosphoric acid. The treatment scheme used at Jasper County involved the following steps (Ref. 5):

- Phosphoric acid was incorporated into the soil, along with potassium chloride (KCl), in an effort to form lead phosphate minerals.
- Hydrated lime [$Ca(OH)_2$] was added several days after phosphoric acid amendment in order to raise soil pH and thereby promote sod rooting or grass seed growth.
- Soil samples were collected for testing at prescribed time intervals following the completion of amendment treatment.

For the OLS, laboratory bench testing followed the completion of pre-treatment soil characterization testing and was also conducted by the LEGS. The objective of this effort was to evaluate various amendment types and strategies and recommend treatment schemes and procedures for field-testing. Numerous treatment schemes were conducted on unsieved splits of soil provided to LEGS by BVSPC using three forms of phosphorus; phosphoric acid (PA), triple super phosphate (TSP), and phosphate rock (PR). The amendment concentrations ranged from 0.5 percent (for example, 0.5 PA) to 2.0 percent (for example, 2 TSP). Some scenarios included the addition of hydrous ferric oxide (HFO) in an effort to reduce arsenic mobilization under high phosphate conditions. All amendments had lime added at the end of their reactive interval to adjust the pH back to a near normal (7.5) pH value. In most instances it was not possible to adjust the pH to pre-treatment levels. The average post-treatment pH was ~ 8.7. It was determined that adding more lime for the bench-scale testing would dilute the samples to an unacceptable level, causing the lime to behave not as a pH buffer, but merely diluting the contaminated soils with a non-lead material. Amendments were run in duplicate (n=2) and sampled at 2, 7 and 14 days, Appendix A, (Table 2A). All analytical testing (SPLP, total P, extractable P, and RBALP) performed on the various treatment schemes are provided on accompanying electronic spreadsheets in Appendix E.

3.1 Total Phosphorus (P)

All of the amendment scenarios added considerable (1000X background) phosphorus to the OLS soils, 3,000-16,000 mg/kg P. As anticipated, the total phosphate remains generally constant, (Figures 3.1 to 3-3), throughout the 14 days testing interval. Phosphorus (P) is an essential element classified as a macronutrient for plants. Adequate P availability for plants stimulates early plant growth and hastens maturity. The soluble phosphate in the soil solution generally moves a short distance. Movement is slow but may be increased by rainfall or irrigation water flowing through the soil. As phosphate ions in solution migrate, most of the phosphate will react with other minerals within the soil. At the OLS, phosphate ions would likely react by adsorbing to soil particles or by combining with elements in the soil such as calcium (Ca), or magnesium (Mg), since soil pH is relatively high (pH >7.0), forming compounds that are solids. The adsorbed phosphate and the newly formed solids are relatively available to meet plant needs. The potential for migration of phosphorus to the water table can only be estimated once sorption isotherms for the OLS are determined; however, surface runoff of phosphorus is likely.

Although P is essential for plant growth, mismanagement of soil P can pose a threat to water quality. When lakes and rivers are polluted with P, excessive growth of algae often results. High levels of algae reduce water clarity and can lead to decreases in available dissolved oxygen (eutrophication) as the algae decays, conditions that can be very detrimental to fish populations.

The complete data set with QA/QC can be review in the accompanying electronic spreadsheet in Appendix E.

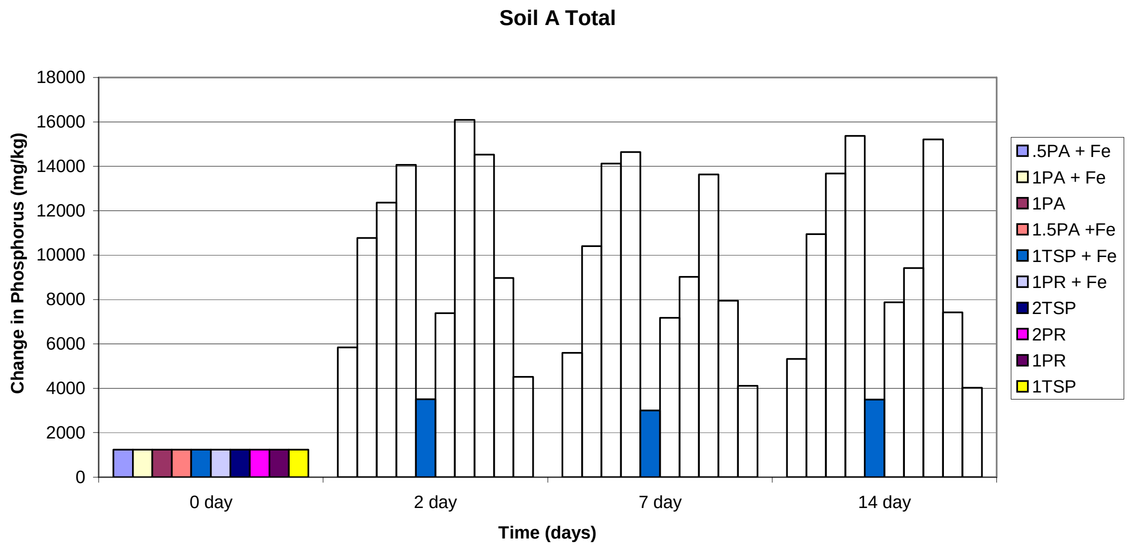


Figure 3-1 - Post-Treatment, Total Phosphorus from Soil A

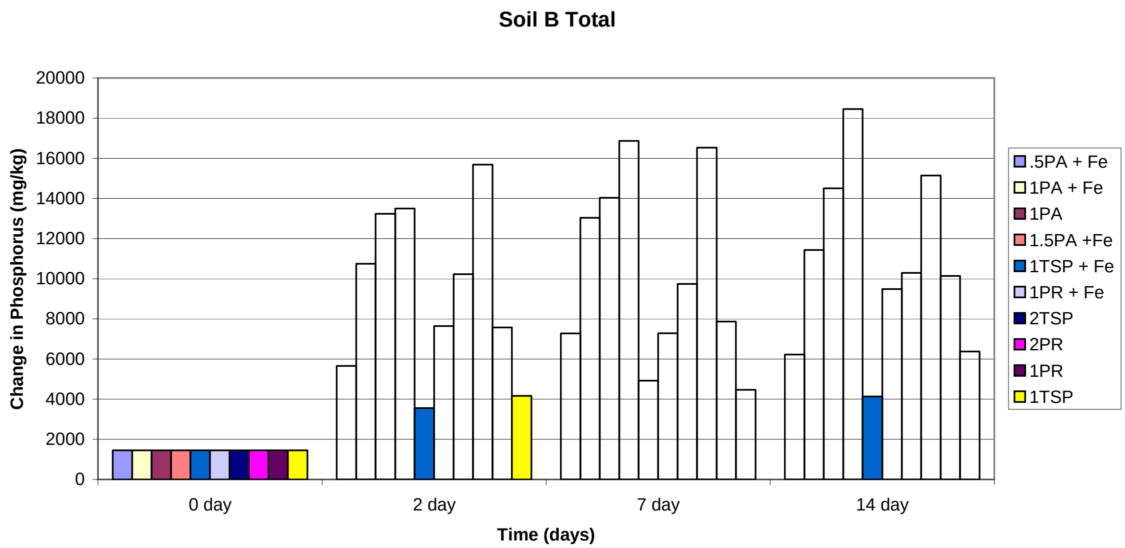


Figure 3-2 - Post-Treatment, Total Phosphorus from Soil B

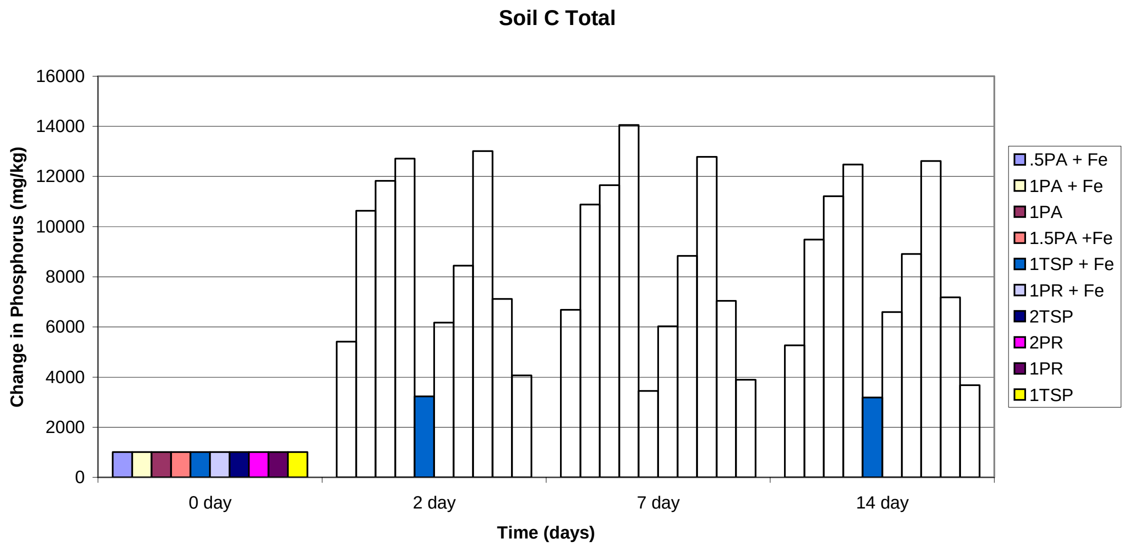


Figure 3-3 - Post-Treatment, Total Phosphorus from Soil C

3.2 Extractable P

Extractable phosphate concentrations are intended to provide an indication of the sustainability of the amendment procedure. Thus, over time, as more lead becomes soluble from normal weathering, there is an issue as to whether there is sufficient phosphorous left in the soil to promote lead phosphate formation. A considerable degree of variation can be seen between the various forms of phosphate amendments and extractable phosphorus. PR yields virtually no extractable phosphate, even after 14 days (Figures 3-4 to 3-6). The other forms, TSP and PA, have 100-800 mg/l extractable P, with PA having the highest final concentrations after 14 days. The complete data set with QA/QC can be reviewed in the accompanying electronic spreadsheet in Appendix E.

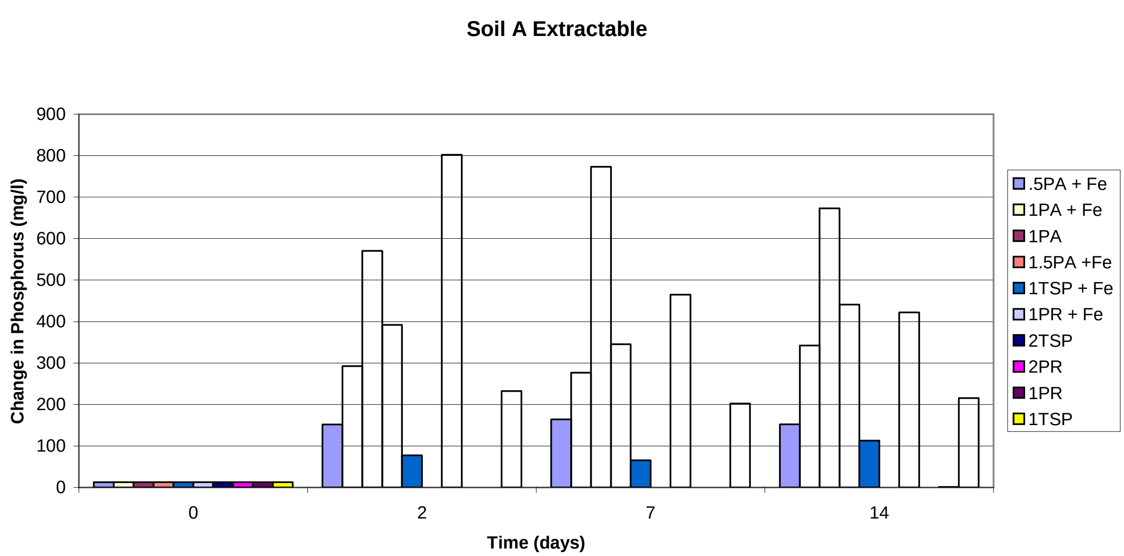


Figure 3-4 - Post-Treatment, Extractable Phosphorus from Soil A

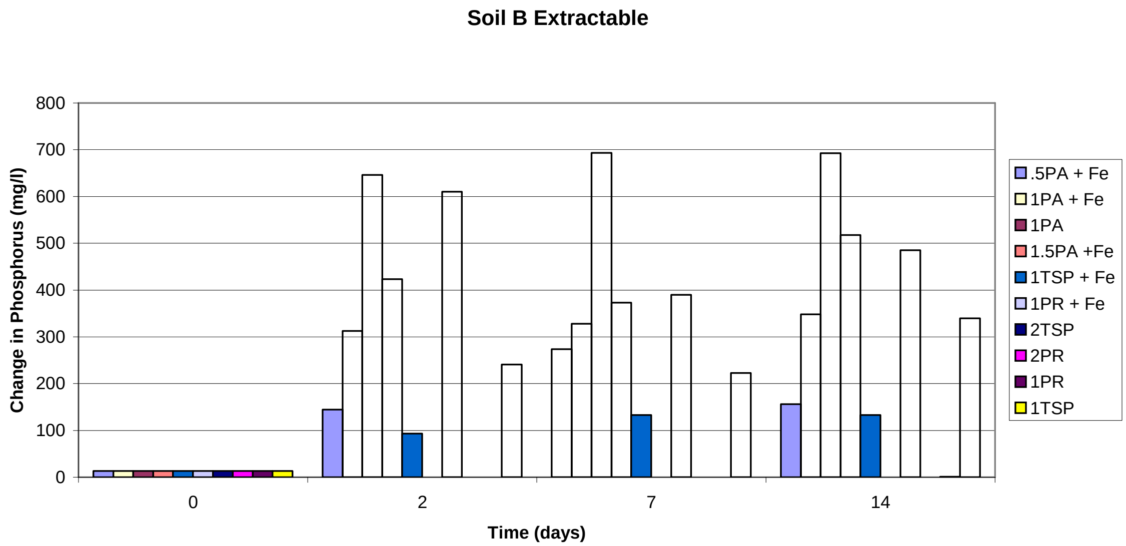


Figure 3-5 - Post-Treatment, Extractable Phosphorus from Soil B

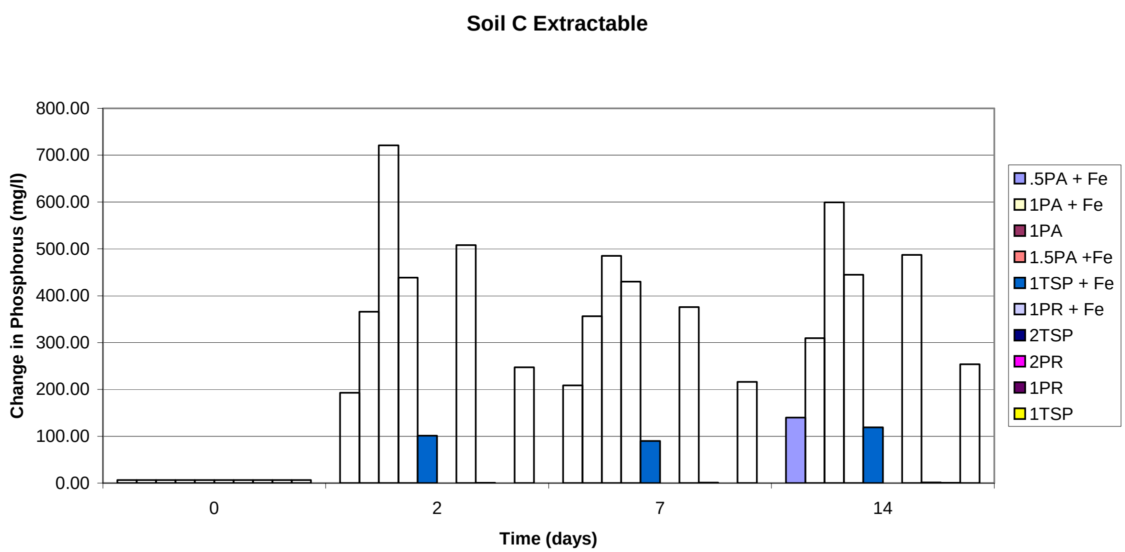


Figure 3-6 - Post-Treatment, Extractable Phosphorus from Soil C

3.3 SPLP- Leachable P

Leachable phosphorus, (the phosphorous that will most likely impact surface runoff and groundwater) as measure by SPLP, is generally low, 2-30 mg/l, above the control soils concentrations. In general, concentrations of phosphorus decrease with time. The samples amended with 2-TSP leached from 40-120 mg/l P and remained high throughout the 14 days. The complete data set with QA/QC can be reviewed in the accompanying electronic spreadsheet in Appendix E.

3.4 *In Vitro* Bioavailability

The *in vitro* bioavailability (IVBA) for lead, as measured using the RBALP, for each of the amended soils is presented in Figures 3-7 to 3-9. All of the samples show some reduction in bulk lead from the control (blue circle) samples. This change is primarily the result of dilution (from the low lead amendments) and a slight increase in particle size of the soils. The changes in IVBA are not significant and vary for each of the soils over time. In general, an average 20% reduction ($IVBA_{Initial} – IVBA_{Final} / IVBA_{Initial} *100$) in bioaccessibility was achieved, with the highest reduction achieved using the amendment of 1.5PA + hydrous ferric oxide (HFO). None of the amendment scenarios consistently lowered the soil IVBA's below EPA's default level (this is the value for IVBA used in the Integrated Exposure Uptake Biokinetic (IEUBK) model when no site-specific bioavailability data is available) of 60%.

As discussed in the Treatability Work Plan (Ref.20), all samples were run with a second *in vitro* pH of 2.5 in order to be able to compare results with similar studies found in the literature. Running the RBALP at a pH of 2.5 (not a validated pH) indicates a much greater reduction in IVBA for all treated samples. As with the 1.5 pH samples, the 1.5PA + hydrous ferric oxide (HFO) amendment showed the greatest reduction, reducing IVBA to approximately 18% (11-24%) from the 50% average IVBA measured pre-treatment at pH 2.5. This represents nearly a 70% reduction in IVBA.

It is very important to note that there has been no validated *in vitro* method published for phosphate-amended soils at any pH values, including pH 1.5 and pH 2.5. Studies on amended soils have limited animal data (Ref. 5 and 21) and are highly variable, indicating both increases and decreases in RBA. Additionally, the 1.5 pH IVBA data from the RBALP agrees well with the OLS *in vivo* data (Ref. 22). Average RBA estimates obtained at pH 1.5 from RBALP are 76 and 71 percent for TM-1 and TM-2 (test materials from swine OLS study), whereas measured values *in vivo* are 96 and 83 percent, respectively. Because the increase in pH from 1.5 to 2.5 standard units (su) for the RBALP would lower estimated RBA, it is clear that the use of a 2.5 pH *in vitro* solution would significantly underestimate the RBA at the OLS.

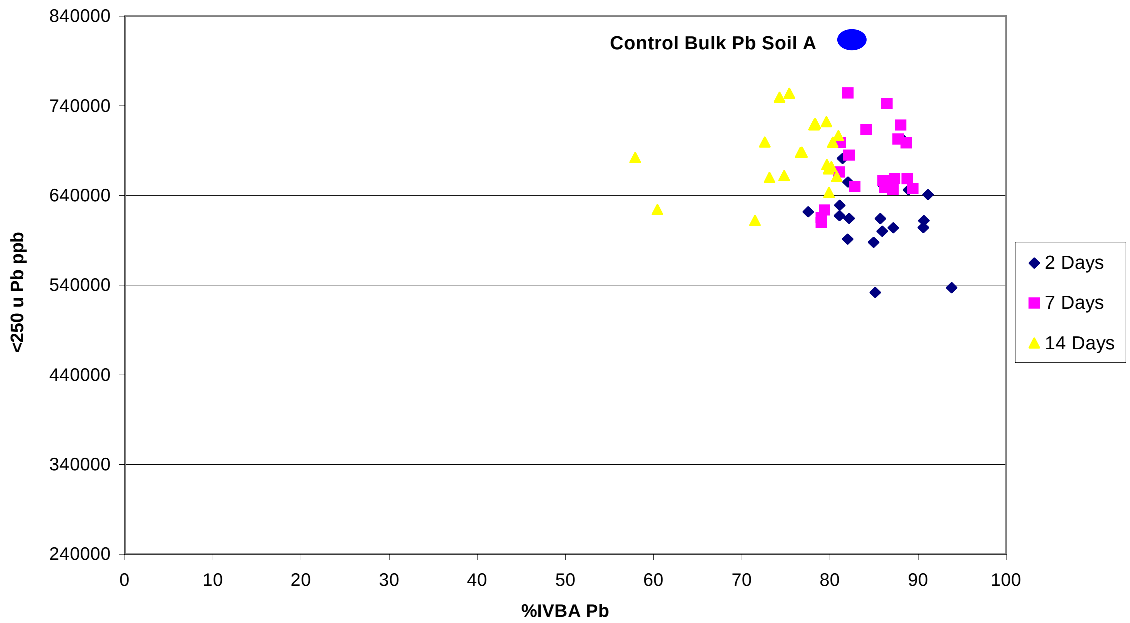


Figure 3-7 - Post-Treatment, IVBA for Lead in Soil A.

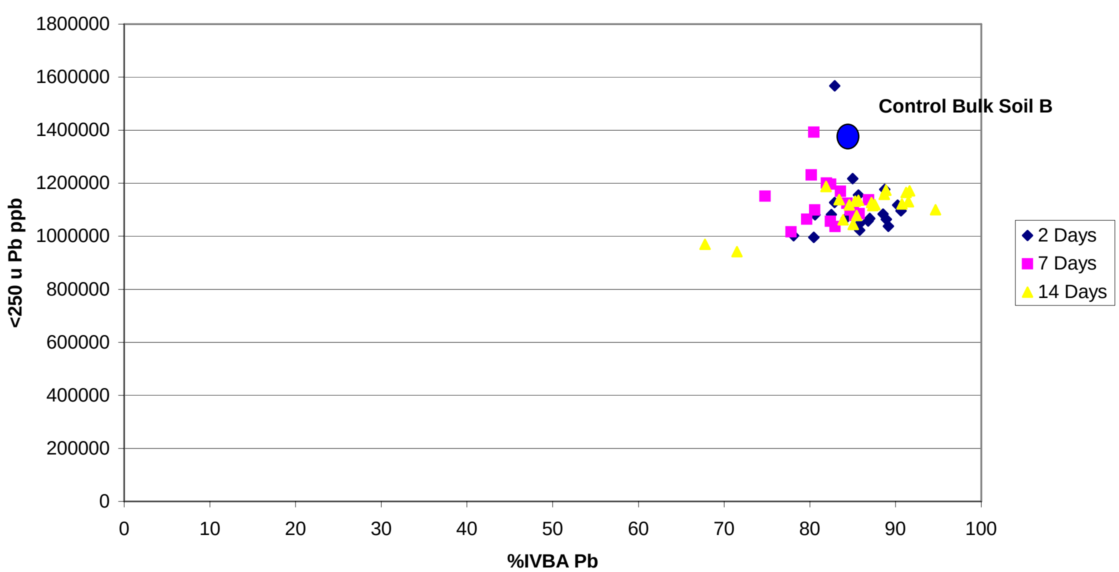


Figure 3-8 - Post-Treatment, IVBA for Lead in Soil B

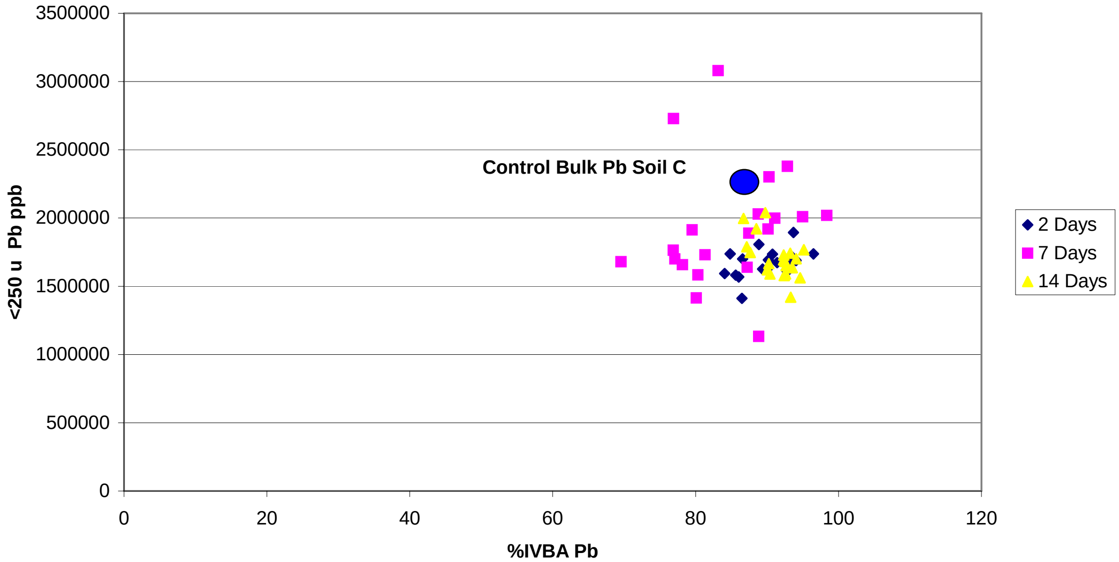


Figure 3-9 - Post-Treatment, IVBA for Lead in Soil C

3.5 Post Treatment Speciation

Post treatment speciation for lead is presented in Tables 3-1 to 3-3 and Figures 3-10 to 3-12. Only a single sample from the 1.5 PA + iron treatment (greatest reduction in IVBA) for each soil was speciated. It is apparent that the treatment procedure speciated is forming a phosphate product. The frequency of occurrence of lead phosphate forms increased in the treated soils to between 66 and 81% from the control soils that contained only 9-17 % lead phosphate. Based on the post-treatment speciation results it appears that the more soluble forms of lead including paint, cerussite, anglesite, and oxides of lead were preferentially dissolved and re-precipitated as a phosphate. Particle size of the lead-bearing forms also plays an apparent role. In all three soils the post treatment, mean particle-size of the lead-bearing forms increased from 14 to 36, 13 to 25, and 2 to 23 microns in soils A, B, and C, respectively. The small (more soluble) particles preferentially dissolved. It also appears that lead associated with iron and manganese oxides does not respond well to phosphate treatment.

Two general forms of phosphate compounds are observed. The first, (labeled as phosphate) generally contain significant quantities of lead (25-60 wt% PbO) but are hydrated, with 10-25 wt% water in their structure. These phosphates, although containing lead and chloride, are clearly not pyromorphite or chloropyromorphite. They are well hydrated, and contain more chlorine and phosphorus than the pyromorphites (Figures 3-13 and 3-14). Although thermodynamically pyromorphites are the stable phase (Ref. 23), they are seldom identified and their diagenetic formation may be kinetically prevented

(Ref. 24). Since the general premise of the phosphate treatment is the formation of the insoluble, Ksp= -84.4, chloropyromorphite, the formation of a potentially more soluble, primary or secondary orthophosphate (Ksp = -9.84, -11.43 respectively) is significant. These phosphates would not likely be less bioaccessable than many of the original lead phases (anglesite Ksp –7.7, and cerussite Ksp –12.8). These observations are in direct support of the limited decrease in IVBA observed in the treated soils.

The second phosphate compound, (Fe-hydrophosphate), is likely formed from the AFH (amorphous ferrihydroxide) added to the amended soils. These hydrated iron oxides have now sorbed phosphorus (1-20 wt% P_2O_5), chlorine (1-3 wt% Cl) and lead (0.08-2.1 wt% PbO). Since they are not chemically similar to either corkite ($PbFe_3PO_4SO_4$-OH_6) or drugmanite, (Pb_2Fe $(PO_4)_2$-OH_3) it is unlikely they represent a stable mineral form.

Table 3-1

Form	Number	Mean	Std-Dev	Range low	Range high
Total	96	35.76	36.72	1	155
Phosphate	21	9.62	23.73	1	110
MnOOH	2	102.5	45.96	70	135
Brass	1	2	ND	2	2
FeOOH	14	25.64	31.72	2	90
PbTiO2	2	2.5	0.71	2	3
Fe-HydroPhosphate	55	48.33	34.36	4	155
Lead Solder	1	2	ND	2	2

Form	(linear) freq	Bio freq	rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
Phosphate	5.88	5.88	47.87	47.87	4.71
MnOOH	5.97	5.97	16.53	16.53	4.74
Brass	0.06	0.06	0	0	0.48
FeOOH	10.46	10.46	9.65	9.65	6.12
PbTiO2	0.15	0.15	1.1	1.1	0.76
Fe-HydroPhosphate	77.42	77.42	24.68	24.68	8.36
Lead Solder	0.06	0.06	0.17	0.17	0.48

Post-Treatment Lead Speciation of Soil A.

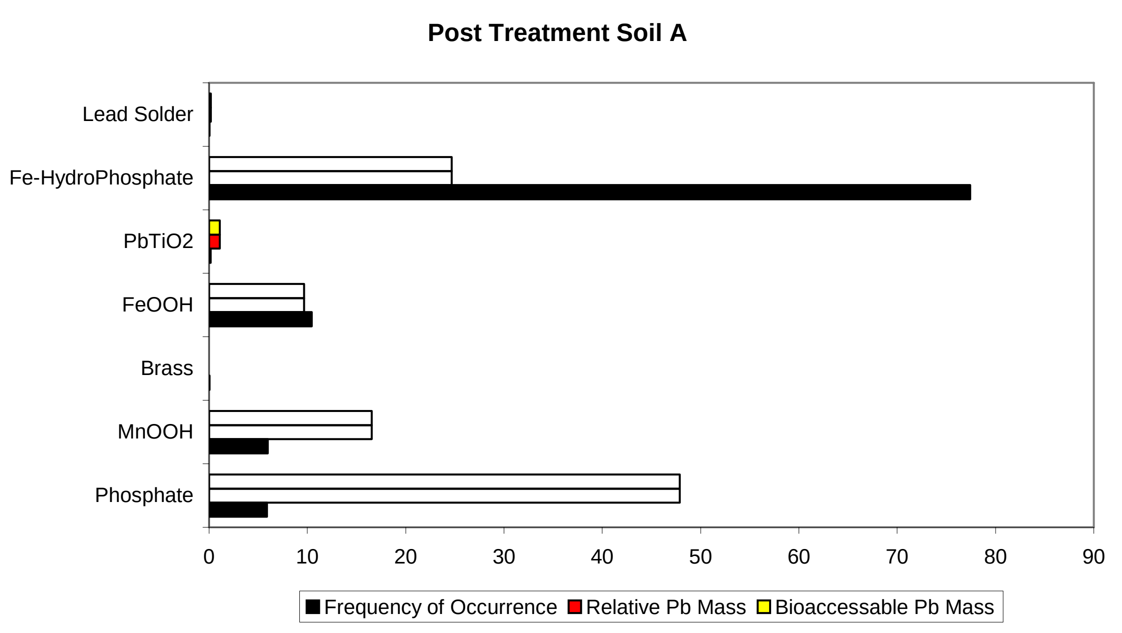


Figure 3-10 - Post-Treatment, Lead Speciation in Soil A

Table 3-2
Post-Treatment Lead Speciation of Soil B

Form	Number	Mean	Std-Dev	Range low	Range high
Total	103	25.4	27.88	1	150
Phosphate	32	5.75	6.4	1	30
FeOOH	15	14.53	11.27	3	45
Clay	1	80	ND	80	80
Brass	1	25	ND	25	25
MnOOH	2	20	1.41	19	21
Cerussite	1	2	ND	2	2
FeSO4	1	10	ND	10	10
Slag	1	70	ND	70	70
Fe-HydroPhosphate	49	40.55	30.64	7	150

Form	(linear) freq	Bio freq	rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
Phosphate	7.03	7.03	58.61	58.61	4.94
FeOOH	8.33	8.33	7.87	7.87	5.34
Clay	3.06	3.06	2.32	2.32	3.33
Brass	0.96	0.96	0	0	1.88
MnOOH	1.53	1.53	4.33	4.33	2.37
Cerussite	0.08	0.08	1.68	1.68	0.53
FeSO4	0.38	0.38	0.07	0.07	1.19
Slag	2.68	2.68	0.31	0.31	3.12
Fe-HydroPhosphate	75.96	75.96	24.79	24.79	8.25

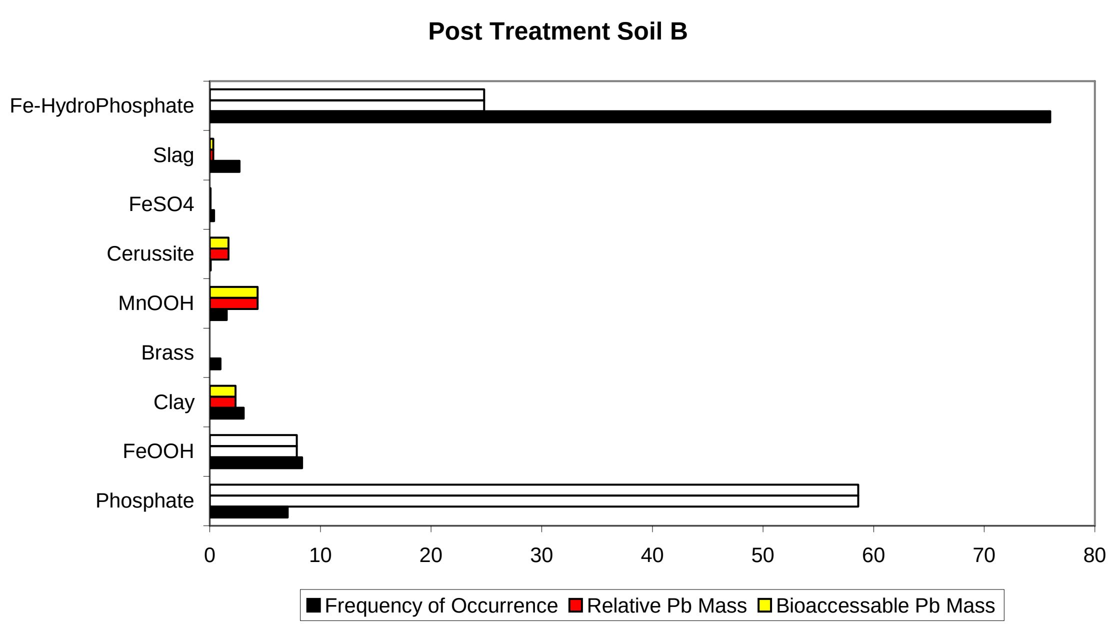


Figure 3-11 - Post-Treatment, Lead Speciation in Soil B

Table 3-3

Post-Treatment Lead Speciation of Soil C

Form	Number	Mean	Std-Dev	Range low	Range high
Total	277	23.01	36.62	1	252
Cerussite	52	7.9	8.72	1	48
MnOOH	15	41.2	26.78	2	90
Phosphate	117	15.97	37.22	1	252
SnMO	1	90	ND	90	90
FeOOH	21	39.43	35.44	7	135
Fe-HydroPhosphate	50	46.94	44.45	5	205
PbMO	1	15	ND	15	15
Barite	2	6	2.83	4	8
PbTiO2	14	1.07	0.27	1	2
Clay	1	55	ND	55	55
Galena	1	4	ND	4	4
Lead Solder	1	80	ND	80	80
Paint	1	30	ND	30	30

Form	(linear) freq	Bio freq	rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
Cerussite	6.45	6.71	31.39	33.86	2.89
MnOOH	9.7	10.1	6.08	6.56	3.48
Phosphate	29.31	26.4	54.04	50.42	5.36
SnMO	1.41	1.47	0.46	0.49	1.39
FeOOH	12.99	13.53	2.72	2.93	3.96
Fe-HydroPhosphate	36.83	38.34	2.66	2.87	5.68
PbMO	0.24	0.25	0.77	0.83	0.57
Barite	0.19	0.2	0	0	0.51
PbTiO2	0.24	0.25	0.4	0.43	0.57
Clay	0.86	0.9	0.14	0.16	1.09
Galena	0.06	0.07	0.39	0.42	0.29
Lead Solder	1.26	1.31	0.84	0.9	1.31
Paint	0.47	0.49	0.12	0.13	0.81

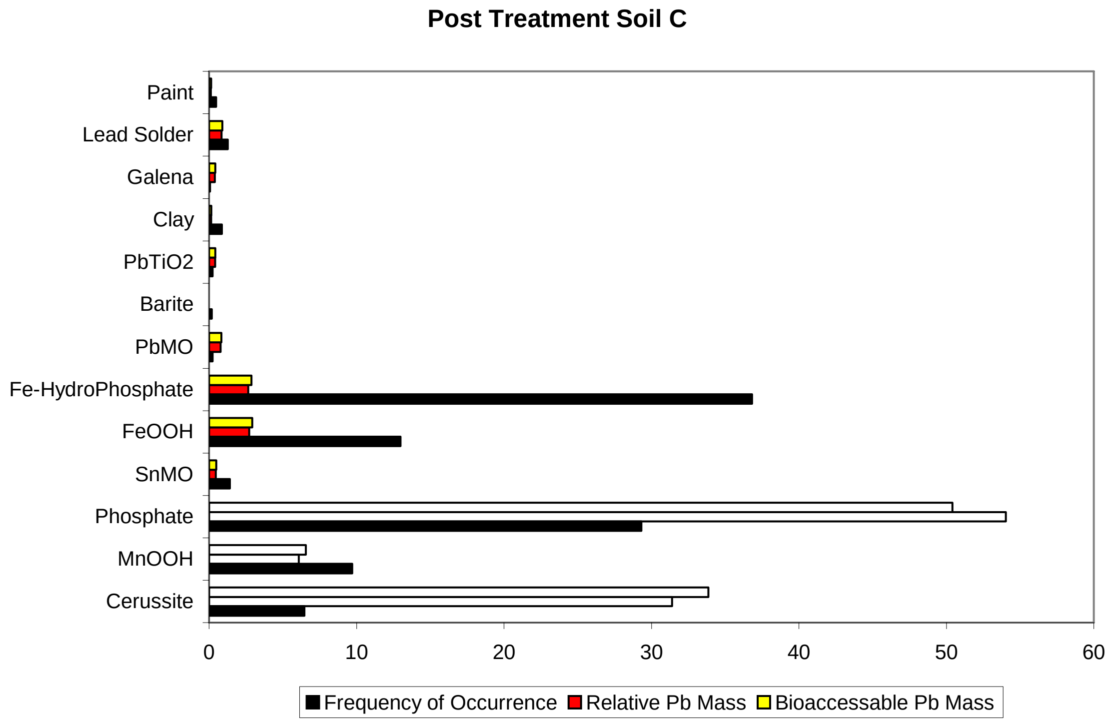
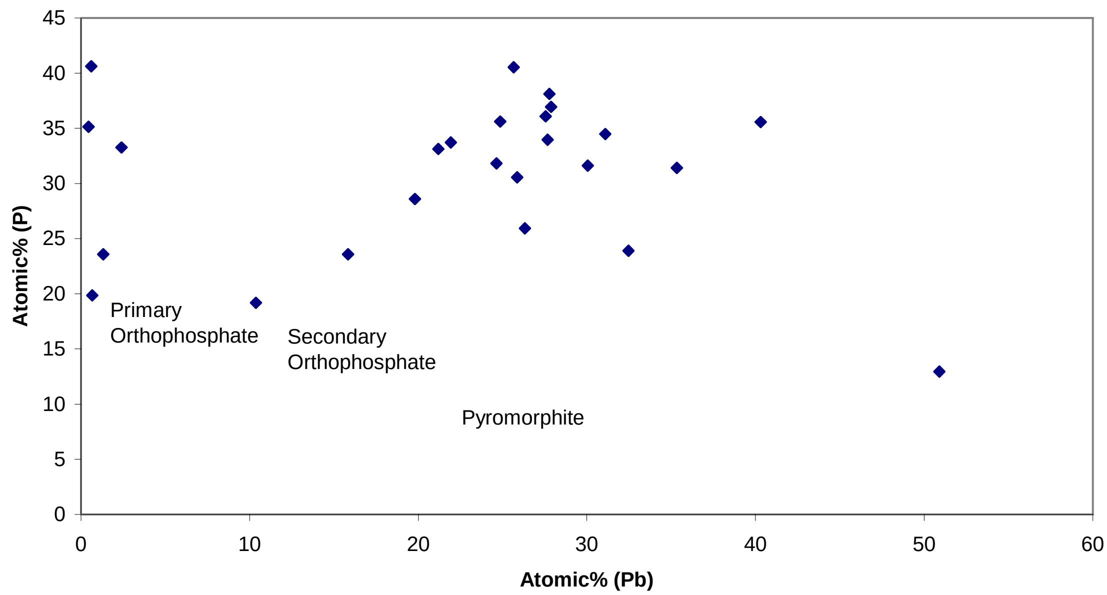
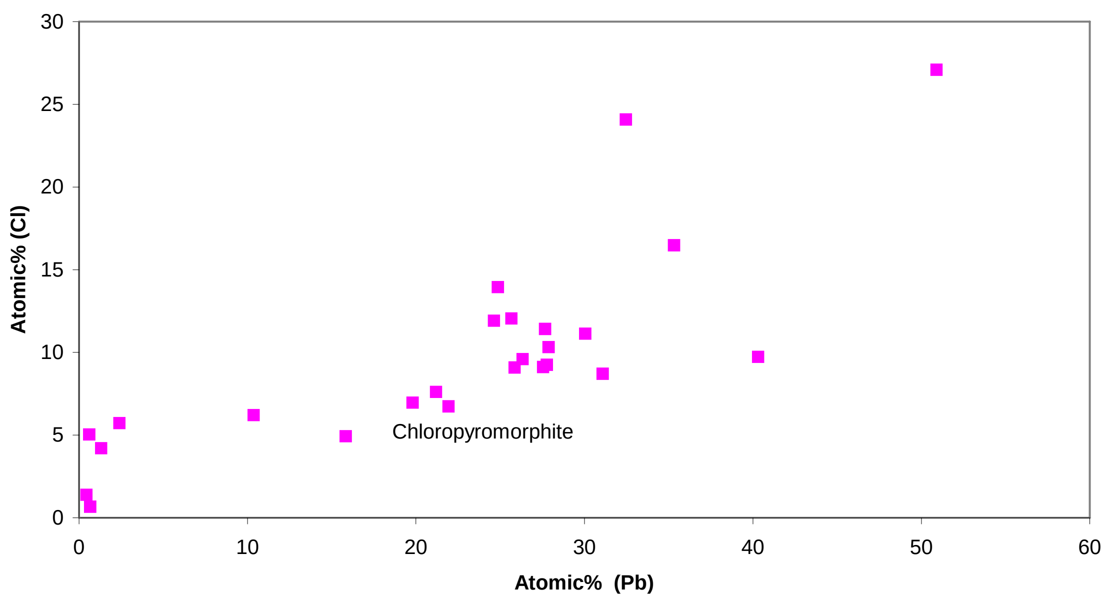


Figure 3-12 - Post-Treatment, Lead Speciation in Soil C

Figures 3-13 & 3-14 – EMPA analyses of Post-Treatment, phosphate compounds.





4.0 Conclusions

As outlined in the work plan, duplicate matrices of soils were assembled containing controls and the phosphate amendments PA, PR, and TSP, both with and without amorphous iron. The matrices were run in triplicate using 2, 7, and 14 day reaction periods. The effectiveness of the amendments were evaluated based on the relative change in IVBA as measured using the RBALP i*n vitro* procedure, with extraction fluids at pH 1.5 and 2.5.

In vivo testing favors soils with lead concentrations greater than 1,000 ppm. Validated test methods do not exist that can measure RBA in phosphate treated soil within the lead concentration range of interest at the OLS. Although RBALP has not been validated for phosphate treated soils at either pH 1.5 or pH 2.5, the procedure may provide an indication of the potential effectiveness in reducing the RBA of lead-contaminated soils.

RBALP at pH 1.5 correlates well with *in vivo* RBA in untreated soils as evidenced by the close agreement of the two methods on the same soils (TM-1 and TM-2) from the OLS. RBALP at pH 2.5 would significantly underestimate the RBA when compared to *in vivo* results at the OLS.

Virtually all of the phosphate amendments showed some reduction in IVBA however, the 14-day, 1.5 PA (with iron) was the most reductive. All of the amendments behaved equally as well on the three soil-types, producing an increased presence of some phosphate form. Two negative results of the phosphate amendments, which could result in localized environmental issues is their release of both phosphate and arsenic to the vadose zone.

The measured effectiveness of the amendment techniques clearly varies between the pH 1.5 and pH 2.5 i*n vitro* results. The pH 1.5 data presented in Table 4-1, which has the strongest correlation with *in vivo* RBA, shows limited reduction in IVBA, ranging from 15 percent to 26 percent reduction for the three soil types tested. The RBALP at pH 2.5 showed more significant reduction in IVBA, ranging from 61 percent to 80 percent; however the RBALP at pH 2.5 did not show good correlation with *in vivo* results on the same test soils and has not been validated by *in vivo* studies.

One sample from each of the three soil types treated with 1.5 PA plus iron was speciated. The speciation indicated that the treatment procedure was forming a phosphate product. The speciation indicated the formation of a potentially more soluble primary or secondary orthophosphate rather than the more insoluble chloropyromorphite. These orthophosphates would be more bioaccessable than the lead phases in the untreated soils and support the limited decrease in IVBA observed in the treated soils.

Finally, as pointed out previously, none of the amendment scenarios consistently lowered soil IVBA below EPA's default level of 60%, and therefore it is unlikely the data from the study would support altering EPA's cleanup decisions which are based on the IEUBK model. In addition, the long term effectiveness of the treatment scenarios has not been demonstrated at other sites and could not be assessed by this bench scale study.

Table 4-1
Summary of Best Performing Amendments

Soil	**Initial %IVBA PH (1.5/2.5)**	**Phosphate Amendment**					
				Post			
				IVBA	**IVBA**	**%Change***	**%Change**
			***In Vitro* pH**	**1.5**	**2.5**	**1.5**	**2.5**
A	80/41	1.5 PA + Iron		59%	14%	-26%	-66%
B	86/49	1.5 PA + Iron		69%	11%	-20%	-80%
C	88/61	1.5 PA + Iron		75%	24%	-15%	-61%

*Change in IVBA = Initial IVBA-Post treatment IVBA/ Initial IVBA*100

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Appendix A
Laboratory Testing Procedures

Appendix A

Proposed Testing Procedures.

Activity	**Parameter**	**Analysis**	**Method**	**Number of Analyses**						
				Initial	**30day**	**60 day**	**90 day**	**1yr**	**2 yr**	**3 yr**
PHASE 1	Soil Properties									
Characterization		Particle Size	ASTM D-2487/D422	4						
		pH	SW 846 9045C	4						
		Acidity	Thomas 1982	4						
		CEC	SW 846 9080/9081	4						
	Soil Chemistry	P total	Blanchard & Stearman 1984	4						
		P extractable	SW 846 9080/9081	4						
		N	Kjeldahl	4						
		TOC	EPA 9060	4						
		Metals*	EPA 3050,6020	4						
	Mineralogy	XRD		4						
		EMPA	Drexler, 00	4						
	Bioaccessability	RBALP	Drexler and Bratin,07	4						
Bench Testing	Soil Properties									
		pH	SW 846 9045C	88						
		P total	Blanchard & Stearman 1984	88						
	Soil Chemistry	P extractable	SW 846 9080/9081	88						
	Mineralogy	EMPA	Drexler, 00	4						
		RBALP	Drexler and Bratin,07	176						
	Bioaccessability	SPLP	EPA 1312	88						
	Column Leaching	Metals*	ASTM 4874	11						
Field Testing	Soil Properties	pH	SW 846 9045C		8	8	8	8	4	4
		Acidity	Thomas 1982		8	8	8	8	4	4
		CEC	SW 846 9080/9081		8	8	8	8	4	4
		Particle Size	ASTM D-2487/D422		8	8	8	8	4	4
		P extractable	SW 846 9080/9081		8	8	8	8	4	4
	Soil Chemistry	Metals*	EPA 3050,6020		8	8	8	8	4	4
		P total	Blanchard & Stearman 1984		8	8	8	8	4	4
		SPLP	EPA 1312							
		N	Kjeldahl		8	8	8	8	4	4
		TOC	EPA 9060				8	8	4	4
	Mineralogy	EMPA	Drexler, 00					8	4	4
	Bioaccessability	RBALP	Drexler and Bratin,07	8				8	4	4

* Metals = Pb, As, and P.

Appendix A

				Proposed Amendment rates based on 50.0g Soil							Day 2	Day 7	Day 14
Sample			Lab ID	Phosphoric Acid		TSP	PR	KCl	$Ca(OH)_2$	HFO	Soil Weight	Soil Weight	Soil Weight
				wt% P	ml Solution*	g	g	mg	g**	g	g	g	g
CompA-1***	Control		A-1	0	0			0	0	0	49.892	49.899	49.702
CompA-2	Control		A-2	0	0			0	0	0	50.344	50.019	50.448
Compa-3	.5PA +Fe		A-3	1	0.6			26	1	4	50.154	49.906	49.785
CompA-4	.5PA +Fe		A-4	1	0.6			26	1	4	50.553	49.941	49.85
CompA-5	1PA +Fe	Soil A	A-5	2	1.2			50	2	4	49.72	49.737	50.537
CompA-6	1PA +Fe		A-6	2	1.2			50	2	4	50.477	49.778	50.296
CompA-7	1PA		A-7	2	1.2			50	2	0	49.876	50.572	49.72
CompA-8	1PA		A-8	2	1.2			50	2	0	49.873	50.009	49.951
CompA-9	1.5PA +Fe		A-9	3	1.6			76	3	4	50.284	49.81	49.704
CompA-10	1.5PA +Fe		A-10	3	1.6			76	3	4	50.278	50.037	50.311
CompA-11	1TSP		A-11			1		50	2	0	49.783	50.328	50.381
CompA-12	1TSP		A-12			1		50	2	0	50.176	50.29	50.329
CompA-13	1PR		A-13				2	50	2	0	50.194	50.264	49.81
CompA-14	1PR		A-14				2	50	2	0	49.554	49.807	50.239
CompA-15	1TSP +Fe		A-15			1		50	2	4	50.138	49.991	49.553
CompA-16	1TSP +Fe		A-16			1		50	2	4	50.11	50.403	50.479
CompA-17	1PR +Fe		A-17				2	50	2	4	49.76	50.243	50.09
CompA-18	1PR +Fe		A-18				2	50	2	4	49.98	50.041	50.021
CompA-19	2TSP		A-19			2		50	2	0	49.595	49.933	50.255
CompA-20	2TSP		A-20			2		50	2	0	49.824	49.859	50.635
CompA-21	2PR		A-21				4	50	2	0	50.298	49.984	49.764
CompA-22	2PR		A-22				4	50	2	0	50.288	49.871	50.601
CompB-1***	Control		B-1	0	0			0	0	0	50.489	50.162	49.974
CompB-2	Control		B-2	0	0			0	0	0	49.582	50.195	50.327
CompB-3	.5PA +Fe		B-3	1	0.6			26	1	4	49.695	50.36	50.163
CompB-4	.5PA +Fe		B-4	1	0.6			26	1	4	49.983	49.614	49.943
CompB-5	1PA +Fe	Soil B	B-5	2	1.2			50	2	4	49.946	49.836	50.017
CompB-6	1PA +Fe		B-6	2	1.2			50	2	4	50.968	49.938	50.311
CompB-7	1PA		B-7	2	1.2			50	2	0	50.579	49.554	49.921
CompB-8	1PA		B-8	2	1.2			50	2	0	51.36	50.099	50.239
CompB-9	1.5PA +Fe		B-9	3	1.6			76	3	4	50.859	50.206	49.686
CompB-10	1.5PA +Fe		B-10	3	1.6			76	3	4	50.491	50.079	50.136
CompB-11	1TSP		B-11			1		50	2	0	50	50.31	50.185
CompB-12	1TSP		B-12			1		50	2	0	49.87	49.83	50.006
CompB-13	1PR		B-13				2	50	2	0	49.558	49.928	50.177
CompB-14	1PR		B-14				2	50	2	0	50.346	49.934	49.709
CompB-15	1TSP +Fe		B-15			1		50	2	4	49.661	50.329	49.698
CompB-16	1TSP +Fe		B-16			1		50	2	4	49.594	49.657	49.739
CompB-17	1PR +Fe		B-17				2	50	2	4	49.812	50.097	50.31
CompB-18	1PR +Fe		B-18				2	50	2	4	49.547	50.09	49.979
CompB-19	2TSP		B-19			2		50	2	0	49.554	49.931	50.153
CompB-20	2TSP		B-20			2		50	2	0	50.124	50.017	50.157
CompB-21	2PR		B-21				4	50	2	0	49.859	50.147	50.482
CompB-22	2PR		B-22				4	50	2	0	49.733	49.82	50.197
CompC-1***	Control		C-1	0	0			0	0	0	51.381	50.135	50.351
CompC-2	Control		C-2	0	0			0	0	0	50.274	50.326	50.169
CompC-3	.5PA +Fe		C-3	1	0.6			26	1	4	50.987	49.955	50.464
CompC-4	.5PA +Fe		C-4	1	0.6			26	1	4	49.398	50.208	50.16
CompC-5	1PA +Fe	Soil C	C-5	2	1.2			50	2	4	49.906	49.998	50.165
CompC-6	1PA +Fe		C-6	2	1.2			50	2	4	49.931	50.558	50.324
CompC-7	1PA		C-7	2	1.2			50	2	0	51.893	50.129	50.565
CompC-8	1PA		C-8	2	1.2			50	2	0	49.926	49.934	50.565
CompC-9	1.5PA +Fe		C-9	3	1.6			76	3	4	49.836	49.858	50.484
CompC-10	1.5PA +Fe		C-10	3	1.6			76	3	4	50.327	49.966	50.321
CompC-11	1TSP		C-11			1		50	2	0	51.285	50.227	50.273
CompC-12	1TSP		C-12			1		50	2	0	51.189	49.905	50.268
CompC-13	1PR		C-13				2	50	2	0	51.294	50.365	50.282
CompC-14	1PR		C-14				2	50	2	0	50.444	49.726	50.281
CompC-15	1TSP +Fe		C-15			1		50	2	4	50.23	50.468	50.515
CompC-16	1TSP +Fe		C-16			1		50	2	4	50.978	50.588	50.19
CompC-17	1PR +Fe		C-17				2	50	2	4	52.009	50.402	50.331
CompC-18	1PR +Fe		C-18				2	50	2	4	50.395	50.475	50.092
CompC-19	2TSP		C-19			2		50	2	0	50.713	50.057	50.29
CompC-20	2TSP		C-20			2		50	2	0	50.692	50.438	50.28
CompC-21	2PR		C-21				4	50	2	0	50.19	50.057	50.43
CompC-22	2PR		C-22				4	50	2	0	50.752	50.423	50.203
	*Based on 85% phosphoric acid solution.										2-day		
	** Lime is added after 14 day period of equilibration with soil and other amendments.										7-day		
	*** Odd samples have phosphate amendment added in two, half increments separated by 7 days.										14-day		

			2 day liming					
Sample			Lab ID	Initial Ca(OH)2 g**	pH 30 min	30 min Ca(OH)2 g**	pH 24hr	24 hr Ca(OH)2 g**
CompA-1***	Control		A2-1	0	7.24			
CompA-2	Control		A2-2	0	7.57			
Compa-3	.5PA +Fe		A2-3	1	5.49	2	7.74	2
CompA-4	.5PA +Fe		A2-4	1	5.42	2	9.4	2
CompA-5	1PA +Fe	Soil A	A2-5	2	4.35	2	7.36	2
CompA-6	1PA +Fe		A2-6	2	4.87	2	6.8	2
CompA-7	1PA		A2-7	2	4.42	2	7.6	2
CompA-8	1PA		A2-8	2	4.49	2	6.42	2
CompA-9	1.5PA +Fe		A2-9	3	4.36	2	6	2
CompA-10	1.5PA +Fe		A2-10	3	4.31	2	6.61	2
CompA-11	1TSP		A2-11	2	7.49		8.4	
CompA-12	1TSP		A2-12	2	7.56		8.33	
CompA-13	1PR		A2-13	2	10.49		9.88	
CompA-14	1PR		A2-14	2	11.55		10.53	
CompA-15	1TSP +Fe		A2-15	2	9.16		8.29	
CompA-16	1TSP +Fe		A2-16	2	8.91		7.86	
CompA-17	1PR +Fe		A2-17	2	10.2		8.88	
CompA-18	1PR +Fe		A2-18	2	10.82		8.62	
CompA-19	2TSP		A2-19	2	7.21		7.03	
CompA-20	2TSP		A2-20	2	6.65		7.09	
CompA-21	2PR		A2-21	2	11.18		10.34	
CompA-22	2PR		A2-22	2	10.19		9.36	
CompB-1***	Control		B2-1	0				
CompB-2	Control		B2-2	0				
CompB-3	.5PA +Fe		B2-3	1	6.05	2	9.48	2
CompB-4	.5PA +Fe		B2-4	1	5.88	2	8.9	2
CompB-5	1PA +Fe	Soil B	B2-5	2	4.97	2	5.22	2
CompB-6	1PA +Fe		B2-6	2	5.43	2	7.4	2
CompB-7	1PA		B2-7	2	6.13	2	6.59	2
CompB-8	1PA		B2-8	2	6.34	2	6.66	2
CompB-9	1.5PA +Fe		B2-9	3	6.79	2	5.26	2
CompB-10	1.5PA +Fe		B2-10	3	5.33	2	5.76	2
CompB-11	1TSP		B2-11	2	7.56		8.57	
CompB-12	1TSP		B2-12	2	7.39		8.35	
CompB-13	1PR		B2-13	2	10.15		10.26	
CompB-14	1PR		B2-14	2	10.48		10.21	
CompB-15	1TSP +Fe		B2-15	2	8.84		8.41	
CompB-16	1TSP +Fe		B2-16	2	8.53		7.62	
CompB-17	1PR +Fe		B2-17	2	9.78		9.23	
CompB-18	1PR +Fe		B2-18	2	9.22		8.99	
CompB-19	2TSP		B2-19	2	8.22		7.98	
CompB-20	2TSP		B2-20	2	8.12		8.05	
CompB-21	2PR		B2-21	2	8.67		10.43	
CompB-22	2PR		B2-22	2	7.63		9.5	
CompC-1***	Control		C2-1	0				
CompC-2	Control		C2-2	0				
CompC-3	.5PA +Fe		C2-3	1	5.5	2	8.2	2
CompC-4	.5PA +Fe		C2-4	1	7.18	2	7.01	2
CompC-5	1PA +Fe	Soil C	C2-5	2	5.5	2	6.54	2
CompC-6	1PA +Fe		C2-6	2	5.14	2	7.04	2
CompC-7	1PA		C2-7	2	5.3	2	5.877	2
CompC-8	1PA		C2-8	2	5.03	2	7.04	2
CompC-9	1.5PA +Fe		C2-9	3	5.4	2	5.68	2
CompC-10	1.5PA +Fe		C2-10	3	4.85	2	7.78	2
CompC-11	1TSP		C2-11	2	7.14		8.32	
CompC-12	1TSP		C2-12	2	6.25		8.35	
CompC-13	1PR		C2-13	2	10.11		10.42	
CompC-14	1PR		C2-14	2	10.88		10.46	
CompC-15	1TSP +Fe		C2-15	2	9		8.43	
CompC-16	1TSP +Fe		C2-16	2	8.84		8.08	
CompC-17	1PR +Fe		C2-17	2	9.75		9.28	
CompC-18	1PR +Fe		C2-18	2	9.22		8.62	
CompC-19	2TSP		C2-19	2	7.47		7.36	
CompC-20	2TSP		C2-20	2	7.58		7.73	
CompC-21	2PR		C2-21	2	10.1		10.3	
CompC-22	2PR		C2-22	2	9.32		9.65	

			7 Day Liming				
Sample			**Lab ID**	**Initial Ca(OH)2**	**pH**	**30 min Ca(OH)2**	**pH**
				g**	**30 min**	**g****	**24hrs**
CompA-1***	Control		A7-1	0			
CompA-2	Control		A7-2	0			
Compa-3	.5PA +Fe		A7-3	5	10.447		9.13
CompA-4	.5PA +Fe		A7-4	5	10.04		8.48
CompA-5	1PA +Fe	Soil A	A7-5	5	8.738		6.94
CompA-6	1PA +Fe		A7-6	5	8.107	+2	6.28
CompA-7	1PA		A7-7	5	5.4		7.43
CompA-8	1PA		A7-8	5	5.829		7.282
CompA-9	15PA +Fe		A7-9	5	5.39	+2	6.17
CompA-10	15PA +Fe		A7-10	5	6.024	+2	6.058
CompA-11	1TSP		A7-11	2	7.18		8.156
CompA-12	1TSP		A7-12	2	7.098		8.422
CompA-13	1PR		A7-13	1	9.84		8.89
CompA-14	1PR		A7-14	1	9.24		9.07
CompA-15	1TSP +Fe		A7-15	2	9.31		8.25
CompA-16	1TSP +Fe		A7-16	2	9.27		8.33
CompA-17	1PR +Fe		A7-17	1	9.027		7.97
CompA-18	1PR +Fe		A7-18	1	8.87		8.3
CompA-19	2TSP		A7-19	2	6.97		7.97
CompA-20	2TSP		A7-20	2	7.024		7.775
CompA-21	2PR		A7-21	1	9.81		8.96
CompA-22	2PR		A7-22	1	9.27		8.81
CompB-1***	Control		B7-1	0			
CompB-2	Control		B7-2	0			
CompB-3	.5PA +Fe		B7-3	5	10.57		10.56
CompB-4	.5PA +Fe		B7-4	5	10.88		10.613
CompB-5	1PA +Fe	Soil B	B7-5	5	8.46		7.5
CompB-6	1PA +Fe		B7-6	5	10.1		8.17
CompB-7	1PA		B7-7	5	5.42		7.83
CompB-8	1PA		B7-8	5	5.7		8.17
CompB-9	15PA +Fe		B7-9	5	6.97		7.05
CompB-10	15PA +Fe		B7-10	5	11.54	ut 20 grams lime (ope	11.027
CompB-11	1TSP		B7-11	2	10.69		9.87
CompB-12	1TSP		B7-12	2	9.907		9.446
CompB-13	1PR		B7-13	1	10.99		10.19
CompB-14	1PR		B7-14	1	10.77		9.61
CompB-15	1TSP +Fe		B7-15	2	10.62		10.36
CompB-16	1TSP +Fe		B7-16	2	11.17		10.2
CompB-17	1PR +Fe		B7-17	1	10.47		9.8
CompB-18	1PR +Fe		B7-18	1	10.8		9.76
CompB-19	2TSP		B7-19	2	9.06		8.56
CompB-20	2TSP		B7-20	2	9.211		8.57
CompB-21	2PR		B7-21	1	10.63		9.53
CompB-22	2PR		B7-22	1	11.04		10.4
CompC-1***	Control		C7-1	0			
CompC-2	Control		C7-2	0			
CompC-3	.5PA +Fe		C7-3	5	12.07		11.17
CompC-4	.5PA +Fe		C7-4	5	12.13		11.16
CompC-5	1PA +Fe	Soil C	C7-5	5	11.61		9.27
CompC-6	1PA +Fe		C7-6	5	11.64		10.2
CompC-7	1PA		C7-7	5	6.88		8.98
CompC-8	1PA		C7-8	5	6.21		8.535
CompC-9	15PA +Fe		C7-9	5	10.75		8..92
CompC-10	15PA +Fe		C7-10	5	10.72		9.606
CompC-11	1TSP		C7-11	2	9.86		9.74
CompC-12	1TSP		C7-12	2	10.188		9.739
CompC-13	1PR		C7-13	1	10.87		10.13
CompC-14	1PR		C7-14	1	10.76		10.77
CompC-15	1TSP +Fe		C7-15	2	11.24		10.34
CompC-16	1TSP +Fe		C7-16	2	11.01		10.12
CompC-17	1PR +Fe		C7-17	1	10.851		10.48
CompC-18	1PR +Fe		C7-18	1	11.02		10.126
CompC-19	2TSP		C7-19	2	8.58		8.74
CompC-20	2TSP		C7-20	2	8.4		8.428
CompC-21	2PR		C7-21	1	10.248		9.861
CompC-22	2PR		C7-22	1	10.6		10.32

14 day liming

Sample			Lab ID	Initial Ca(OH)2 g**	pH 30 min		pH 24hrs
CompA-1***	Control		A14-1	0			
CompA-2	Control		A14-2	0			
Compa-3	.5PA +Fe		A14-3	5	10.1		9.2
CompA-4	.5PA +Fe		A14-4	5	9.5		9.5
CompA-5	1PA +Fe	Soil A	A14-5	5	7.7		9.1
CompA-6	1PA +Fe		A14-6	5	6.9		9.8
CompA-7	1PA		A14-7	5	6.8		9.4
CompA-8	1PA		A14-8	5	7.5		7.9
CompA-9	1.5PA +Fe		A14-9	5	6.9		6.5
CompA-10	1.5PA +Fe		A14-10	5	7.9		7
CompA-11	1TSP		A14-11	2	9.8		9
CompA-12	1TSP		A14-12	2	10.6		9.9
CompA-13	1PR		A14-13	1	9.5		9.7
CompA-14	1PR		A14-14	1	10.1		9
CompA-15	1TSP +Fe		A14-15	2	9.2		8.2
CompA-16	1TSP +Fe		A14-16	2	9.4		8.6
CompA-17	1PR +Fe		A14-17	1	9.7		8.8
CompA-18	1PR +Fe		A14-18	1	8.5		9.2
CompA-19	2TSP		A14-19	2	8		7.8
CompA-20	2TSP		A14-20	2	8.9		7.7
CompA-21	2PR		A14-21	1	9.6		9.3
CompA-22	2PR		A14-22	1	9.5		9.1
CompB-1***	Control		B14-1	0			
CompB-2	Control		B14-2	0			
CompB-3	.5PA +Fe		B14-3	5	11.6		9.8
CompB-4	.5PA +Fe		B14-4	5	11.2		9.7
CompB-5	1PA +Fe	Soil B	B14-5	5	10.5		8.6
CompB-6	1PA +Fe		B14-6	5	9.5		7.7
CompB-7	1PA		B14-7	5	9.5		8.2
CompB-8	1PA		B14-8	5	8.3		7.9
CompB-9	1.5PA +Fe		B14-9	5	7.7		7.9
CompB-10	1.5PA +Fe		B14-10	5	7.4		8.6
CompB-11	1TSP		B14-11	2	9.9		9.6
CompB-12	1TSP		B14-12	2	9.8		9.9
CompB-13	1PR		B14-13	1	10.8		10.2
CompB-14	1PR		B14-14	1	11		8.3
CompB-15	1TSP +Fe		B14-15	2	9.3		8.5
CompB-16	1TSP +Fe		B14-16	2	9.7		9
CompB-17	1PR +Fe		B14-17	1	9.6		7.7
CompB-18	1PR +Fe		B14-18	1	9.5		7.6
CompB-19	2TSP		B14-19	2	8		8.4
CompB-20	2TSP		B14-20	2	8.9		8.7
CompB-21	2PR		B14-21	1	8.8		9.6
CompB-22	2PR		B14-22	1	10		9.7
CompC-1***	Control		C14-1	0			
CompC-2	Control		C14-2	0			
CompC-3	.5PA +Fe		C14-3	5	10.9		10.8
CompC-4	.5PA +Fe		C14-4	5	11.5		10.8
CompC-5	1PA +Fe	Soil C	C14-5	5	10.5		9.5
CompC-6	1PA +Fe		C14-6	5	9.9		9.2
CompC-7	1PA		C14-7	5	9.1		11.1
CompC-8	1PA		C14-8	5	9.3		9.2
CompC-9	1.5PA +Fe		C14-9	5	8.2		8.4
CompC-10	1.5PA +Fe		C14-10	5	8.5		8.2
CompC-11	1TSP		C14-11	2	9.6		9.6
CompC-12	1TSP		C14-12	2	9.5		9.7
CompC-13	1PR		C14-13	1	10.4		9.8
CompC-14	1PR		C14-14	1	10.2		9.6
CompC-15	1TSP +Fe		C14-15	2	10.3		9.4
CompC-16	1TSP +Fe		C14-16	2	9.4		8.9
CompC-17	1PR +Fe		C14-17	1	9.3		8.9
CompC-18	1PR +Fe		C14-18	1	9.4		8.8
CompC-19	2TSP		C14-19	2	9.4		8.2
CompC-20	2TSP		C14-20	2	8		8.1
CompC-21	2PR		C14-21	1	9.1		9.4
CompC-22	2PR		C14-22	1	10.6		9.5

Appendix B

Metal Speciation Standard Operating Procedure

Appendix B

UNIVERSITY of COLORADO
Laboratory for Geological and Environmental Studies (LEGS)

October 11, 2007 (Rev. #2)

Title: METAL SPECIATION SOP

SYNOPSIS: A standardized method for speciating metals in solid samples is described. Equipment operating conditions, sample preparation and handling, and statistical equations for data analysis and presentation are included.

1.0 OBJECTIVES

The objectives of this Standard Operating Procedure (SOP) are to specify the proper methodologies and protocols to be used during metal speciation of various solid samples including; tailings, slags, sediments, dross, bag house dusts, wipes, paint, soils, and dusts for metals. The metal speciation data generated from this SOP may be used to assess the solid samples as each phase relates to risk. Parameters to be characterized during the speciation analyses include particle size, associations, stoichiometry, frequency of occurrence of metal-bearing forms and relative mass of metal-bearing forms. This electron microprobe analyses (EMPA) technique, instrument operation protocols and sample preparation to be used during implementation of the Metals Speciation SOP are discussed in the following sections.

2.0 BACKGROUND

To date, numerous metal-bearing forms have been identified from various environments within western mining districts (Emmons et al., 1927; Drexler, 1991 per. comm.; Drexler, 1992; Davis et al., 1993; Ruby et al., 1994; CDM, 1994; WESTON, 1995), and industrial or agricultural (Drexler , 1999 per. comm.) settings, Table 2-1. This listing does not preclude the identification of other metal-bearing forms, but only serves as an initial point of reference. Many of these forms are minerals with varying metal concentrations (e.g., lead phosphate, iron-lead oxide, and slag). Since limited thermodynamic information is available for many of these phases and equilibrium conditions are rarely found in soil environments, the identity of the mineral class (e.g., lead phosphate) will be sufficient and exact stoichiometry is not necessary.

It may be important to know the particle-size distribution of metal-bearing forms in order to assess potential risk. It is believed that particles less than 250 microns (µm) are most available for human ingestion and/or inhalation (Bornschein, et al., 1987). For this study, the largest dimension of any one metal-bearing form will be measured and the frequency of occurrence weighted by that dimension. Although not routinely performed, particle area can be determined, it has been shown (CDM, 1994) that data collected on particle area produces similar results. These measurements add a considerable amount of time to the procedure, introduce new sources of potential error and limit the total number of particles or samples that can be observed in a study.

Mineral association may have profound effects on the ability for solubilization. For example, if a lead-bearing form in one sample is predominantly found within quartz grains while in another sample it is free in the sample matrix, the two samples are likely to pose significantly different risk levels to human health. Therefore, associations of concern include the following:

1) free or liberated
2) inclusions within a second phase
3) cementing

3.0 SAMPLE SELECTION

Samples should be selected and handled according to the procedure described in the Project Plan.

4.0 SCHEDULE

A schedule for completion of projects performed under this Metals Speciation SOP will be provided in writing or verbally to the contractor along with monthly reporting requirements if large projects are performed. These schedules are based on an aggressive analytical program designed to ensure that the metals speciation analyses are completed in a timely period. Monthly reports are expected to reflect schedule status.

5.0 INSTRUMENTATION

Speciation analyses will be conducted at the Laboratory for Environmental and Geological Studies (LEGS) at the University of Colorado, Boulder or other comparable facilities. Primary equipment used for this work will include:

Electron Microprobe (JEOL 8600) equipped with four wavelength spectrometers, energy dispersive spectrometer (EDS), BEI detector and Geller Microanalytical data processing system. An LEDC spectrometer crystal for carbon and LDE-1 crystal for oxygen analyses are essential.

6.0 PRECISION AND ACCURACY

The precision of the EMPA speciation and polarized light microscopy (PLM) will be evaluated based on sample duplicates analyzed at a frequency of 10%. The precision of the data generated by the manual PLM particle count and by the "EMPA point count" will be evaluated by preparing a graph that compares the original result with the duplicate result. The accuracy of the analyses will be estimated based on a number of methods, depending on the source of the data. Data generated by the "EMPA point count" or will be evaluated statistically based on the methods of Mosimann (1965) at the 95% confidence level on the frequency data following Equation 1.

$$E_{0.95} = 2P(100-P)/N \qquad \text{(Eq. 1)}$$

Where: $E_{0.95}$ = Probable error at the 95% confidence level

P = Percentage of N of an individual metal-bearing phase based on percent length frequency

N = Total number of metal-bearing grains counted

In general, site-specific concentrations for these variable, metal-bearing forms will be determined by performing “peak counts” on the appropriate wavelength spectrometer. Average concentrations will then be used for further calculations. Data on specific gravity will be collected from referenced databases or estimated based on similar compounds.

7.0 PERSONNEL RESPONSIBILITY

The analysts will carefully read this SOP prior to any sample examination.

It is the responsibility of the laboratory supervisor and designates to ensure that these procedures are followed, to examine quality assurance (QA) samples and replicate standards, and to check EDS and WDS calibrations. The laboratory supervisor will collect results, ensure they are in proper format, and deliver them to the contractor.

Monthly reports summarizing all progress, with a list of samples speciated to date with data analyses sheets (DAS), will be submitted each month.

It is also the responsibility of the laboratory supervisor to notify the contractor representative of any problems encountered in the sample analysis process.

8.0 SAMPLE PREPARATION

Grain mounts (1.5 inches in diameter) of each sample will be prepared using air-cured epoxy. This grain mounting technique is appropriate for most speciation projects, however polished thin-sections, paint chips, dust wipes, or filters may be prepared in a similar manner. The grain mounting is performed as follows:

1) Log the samples for which polished mounts will be prepared.

2) Inspect all disposable plastic cups, making sure each is clean and dry.

3) Label each “mold” with its corresponding sample number.

4) All samples will be split to produce a homogeneous 1-4 gram sample.

5) Mix epoxy resin and hardener according to manufacturer’s directions.

6) Pour 1 gram of sample into mold. Double check to make sure sample numbers on mold and the original sample container match. Pour epoxy into mold to just cover sample grains.

7) Use a new wood stirring stick with each sample, carefully blend epoxy and grains so as to coat all grains with epoxy.

8) Set molds to cure at ROOM TEMPAERATURE in a clean restricted area. Add labels with sample numbers and cover with more epoxy resin. Leave to cure completely at room temperature.

9) One at a time remove each sample from its mold and grind flat the back side of the mount.

10) Use 600 grit wet abrasive paper stretched across a grinding wheel to remove the bottom layer and expose as many mineral grains as possible. Follow with 1000 grit paper.

11) Polish with 15 um oil-based diamond paste on a polishing paper fixed to a lap. Use of paper instead of cloth minimizes relief.

12) Next use 6um diamond polish on a similar lap.

13) Finally polish the sample with 1um oil-based diamond paste on polishing paper, followed by 0.05 um alumina in water suspension. The quality should be checked after each step. Typical polishing times are 30 minutes for 15 um, 20 minutes for 6 um, 15 minutes for 1 um, and 10 minutes for 0.05 um.

NOTE: use low speed on the polishing laps to avoid "plucking" of sample grains.

14) Samples should be completely cleaned in an ultrasonic cleaner with isopropyl alcohol or similar solvent to remove oil and fingerprints.

15) To ensure that no particles of any metal are being cross-contaminated during sample preparation procedures, a blank (epoxy only) mold will be made every 20th sample (5% of samples) following all of the above procedures. This mold will then be speciated along with the other samples.

16) Each sample must be carbon coated. Once coated, the samples should be stored in a clean, dry environment with the carbon surface protected from scratches or handling.

9.0 GEOCHEMICAL SPECIATION USING ELECTRON MICROPROBE

All investigative samples will also be characterized using EMPA analysis to determine the chemical speciation, particle size distribution and frequency for several target metals.

10.1 Concentration Prescreening

All samples will be initially examined using the electron microprobe to determine if the number of particles are too great to obtain a representative count. The particle counting will be considered representative if the entire sample (puck) has been traversed about the same time in which the counting criteria are achieved.

If this examination reveals that one metal is abundant (> 1% of total metals concentration), clean quartz sand (SiO_2) will be mixed with the sample material. The sand should be certified to be free of target analytes. The quartz sand should be added to an aliquot of the investigative sample, then mixed by turning the sample for a minimum of one hour, or until the sample is fully homogenized. The initial mass of the investigative sample aliquot, and the mass of the quartz addition will be recorded.

10.2 Point Counting

Counts are made by traversing each sample from left-to-right and top-to-bottom as illustrated in Figure 10-2. The amount of vertical movement for each traverse would depend on magnification and CRT (cathode-ray tube) size. This movement should be minimized so that NO portion of the sample is missed when the end of a traverse is reached. Two magnification settings generally are used. One ranging from 40-100X and a second from 300-600X. The last setting will allow one to find the smallest identifiable (1-2 micron) phases.

The portion of the sample examined in the second pass, under the higher magnification, will depend on the time available, the number of metal-bearing particles, and the complexity of metal mineralogy. A maximum of 8 hours will be spent on each analysis.

10.3 Data Reduction

Analysts will record data as they are acquired from each sample using the LEGS software, (Figure 10-3A) which places all data in a spreadsheet file format. Columns have been established for numbering the metal-bearing phase particles, their identity, size of longest dimension in microns, along with their association (L = liberated, C= cementing, I = included) (Figure 10-3B). The analyst may also summarize his/her observations in the formatted data summary files.

The frequency of occurrence and relative metal mass of each metal-bearing form as it is distributed in each sample will be depicted graphically as a frequency bar-graph. The particle size distribution of metal-bearing forms will be depicted in a histogram. Size-histograms of each metal-bearing form can be constructed from data in the file.

Data from EMPA will be summarized using two methods. The first method is the determination of FREQUENCY OF OCCURRENCE. This is calculated by summing the longest dimension of all the metal-bearing phases observed and then dividing each phase by the total.

Equation 2 will serve as an example of the calculation.

$$F_M \text{ in phase-1} = \frac{\Sigma (PLD)_{\text{phase 1}}}{\Sigma (PLD)_{\text{phase-1}} + \Sigma (PLD)_{\text{phase-2}} + \Sigma (PLD)_{\text{phase-n}}} \qquad \text{(Eq. 2)}$$

Where:
F_M = Frequency of occurrence of metal in a single phase.
PLD = An individual particle's longest dimension
$\%F_M$ in phase-1 = F_M in phase-1 * 100

These data thus illustrate which metal-bearing phase(s) are the most commonly observed in the sample or relative volume percent.

The second calculation used in this report is the determination of RELATIVE METAL MASS. These data are calculated by substituting the PLD term in the equation above with the value of M_M. This term is calculated as defined below.

$$M_M = FM * SG * ppm_M \qquad \text{(Eq. 3)}$$

Where:
M_M = Mass of metal in a phase
SG = Specific Gravity of a phase
ppm_M = Concentration in ppm of metal in a phase

The advantage in reviewing the RELATIVE METAL MASS determination is that it gives one information as to which metal-bearing phase(s) in a sample are likely to control the total bulk concentration for a metal of interest. For example, PHASE-1 may comprise 98% relative volume of the sample; however, it has a low specific gravity and contains only 1,000 parts per million (ppm) arsenic. PHASE-2 comprised 2% of the sample, has a high specific gravity, and contains 850,000 ppm of arsenic. In this example it is PHASE-2 that is the dominant source of arsenic to the sample.
1The third calculation is to determine the BIOACCESSABLE MASS lead (Bio_{Pb}). For this calculation the same procedure as outlined above is used however, the original particle-count data set has been screened to use **only** liberated and cemented particles less than 250 microns in size (BIOACCESSABLE FREQUENCY) . The reasoning behind these calculations are: 1) A particle greater than 250 microns is not bioaccessable. It will not adhere to clothes or hands. 2) A particle of lead that is enclosed within another mineral is considered far less bioaccessable, as one would need to dissolve the outer mineral or free the enclosed lead particle to make it available. 3) Finally, these data are considered likely to better reflect results observed from *invitro* or *invivo* studies.

The accuracy of an analysis will be estimated from a statistical evaluation of point counting data based on the method of Mosimann (1965) these data will be tabulated in Table 3 as $E^{95\%}$.

10.4 Analytical Procedure

A brief visual examination of each sample will be made, prior to EMPA examination. This examination may help the operator by noting the occurrence of slag and/or organic matter. Standard operating conditions for quantitative and qualitative analyses of most metal-bearing forms are given in Table 8-1. However, it is the responsibility of the operator to select the appropriate analytical line (crystal/KeV range) to eliminate peak overlaps and ensure proper identification/quantification of each analyte. Quality control will be maintained by analyzing duplicates at regular intervals (Section 8.5).
The backscattered electron threshold will be adjusted so that all particles in a sample are seen. This procedure will minimize the possibility that low metal-bearing minerals may be overlooked during the scanning of the polished grain mount. The scanning will be done manually in a manner similar to that depicted in Figure 8-2. Typically, the magnification used for scanning all samples except for airborne samples will be 40-100X and 300-600X. The last setting will allow the smallest identifiable (1-2 um) phases to be found. Once a candidate particle is identified, then the backscatter image will be optimized to discriminate any different phases that may be making up the particle or defining its association. Identification of the metal-bearing phases will be done using both EDS and WDS on an EMPA, with spectrometers typically peaked at sulfur, oxygen, carbon and the metal(s) of concern (M). The size of each metal-bearing phase will be determined by measuring in microns the longest dimension.

As stated previously, a maximum of 8 hours will be spent in scanning and analyzing each mount. For most speciation projects the goal is to count between 100-200 particles. In the event that these goals are achieved in less than 8 hours, particle counting may continue or the analyst may move to another sample in order to increase the sample population.

Quantitative Analyses

Quantitative EMPA analyses are required to establish the average metal content of the metal-bearing minerals, which have variable metal contents as: Iron-(M) sulfate, Iron-(M) oxide, Manganese-(M) oxide, organic, and slag. These determinations are important, especially in the case of slag, which is expected to have considerable variation in their dissolved metal content.

EMPA quantitative results will be analyzed statistically to establish mean values. They may also be depicted as histograms to show the range of metal concentrations measured as well as the presence of one or more populations in terms of metal content. In the later case, non-parametric statistics may have to be used or the median value has to be established.

Associations

The association of the metal-bearing forms will be established from the backscattered electron images. Particular attention will be paid in establishing whether the grains are totally enclosed, encapsulated or liberated. The rinds of metal-bearing grains will be identified. Representative photomicrographs of backscatter electron images establishing the association of the principal metal-bearing forms will be obtained for illustration purposes.

2Compound Identification

As outlined in the EMPA SOP, an electron microprobe with combined EDS (energy dispersive spectrometer) and multiple WDS (wavelength dispersive spectrometers) are used to identify all metal-bearing phases of interest. A 1-2 gram split of dryed sample is placed in a 2.5 cm plastic mold and impregnated with epoxy. Once the sample is hardened it is polished and carbon coated for EMPA. The EMPA is operated at 15 kV accelerating voltage, with a 20 NanoAmp current and a 1 micron focused beam. Elements of interest are standardized using certified mineral or pure metal standards and counting times are chosen to provide 3-sigma detection limits of between 100-200 ppm. Elemental concentrations are corrected using ZAF factors and concentration errors are generally less than 5% relative. For a more detail explanation of the EMPA method of analyses see Birks, 1971, or Heinrich, 1981.

Although the electron microprobe is capable of determining stoichiometries of virtually any compound composed of elements Be thru U, such a task requires a great deal of standardization and analytical time to complete. It has been determined that for the purposes these data are utilized in either risk assessments or site characterizations the term “speciation” would have a more general definition. The primary justification for this factor is that it has been shown the time required for more precise phase identification greatly impacted on the total identified-particle population. The significance to the data interpretation is highly dependent on the total number of metal-bearing phases counted. Not only would the time impact the statistical significance of sample interpretation, but it would limit the total number of samples one could study, thus the representativeness of the data to the site.

A number of phases for both lead and arsenic are considered stoichiometric. These include the following:

Galena (PbS)
Lead Oxide (PbO)
Native Lead (Pb)
Cerussite ($PbCO_3$)

Anglesite ($PbSO_4$)
Crocoite ($PbCrO_4$)
Alamosite ($PbSiO_3$)
Lead Arsenate (PbAsO)
Arsenolite (As_2O_3)
Realgar (AsS)
Orpiment (As_2S_3)
Arsenopyrite (AsFeS)

The author is aware that these are not all strictly stoichiometric phases. As an example, "lead oxide" would include; litharge (PbO), massicot (PbO), minium (Pb_3O_4, plattnerite (PbO_2), and scrutinyite (αPbO_2). In addition, phases such as lead hydroxide, lead isobuyrate, lead lactate, lead laurate, lead malate, lead oxalate and even lead nitrate would be grouped in this category. The phase "lead arsenate" would include; schultenite ($PbHAsO_4$), paulmooreite ($Pb_2As_2O_5$) as well as all the meta/ortho arsenate/arsenite phases. With very careful EMPA analyses most of these phases could be isolated; however, as the data is currently used this effort is not taken unless the client request further work.

The remaining phases that are commonly identified are far more generic. The concentration of the metal(s) of interest in these phases are thus variable and require site-specific estimates of there concentration values. These are obtained for each project by randomly collecting EMPA quantitative analyses (for lead or arsenic) for these phases and calculating average values. For these phases the first criteria used in identification is to determine if the phase is either; an oxide, carbonate, sulfide, sulfate, or phosphate. Secondly, with the exception of the "phosphates", the major cation associated with the phase is further identified. Therefore, phases such as Fe-sulfate, FeOOH, MnOOH, PbMO, AsMO, or $PbMSO_4$ are identified. Some of these phases could represent a stoichiometric mineral forms such as allactite $Mn_7(AsO_4)_2(OH)_8$, plumbojarosite $PbFe_6(SO_4)_4(OH)_{12}$, plumboferrite $PbFe_4O_7$, carminite $PbFe_2[OHAsO_4]_2$, nelenite $(Mn,Fe)_{16}Si_{12}As_3O_{36}(OH)_{17}$, or quenselite $PbMnO_2(OH)$; however, it is the authors belief that most of these phases are metastable and/or amorphous and have some quantity of arsenic and/or lead sorbed to their surface.

The "phosphate" group is even more generic in that the only common dominant ion is PO_4. There are many crystalline forms of phosphate that contain lead such as; pyromorphite $Pb_5[Cl(PO_4)_3]$, plumbogummite $PbAl_3(PO_4)_2(OH)_5$-H_2O, orpheite $PbAl_3[(OH)_6(PO_4,SO_4)_2]$, drugmanite $Pb_2(Fe,Al)(PO_4)2OH$-H_2O, and corkite $PbFe_3[(OH)_6\ SO_4\ PO_4]$. Although arsenic and phosphorus are considered competitive, a number of arsenic-bearing phosphates have been identified; walentaite $(Ca,Mn,Fe)Fe_3(AsO_4,PO_4)_4$-$7H_2O$, morelandite $(Ba,Ca,Pb)_5\ Cl[AsO_4,PO_4]_3$, and turneaureite $Ca_5(Cl)[(AsO_4, PO_4)_3]$. As with previous phases, careful EMPA analyses could isolated the complete stoichiometry; however, as the data is currently used this effort is not taken unless the client request further work.

Since the chemistry and/or sorption capacity of these categories are quite variable one should be careful in ascribing RBA (relative bioaccessability) to these metal forms. In particular, if sorption is the primary factor controlling the presence of arsenic or lead, factors such as temperature, redox, and pH can influence the metal stability significantly. However, if particle size and morphology (liberated-included) are similar, it appears, primarily from in vitro studies, that iron oxides and sulfates tend to be less bioaccessable than manganese oxides and phosphates.

10.5 Instrument Calibration and Standardization

The WDS will have spectrometers calibrated for the metal of concern, carbon, oxygen and sulfur on the appropriate crystals using mineral standards. The EDS will have multi-channel analyzer (MCA) calibrated for known peak energy centroids. Calibration will be performed so as to have both low (1.0-3.0 KeV) and high (6.0-9.0 KeV) energy peaks fall within 0.05 KeV of its known centroid.

The magnification marker on the instrument will be checked once a week. This will be performed by following manufacturer instructions or by measurement of commercially available grids or leucite spheres. Size measurements must be within 4 microns of certified values.

Initial calibration verification standards (ICVs) must be analyzed at the beginning of each analytical batch or once every 48 hours, whichever is more frequent. A set of mineral or glass standards will be run quantitatively for the metal of concern, sulfur, oxygen and carbon. If elemental quantities of the ICVs do not fall within +/- 5% of certified values for each element, the instrument must be recalibrated prior to analysis of investigative samples.

The metal-bearing forms in these samples will be identified using a combination of EDS, WDS and BEI. Once a particle is isolated with the backscatter detector, a 5-second EDS spectra is collected and peaks identified. The count rates for the metal(s) of concern, sulfur, carbon and oxygen can be either visually observed on the wavelength spectrometers or K-ratios calculated.

10.6 Documentation

Photomicrographs must be taken for each sample, at a rate of 5% (1 photograph per 20 particles counted), for a maximum of 10 per sample and submitted with the results . Particles selected for photography must be recorded on the EMPA graph.
A 128x128 (minimum) binary image in ".tif" format may be stored. Recorded on each photomicrograph and negative will be a scale bar, magnification, sample identification , date and phase identification. Abbreviations for the identified phases can be used. Examples are listed in Table 10-2. A final list must be submitted with the laboratory report.

10.0 PERSONAL HEALTH AND SAFETY

Each individual operating the electron microprobe instruments will have read the "Radiation Safety Handbook" prepared by the University and follow all State guidelines for operation of X-ray equipment.

Latex gloves and particulate masks will be worn during preparation of sample cups. All material that comes in contact with the samples or used to clean work surface areas will be placed in poly-bags for disposal.

11.0 FINAL REPORT

A final laboratory report will be provided to the Contractor. The report will include all EMPA data including summary tables and figures. Individual sample data will be provided on disk.

Speciation results will include: 1) a series of tables summarizing frequency of occurrence for each metal phase identified along with a confidence limit; (Figure 11.0A) 2) summary histograms of metal phases identified for each waste type; (Figure 11.0B) 3) a summary histogram of particle size distribution in each waste type; (Figure 11.0C) and 4) a summary of metal phase associations (Figure 11.0D) . Representative photomicrographs or .tif images will also be included in the final report (Figure 11.0E).

12.0 REFERENCES

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Mosimann, J.E. 1965. Statistical methods for the Pollen Analyst. In: B. Kummel and D. Raup (EDS.). *Handbook of Paleontological Techniques.* Freeman and Co., San Francisco, pp. 636-673.

Ruby, M.V., A. Davis, J.H. KEMPAton, J.W. Drexler, and P.D. Bergstrom. 1992. Lead bioavailability: Dissolution kinetics under simulated gastric conditions. *Environ. Sci. Technol.* 26(6): pp 1242-1248.

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Table 2-1
Common Metal-Bearing Forms Found Within Mining, Smelting, Agricultural, Industrial and Residential Media

OXIDES

Lead Oxide
Manganese (metal) oxide
Iron (metal) oxide
Lead molybdenum oxide
Arsenic (metal) Oxide
Lead (metal) Oxides
Cadmium Oxide
Copper Oxides
Zinc Oxide
Lead Arsenate
Arsenic Trioxide
Calcium (metal) oxide

SILICATES

Slag
Lead silicate
Arsenic silicate
Zinc silicate
Clays

SULFATES

Iron (metal) sulfate
Lead sulfate
Lead barite
Zinc Sulfate
Arsenic sulfate
Copper sulfate

CARBONATES

Lead Carbonate
Zinc Carbonate

PHOSPHATES

(metal) phosphates

SULFIDES

Lead sulfide
Sulfur-containing salts
Iron-arsenic sulfide
Zinc sulfide
Copper sulfides
Copper-iron sulfide
Cadmium Sulfide

OTHER

Native: Lead, Copper, Cadmium, Mercury, Indium, Thallium, Selenium
Lead/Arsenic/Cadmium/Mercury Chlorides
Paint
Solder
Organic lead
Lead vanadate
Minor telluride, and bismuth-lead phases

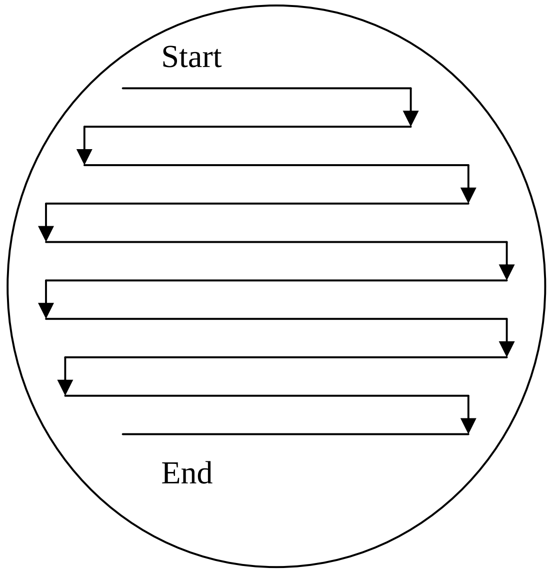


Figure 10-2

Form	**Association**	**Size (microns)**									
Cer	Liberated	5		Form	Number	Mean	Std-Dev	Range low	Range high		
Ga	Liberated	3		total	287	35.09	131.89	1	1400		
Ang	Liberated	12		Cerussite	3	18	11.79	5	28		
Ang	Liberated	13		Galena	144	9.83	9.99	1	50		
Sulf	Liberated	35		Anglesite	111	66.7	205.29	1	1400		
Ang	Liberated	9		FeSO4	6	39.33	28.23	8	90		
Ga	Cemented	5		MnOOH	8	24.13	25.86	8	85		
Ga	Cemented	5		FeOOH	11	60.27	101.4	4	350		
Ga	Cemented	5		PbBiO	3	32.67	19.4	20	55		
Ang	Liberated	21		Clay	1	8	ND	8	8		
Ang	Liberated	7									
Ang	Liberated	36		Form	(linear) freq	Bio freq	rm pb	Biorm pb			error-95%
Ang	Liberated	110		%	%	%	%	%			
Ga	Inclusion	32		Cerussite	0.54	1.32	0.65	1.73			0.84
Mn	Cemented	25		Galena	14.06	12.88	21.74	21.39			4.02
Mn	Cemented	30		Anglesite	73.51	65	75.41	71.62			5.11
Mn	Rimming	15		FeSO4	2.34	5.79	0.1	0.27			1.75
Mn	Rimming	10		MnOOH	1.92	4.73	0.8	2.14			1.59
Mn	Rimming	10		FeOOH	6.58	7.68	0.61	1.04			2.87
Mn	Rimming	10		PbBiO	0.97	2.4	0.67	1.79			1.14
Ga	Inclusion	12		Clay	0.08	0.2	0.01	0.02			0.33

Figure 10-3B

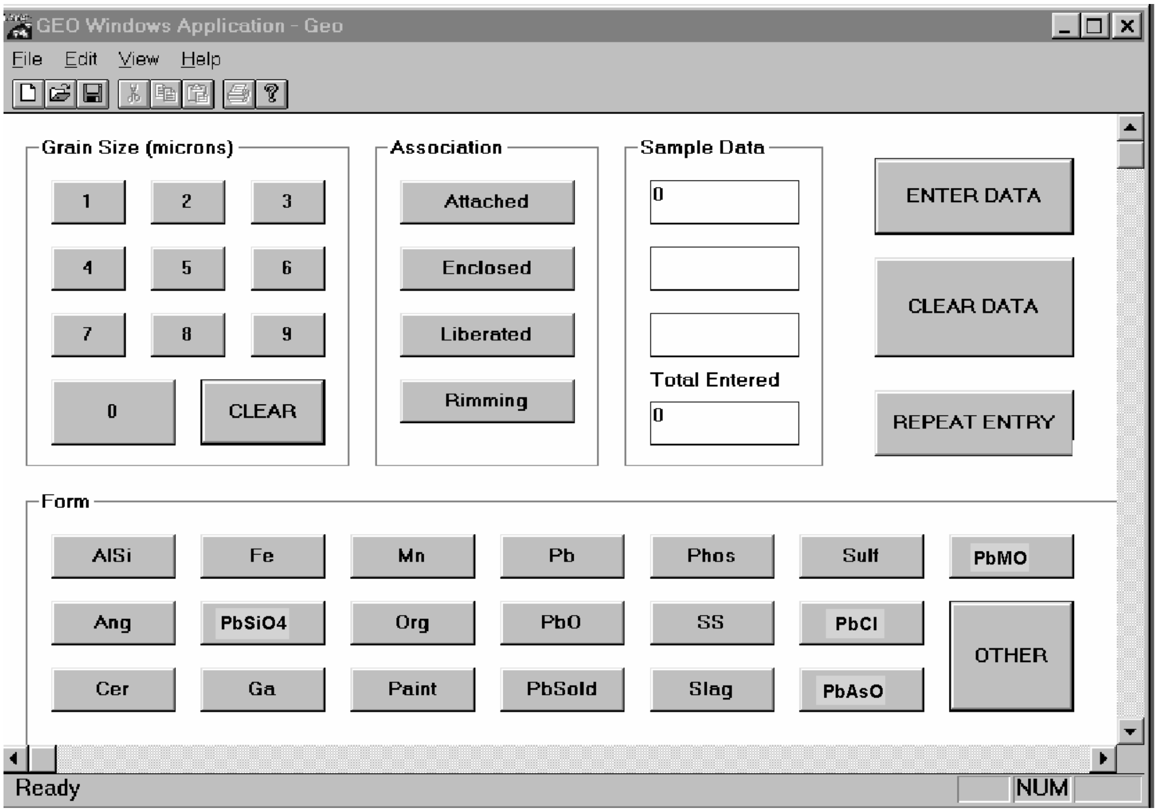

GEO Windows Application - Geo
File Edit View Help
Grain Size (microns)
1
2
3
4
5
6
7
8
9
0
CLEAR
Association
Attached
Enclosed
Liberated
Rimming
Sample Data
0
Total Entered
0
ENTER DATA
CLEAR DATA
REPEAT ENTRY
Form
AlSi
Fe
Mn
Pb
Phos
Sulf
PbMO
Ang
PbSiO4
Org
PbO
SS
PbCl
OTHER
Cer
Ga
Paint
PbSold
Slag
PbAsO
Ready
NUM

Figure 10-3A

Table 10-1
EMPA Standard Operating Conditions

	WDS	EDS
Accelerating Voltage	15 KV	15-20 KV
Beam Size	1-2 microns	1-2 microns
Cup Current	10-30 NanoAmps	10-30 NanoAmps
Ev/Channel	NA	10 or 20
Stage Tilt	NA	Fixed
Working Distance	NA	Fixed
MCA time Constant	NA	7.5-12 microseconds
X-ray lines	S K-alpha PET O K-alpha LDE1 C K-alpha LDEC Zn K-alpha PET As L-alpha TAP Cu K-alpha LIF Cd L-alpha PET Pb M-alpha PET Pb L-alpha LIF In L-alpha PET Tl L-alpha LIF Hg L-alpha LIF Se L-alpha LIF Sb L-alpha PET	S K-alpha 2.31 KeV O K-alpha 0.52 KeV C K-alpha 0.28 KeV Pb M-alpha 2.34 KeV Pb L-alpha 10.5 KeV Zn K-alpha 8.63 KeV Cu K-alpha 8.04 KeV As K-alpha 10.5 KeV As L-alpha 1.28 KeV Cd L-alpha 3.13 KeV In L-alpha 3.28 KeV Tl M-alpha 2.27 KeV Tl L-alpha 10.26 KeV Hg L-alpha 9.98 KeV Hg M-alpha 2.19 KeV Se L-alpha 1.37 KeV Sb L-alpha 3.60 KeV

Table 10-2
Suggested Abbreviation for Photomicrographs

Metal-bearing Phase	Abbreviation
In	In
Tl	Tl
Hg	Hg
Se	Se
Sb	Sb
Lead Sulfide	Ga
Lead Sulfate	Ang
Lead Carbonate	Cer
Mn-(M) Oxide	Mn(M)
Fe-(M) Oxide	Fe(M)
(M)Phosphate	(M)Phos
Fe-(M) Sulfate	Fe(M)Sul
Metal Oxide	(M)O
Pb-Mo Oxide	Wulf
Slag	Slag
Metallic Phase	(M)
Metal Silicate	(M)Si
Solder	Sold
Paint	Pnt
Metal-bearing Organic	(M)(Org)
(M) barite	(M)Bar
Pb arsenate	PbAsO
Pb vanadate	PbVan
As-Sb Oxide	AsSbO
Chalcopyrite	Cp
Sphalerite	Sph
Arsenopyrite	Apy

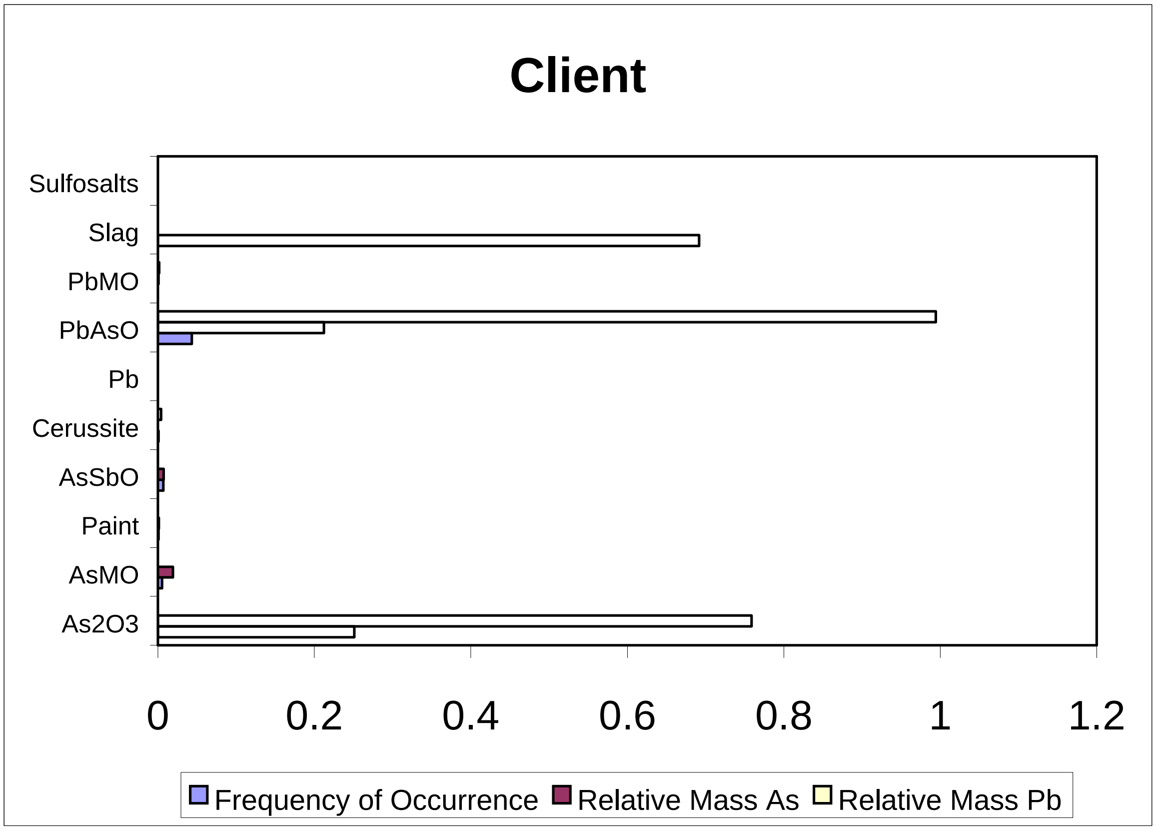

Client
Sulfosalts
Slag
PbMO
PbAsO
Pb
Cerussite
AsSbO
Paint
AsMO
As2O3
0
0.2
0.4
0.6
0.8
1
1.2
Frequency of Occurrence
Relative Mass As
Relative Mass Pb

Figure 11-0B

Table 1
Metal Speciation Frequency of Occurrence and Error Summary.

	Sample 1	+/-	Sample 2	+/-	Sample 3	+/-
Brass	4%	1-21				
Cerussite	8%	2-26	23%	17-30	9%	4-15
Fe-Pb Oxide	41%	23-61	64%	57-71	54%	42-61
PbMO*	5%	2-22	1%	Tr-4	Tr	
Pb Phosphate	33%	16-53	7%	4-12	24%	17-33
Fe-Pb Sulfate	10%	2-28			9%	4-16
CuAlSO4			1%	Tr-4	2%	Tr-6
Galena			3%	1-6		
Pb Vanadate			Tr		Tr	
Clays					Tr	
Particles Counted		22		173		104

* M represents the occurrence of small quantities of Sb and Sn.

Figure 11-10A

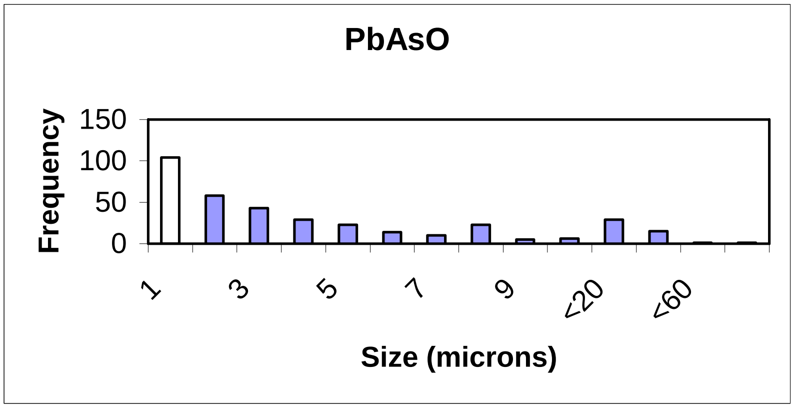


Figure 11-0C

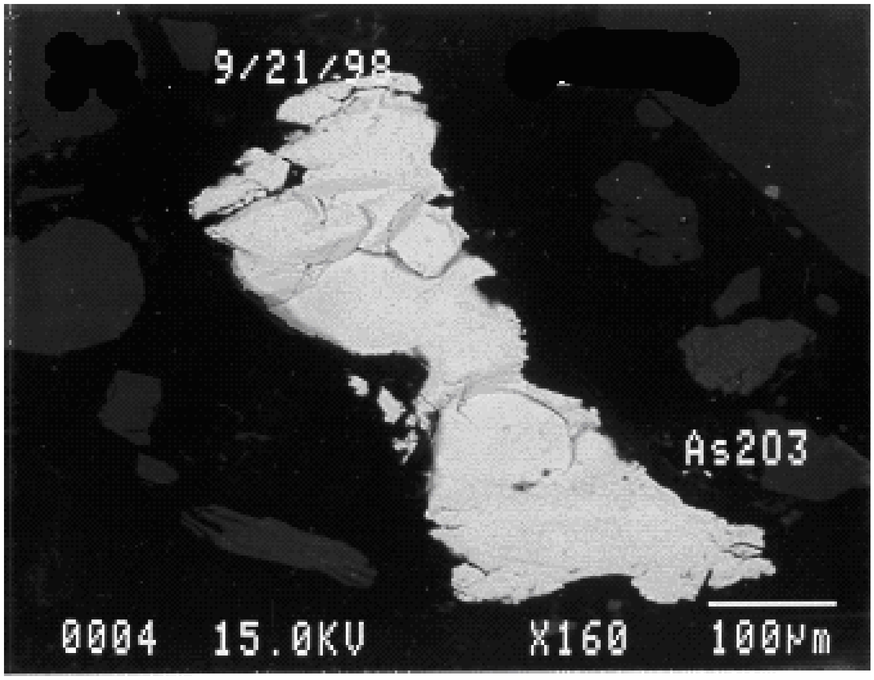


Figure 11-0E

Appendix C

Relative Bioavailability Leaching Procedure

Relative Bioavailability Leaching Procedure (RBLP)

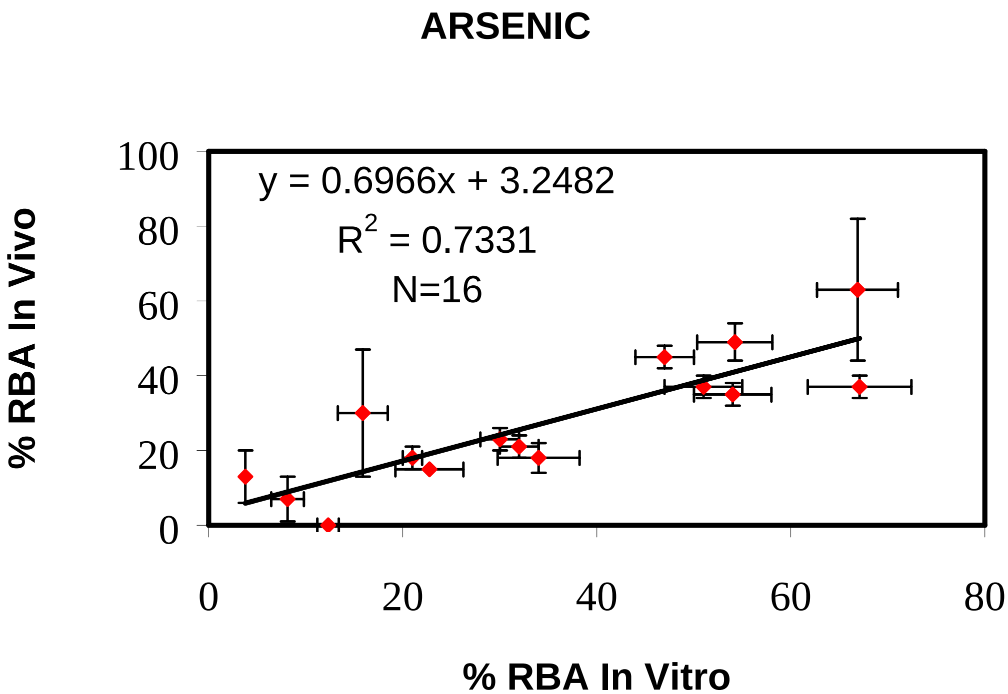
Standard Operating Procedure

1.0 Purpose

An increasingly important property of contaminated media found at environmental sites is the bioavailabilty of individual contaminants. Bioavailability is the fraction of a contaminant that is absorbed by an organism via a specific exposure route. Many animal studies have been conducted to experimentally determine oral bioavailability of individual metals, particularly lead and arsenic. During the period 1989-97, a juvenile swine model developed by USEPA Region VIII was used to predict the relative bioavailability of lead and arsenic in approximately 20 substrates (Weis and LaVelle 1991; Weis et al. 1994). The bioavailability determined was relative to that of a soluble salt (i.e. lead acetate trihydrate or sodium arsenate). The tested media had a wide range of mineralogy, and produced a range of lead and arsenic bioavailabilty values. In addition to the swine studies, other animal models (e.g. rats and monkeys) have been used for measuring the bioavailabilty of lead and arsenic from soils.

Several researchers have developed in vitro tests to measure the fraction of a chemical solubilized from a soil sample under simulated gastrointestinal conditions. The in vitro tests consist of an aqueous fluid, into which the contaminant is introduced. The solution than solubilizes the media under simulated gastric conditions. Once this procedure is complete, the solution is analyzed for lead and/or arsenic concentrations. The mass of the lead and/or arsenic found in the filtered extract is compared to the mass introduced into the test. The fraction liberated into the aqueous phase is defined as the bioavailable fraction of lead or arsenic in that media. To date, for lead-bearing materials tested in the USEPA swine studies, this in vitro assay has correlated well ($R^2 = 0.93$, p= .0001) with relative bioavailability. Arsenic has yet to be fully validated but shows a promising correlation with in vivo results.

It has been postulated that a simplified in vitro method could be used to determine



bioavailability of lead and arsenic. The method described in this SOP represents a simplified in vitro method, which is currently being subjected to a formal validation.

2.0 Scope

This procedure has been developed to test contaminated media in animal studies, to determine the correlation between in vitro and in vivo. Only samples from which mineralogy has been fully characterized by EMPA techniques and for which bioavailability results from acceptable animal studies are available have been used for this study. A total of 20 substrates have been tested in validating the relative bioavailability leaching procedure (RBLP).

3.0 Relevant Literature

Background on the development and validation of in vitro test systems for estimating lead and arsenic bioaccessibility can be found in; Ruby et al. (1993, 1996); Medlin (1972); Medlin and Drexler, 1997; Drexler, 1998; and Drexler et al., 2003.

Background information for the USEPA swine studies may be found in (Weis and LaVelle, 1991; Weis et al. 1994; and Casteel et al., 1997) and in the USEPA Region VIII Center in Denver, Colorado.

4.0 Sample Preparation

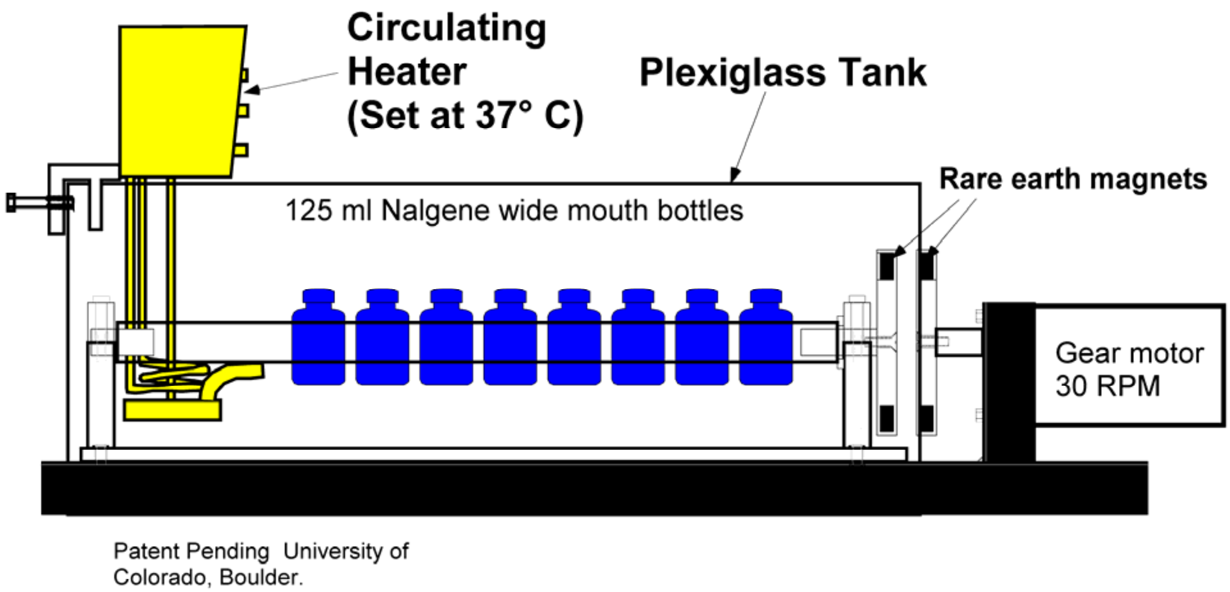
All media are prepared for the in vitro assay by first drying (<40 °C) all samples and then sieving to < 250 m. The <250   micron size fraction was used because this is the particle size is representative of that which adheres to children's hands. Samples were thoroughly mixed prior to use to ensure homogenization. Samples are archived after the study completion and retained for further analysis for a period of six months unless otherwise requested. Prior to obtaining a subsample for testing in this procedure, each sample must be homogenized in its sample container by end-over-end mixing.

5.0 Apparatus and Materials

5.1 Equipment

The main piece of equipment required for this procedure is the extraction device illustrated in Figure 1. The device can be purchased from the Department of Geological Sciences, University of Colorado. For further information contact Dr. John W. Drexler, at (303) 492-5251 or drexlerj@spot.colorado.edu. The device holds ten 125 ml, wide-mouth high-density polyethylene (HDPE) bottles. These are rotated within a Plexiglas tank by a TCLP extractor motor with a modified flywheel. The water bath must be filled such that the extraction bottles remained immersed. Temperature in the water bath is maintained at 37 +/- 2 °C using an immersion circulator heater (Fisher Scientific Model 730).

The 125-ml HDPE bottles must have an airtight screw-cap seal (Fisher Scientific #02-893-5C), and care must be taken to ensure that the bottles do not leak during the extraction procedure.


Circulating
Heater
(Set at 37° C)
Plexiglass Tank
Rare earth magnets
125 ml Nalgene wide mouth bottles
Gear motor
30 RPM
Patent Pending University of
Colorado, Boulder.

5.2 Standards and Reagents

The leaching procedure for this method uses an aqueous extraction fluid at a pH value of 1.5. The pH 1.5 fluid is prepared as follows:

Prepare 2 L of aqueous extraction fluid using ASTM Type II demonized (DI) water. The buffer is made up in the following manner. To 1.9 L of DI water, add 60.06 g glycine (free base, reagent grade), and bring the solution volume to 2 L (0.4M glycine). Place the mixture in the water bath at 37 °C until the extraction fluid reaches 37 °C. Standardize the pH meter (one should use both a 2.0 and a 4.0 pH buffer for standardization) using temperature compensation at 37 °C or buffers maintained at 37 °C in the water bath. Add trace metal grade, concentrated hydrochloric acid (12.1N) until the solution pH reaches a value of 1.50 +/_ 0.05 (approximately 60 mL).

All reagents must be free of lead and arsenic, and the final fluid must be tested to confirm that lead and arsenic concentrations are less than one-fourth the project required detection limits (PRDLs) of 100 and 20 µg/L, respectively (e.g., less than 25 µg/L lead and 5µg/L arsenic 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 must be properly cleaned, acid washed, and finally, triple-rinsed with demonized water prior to use.

6.0 Leaching Procedure

Measure 100 +/- 0.5 mL of the extraction fluid, using a graduated cylinder, and transfer to a 125 mL wide-mouth HPDE bottle. Add 1.00 +/- 0.5 g of test substrate (<250 m) to the bottle, ensuring that static electricity does not cause soil particles to adhere to the lip or outside threads of the bottle. If necessary, use an antistatic brush to eliminate static electricity prior to adding the media. Record the mass of substrate added to the bottle. Hand-tighten each bottle top and shake/invert to ensure that no leakage occurs, and that no media is caked on the bottom of the bottle.

Place the bottle into the modified TCLP extractor, making sure each bottle is secure and the lid(s) are tightly fastened. Fill the extractor with 125 mL bottles containing test materials or QA samples.

The temperature of the water bath must be 37 +/- 2 °C.

Turn on the extractor and rotate end-over-end at 30 +/- 2 rpm for 1 hour. Record the start time of rotation.

When extraction (rotation) is complete, immediately stop the extractor rotation and remove the bottles. Wipe them dry and place upright on the bench top.

Draw extract directly from the reaction vessel into a disposable 20 cc syringe with a Luer-Lok attachment. Attach a 0.45 µm cellulose acetate disk filter (25 mm diameter) to the syringe, and filter the extract into a clean 15 mL polypropylene centrifuge tube (labeled with sample ID) or other appropriate sample vial for analysis.

Record the time that the extract is filtered (i.e. extraction is stopped). If the total time elapsed is greater than 1 hour 30 minutes, the test must be repeated.

Measure the pH of the remaining fluid in the extraction bottle. If the fluid pH is not within +/_ 0.5 pH units of the starting pH, the test must be discarded and the sample reanalyzed as follows:

If the pH has changed more than 0.5 units, the test will be re-run in an identical fashion. If the second test also results in a decrease in pH of greater than 0.5 s.u. this will be recorded, and the extract filtered for analysis. If the pH has increased by 0.5 s.u. or more, the test must be repeated, but the extractor must be stopped at specific intervals and the pH manually adjusted down to pH of 1.5 with dropwise addition of HCl (adjustments at 5, 10, 15, and 30 minutes into the extraction, and upon final removal from the water bath { 60 min}). Samples with rising pH values might better be run following the method of Medlin, 1997.

Store filtered samples in a refrigerator at 4 °C until the are analyzed. Analysis for lead and arsenic concentrations must occur within 1 week of extraction for each sample.

Extracts are to be analyzed for lead and arsenic, as specified in SOP #2, following EPA methods 6010B, 6020, or 7061A.

6.1 Quality Control/Quality Assurance

Quality Assurance for the extraction procedure will consist of the following quality control samples.

Reagent Blank-extraction fluid analyzed once per batch.

Bottle Blank-extraction fluid only run through the complete procedure at a frequency of 1 in 20 samples.

Duplicate sample-duplicate sample extractions to be performed on 1 in 10 samples.

Matrix Spike-a subsample of each material used will be spiked at concentrations of 10 mg/L lead and 1 mg/L arsenic and run through the extraction procedure (frequency of 1 in 10 samples).

National Institute of Standards and Testing (NIST) Standard Reference Material (SRM) 2711 will be used as a control soil. The SRM will be analyzed at a frequency of 1 in 25 samples.

Control limits and corrective actions are listed in Table 1.

	Analysis Frequency	**Control Limits**
Reagent Blank	once per batch	< 25 Φg/L lead
Bottle blank	5%	<50 Φg/L lead
Blank spike*	5%	85-115% recovery
Matrix spike*	10%	75-125% recovery
Duplicate sample	10%	+/- 20% RPD**
Control soil***	5%	+/- 10% RPD

* Spikes contained 10 mg/L lead. ** RPD= relative percent difference. *** The National Institute of Standards and Technology (NIST) Standard Reference Material (SRM)

7.0 Chain-of-Custody Procedures

All media once received by the Laboratory must be maintained under standard chain-of-custody.

8.0 Data Handling and Verification

All sample and fluid preparation calculations and operations must be recorded on data sheets, Figure 3. Finally all key data will be entered into the attached EXCEL spreadsheet for final delivery and calculation of Bioavailability.

9.0 References

Casteel, S.W., R.P. Cowart, C.P. Weis, G.M. Henningsen, E.Hoffman and J.W. Drexler, 1997. Bioavailability of lead in soil from the Smuggler Mountain site of Aspen Colorado. Fund. Appl. Toxicol. 36: 177-187.

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Medlin, E., and Drexler, J.W., 1995. Development of an in vitro technique for the determination of bioavalability from metal-bearing solids., International Conference on the Biogeochemistry of Trace Elements, Paris, France.

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Weis, C.P., and J.M. LaVelle. 1991. Characteristics to consider when choosing an animal model for the study of lead bioavailability. In: Proceedings of the International Symposium on the Bioavailability and Dietary Uptake of Lead. Sci. Technol. Let. 3:113-119.

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Appendix D

Mineralogy by X-Ray diffraction

Appendix D

Mineralogy by X-Ray Diffraction

X-ray diffraction (XRD) has long been regarded as a definitive tool for identifying minerals in geological materials, especially those containing significant proportions of clay minerals (Ref. 18). XRD analysis of clay-bearing substances may be based on the evaluation of a bulk sample of the whole material mounted in randomly oriented powder form. Analyses of clay-fractions themselves, however, may use oriented aggregate samples of the clay fraction subjected to XRD after saturation with ethylene glycol to isolate expandable clay minerals and after heating to collapse any expandable lattice structures. The samples were prepared following standard procedures (Refs. 16 and 13). Splits of the bulk sample were used for characterization of the whole rock mineralogy. Approximately 5 g of each soil sample was ground with a "shatter-box" crusher to obtain a homogenous powder with particle sizes <40µm.

Clay mineral analyses were based on the standard method (Ref. 16). A split of the powdered soil was mixed with de-ionized water (pH 7-8) and agitated. The carbonate fraction was removed with the addition of HCl (0.5 N) at < 80°C temperature for 30 minutes or more until all the carbonate was dissolved. Ultrasonic desegregation is accomplished during 3 minute intervals. The insoluble residue was washed and centrifuged (5-6 times) until a neutral suspension was obtained (pH 7-8). Separation of the clay-size fractions were obtained by the timed settling method based on Stokes law. The selected fraction was then dispersed onto glass slides and air-dried at room temperature. XRD analysis of oriented clay samples were made after air-drying at room temperature, treating with ethylene-glycol, and heat treated steps.

All samples were analyzed on a Scintag PAD V X-ray diffractometer. Scanned from 3° to 65°2θ at the following parameters: radiation = CuKα; scan rate = 2°/min; step size = 0.02; voltage = 40 kV; current = 30 mA; and slits = 0.2 mm. To correct for misalignments of the goniometer a diffractogram of quartz (100) reflection at 4.26 Å was obtained. The methods described by Refs. 12,14,15,16, and 19 were used. The bulk XRD analyses of all three soils are dominated (Figures 2.2-2.4) by quartz (SiO_2), plagioclase ($Na,CaAlSi_3O_8$), and microcline ($KAlSi_3O_8$). Soil B (93206) additionally contained a significant amount of hematite (Fe_2O_3). The further analyses of their clay fraction (Figures 2.5-2.6) require greater interpretation, however, it appears all three soils are dominated by the presence of the minerals illite, kaolinite, and smectite as described below.

Illite

Illite is distinguished by the peak series; 10Å, 5Å, and 3.33Å. It is unaffected by glycolation and heat treatment to (550°C). It is perhaps the easiest to identify. The only possible misidentification is with palygorsite at 10.4Å and hydrated halloysite at 10Å but these minerals lack the characteristic illite peaks at 5Å, and 3.33Å.

Kaolinite

Kaolinite is a large class of clay minerals that range from the very ordered (narrow and intense diffraction peaks) to the very disordered (weak and broad diffraction peaks). The characteristic lines of kaolinite are 7.1Å and 3.57Å. These are possibly confused with chlorite (14Å, 7Å and 3.53Å), but the loss of the 7Å peak at 550°C rules out chlorite. Kaolinite survives heat treatment to 350°C, but not to 550°C. Kaolinite is unaffected by glycolation.

Smectite

Smectite is a diverse group. Members of the smectite group include the dioctahedral minerals montmorillonite, beidellite, and nontronite, and the trioctahedral minerals hectorite (Li-rich), saponite (Mg-rich), and sauconite (Zn-rich). In air-dried samples it has a peak in the range 12Å to 15Å which on glycolation it expands uniformly to 17.2Å (the peak usually sharpens and increases in intensity with glycolation - also an often observed 002 peak occurs at 8.5Å– there is no 002 peak in the air-dried oriented samples). Confirmation was obtained by heating to 300°C - the first diffraction peak collapses to an illite-like 10Å peak.

Appendix E

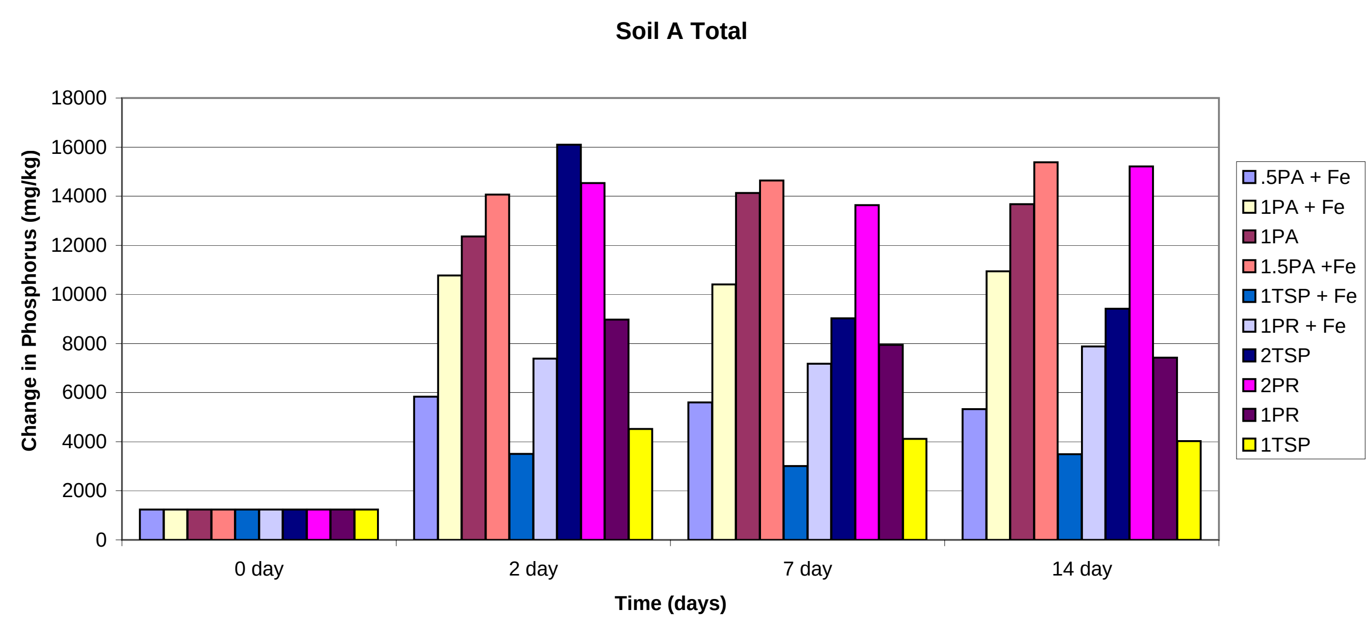
Electronic Data

MDL=0.06	P ppm	Change in P	Average Change
A3-2	7439.998395	6206.998	5839.123961
A4-2	6704.249527	5471.25	
A5-2	11745.9904	10512.99	10771.39548
A6-2	12262.80057	11029.8	
A7-2	13884.78438	12651.78	12364.43662
A8-2	13310.08886	12077.09	
A9-2	14717.25254	13484.25	14066.04311
A10-2	15880.83368	14647.83	
A11-2	5386.092255	4153.092	4518.229044
A12-2	6116.365833	4883.366	
A13-2	9822.195909	8589.196	8970.676568
A14-2	10585.15723	9352.157	
A15-2	4658.174606	3425.175	3505.719991
A16-2	4819.265376	3586.265	
A17-2	8683.240335	7450.24	7381.976075
A18-2	8546.711815	7313.712	
A19-2	18018.4179	16785.42	16093.51617
A20-2	16634.61444	15401.61	
A21-2	16053.43519	14820.44	14532.76997
A22-2	15478.10475	14245.1	
A3-7	6352.821312	5119.821	5602.513595
A4-7	7318.205879	6085.206	
A5-7	11853.64943	10620.65	10406.36567
A6-7	11425.08191	10192.08	
A7-7	15326.81037	14093.81	14127.90249
A8-7	15394.9946	14161.99	
A9-7	16346.72501	15113.73	14639.17975
A10-7	15397.63448	14164.63	
A11-7	5403.713051	4170.713	4114.718127
A12-7	5291.723202	4058.723	
A13-7	8923.229814	7690.23	7948.448252
A14-7	9439.66669	8206.667	
A15-7	4084.340902	2851.341	3002.666644
A16-7	4386.992386	3153.992	
A17-7	9289.428919	8056.429	7175.598337
A18-7	7527.767755	6294.768	
A19-7	10369.91935	9136.919	9025.182441
A20-7	10146.44553	8913.446	
A21-7	14264.71159	13031.71	13640.65124
A22-7	15482.59089	14249.59	
A3-14	7079.93768	5846.938	5320.767122
A4-14	6027.596565	4794.597	
A5-14	12254.87941	11021.88	10941.79402
A6-14	12094.70863	10861.71	
A7-14	15569.83278	14336.83	13679.5558
A8-14	14255.27881	13022.28	
A9-14	16746.76305	15513.76	15375.58031
A10-14	16470.39758	15237.4	
A11-14	5483.189753	4250.19	4028.468409
A12-14	5039.747064	3806.747	
A13-14	8547.239795	7314.24	7421.948982
A14-14	8762.658168	7529.658	
A15-14	4887.656276	3654.656	3494.206939
A16-14	4566.757602	3333.758	
A17-14	8573.750508	7340.751	7874.035875
A18-14	9640.321243	8407.321	
A19-14	11054.54154	9821.542	9413.840887
A20-14	10239.14023	9006.14	
A21-14	16787.96102	15554.96	15210.32014
A22-14	16098.67926	14865.68	

Control	
A1-2	1232.919
A1-7	1301.493
A1-14	1263.107
A2-2	1225.912
A2-7	1172.385
A2-14	1202.563
Average	**1233.063**
StDev	**45.27388**
B1-2	1418.918
B1-7	1413.406
B1-14	1520.994
B2-2	1429.489
B2-7	1414.314
B2-14	1484.186
Average	**1446.884**
StDev	**45.05537**
C1-2	1133.173
C1-7	962.7538
C1-14	974.23
C2-2	975.9716
C2-7	999.0791
C2-14	988.1236
Average	**1005.555**
StDev	**63.75016**

Total Phosphorous

		A				B				C			
		0	2	7	14	0	2	7	14	0	2	7	14
Series 1	.5PA + Fe	**1233**	5839.124	5602.51	5320.77	**1446.00**	5648.62	7269.76	6227.51	**1005.00**	5414.93	6684.25	5268.79
Series 3	1PA + Fe	**1233**	10771.4	10406.37	10941.79	**1446.00**	10743.71	13038.61	11431.57	**1005.00**	10629.93	10888.28	9488.18
Series 5	1PA	**1233**	12364.44	14127.90	13679.56	**1446.00**	13239.54	14033.33	14507.47	**1005.00**	11824.35	11656.81	11217.90
Series 7	1.5PA +Fe	**1233**	14066.04	14639.18	15375.58	**1446.00**	13500.40	16870.95	18452.86	**1005.00**	12709.61	14051.39	12480.44
Series 9	1TSP	**1233**	4518.229	4114.72	4028.47	**1446.00**	4161.36	4469.25	6373.83	**1005.00**	4067.53	3897.82	3679.68
Series 11	1PR	**1233**	8970.677	7948.45	7421.95	**1446.00**	7568.49	7866.38	10141.77	**1005.00**	7114.02	7034.83	7185.09
Series 13	1TSP + Fe	**1233**	3505.72	3002.67	3494.21	**1446.00**	3555.33	4920.24	4131.60	**1005.00**	3223.69	3443.39	3186.78
Series 15	1PR + Fe	**1233**	7381.976	7175.60	7874.04	**1446.00**	7645.44	7284.47	9490.64	**1005.00**	6171.85	6019.53	6587.46
Series 17	2TSP	**1233**	16093.52	9025.18	9413.84	**1446.00**	10230.68	9736.38	10286.49	**1005.00**	8443.15	8832.82	8909.46
Series 19	2PR	**1233**	14532.77	13640.65	15210.32	**1446.00**	15678.75	16523.72	15135.23	**1005.00**	13008.19	12782.18	12617.06
		0 day	2 day	7 day	14 day		2 day	7 day	14 day		2 day	7 day	14 day



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B4-2	6776.262235	5330.262	
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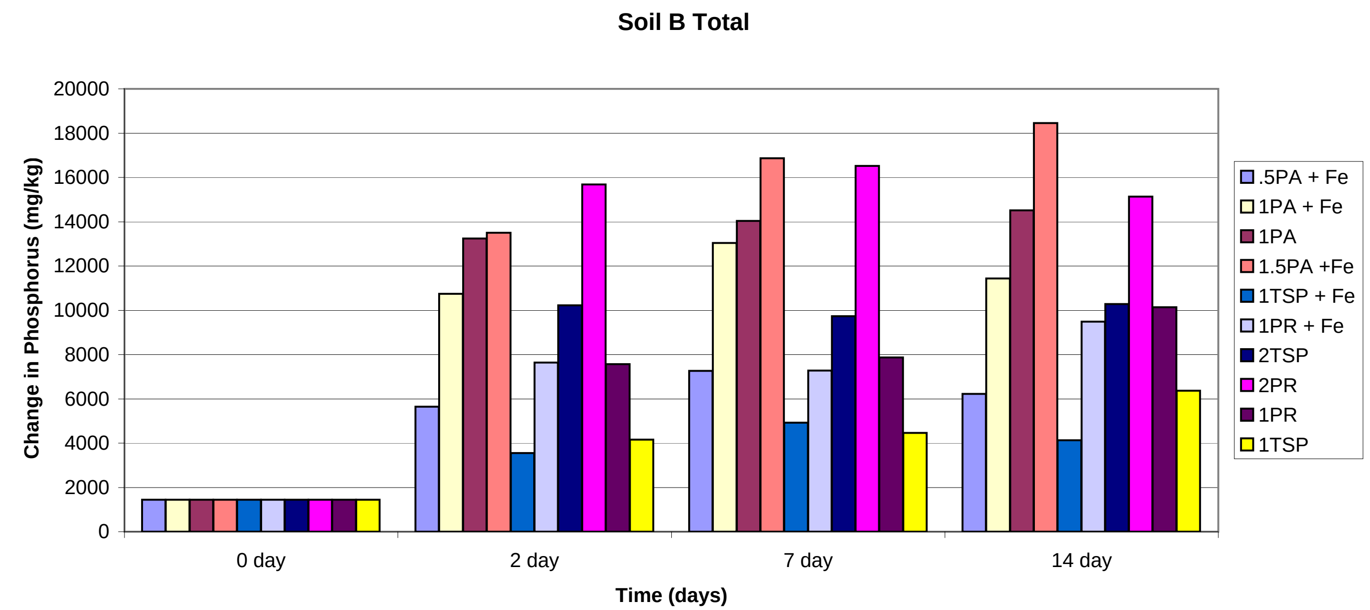
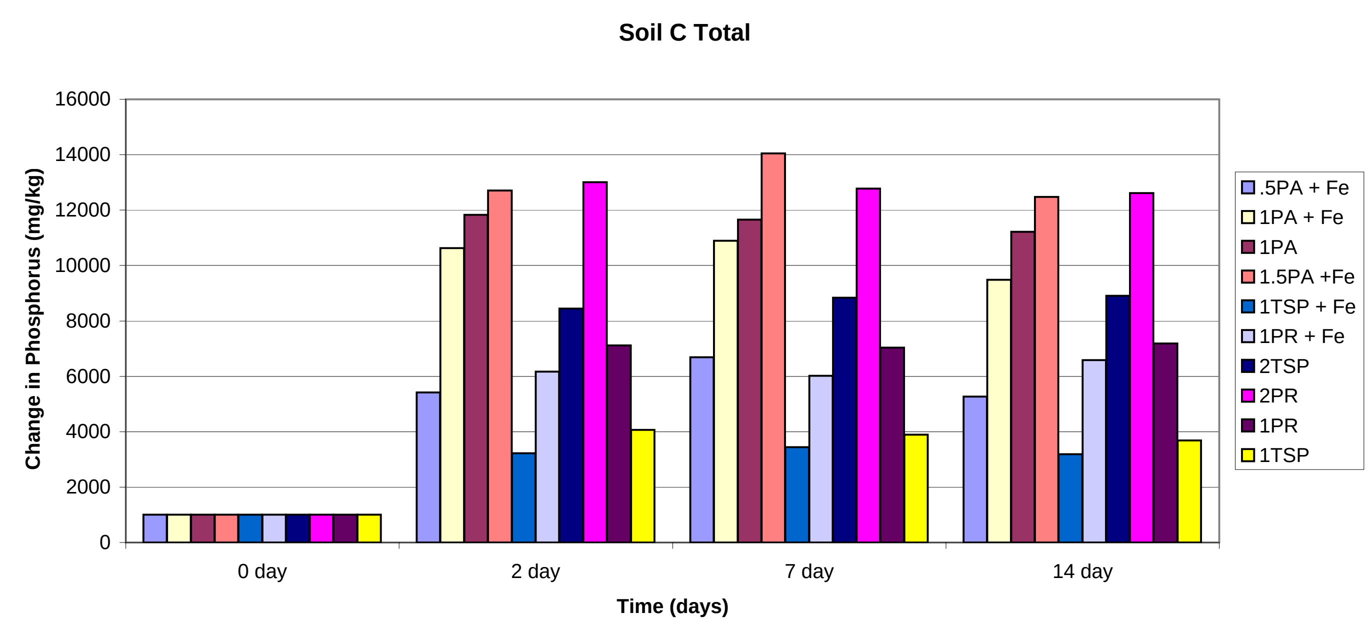
B6-2	12195.52385	10749.52	
B7-2	14601.21227	13155.21	13239.53534
B8-2	14769.85841	13323.86	
B9-2	14839.01817	13393.02	13500.40153
B10-2	15053.78488	13607.78	
B11-2	5697.515418	4251.515	4161.362966
B12-2	5517.210514	4071.211	
B13-2	8793.77584	7347.776	7568.490801
B14-2	9235.205762	7789.206	
B15-2	4678.400354	3232.4	3555.331452
B16-2	5324.262549	3878.263	
B17-2	8131.532496	6685.532	7645.439615
B18-2	10051.34673	8605.347	
B19-2	11792.36621	10346.37	10230.68289
B20-2	11560.99958	10115	
B21-2	17928.59982	16482.6	15678.75014
B22-2	16320.90046	14874.9	

B3-7	9451.925303	8005.925	7269.761847
B4-7	7979.598392	6533.598	
B5-7	14979.0874	13533.09	13038.61496
B6-7	13990.14253	12544.14	
B7-7	16025.79834	14579.8	14033.32512
B8-7	14932.85189	13486.85	
B9-7	19248.95009	17802.95	16870.9493
B10-7	17384.94851	15938.95	
B11-7	5754.608637	4308.609	4469.247148
B12-7	6075.885659	4629.886	
B13-7	9120.980757	7674.981	7866.379157
B14-7	9503.777558	8057.778	
B15-7	7064.520299	5618.52	4920.244652
B16-7	5667.969005	4221.969	
B17-7	8516.510891	7070.511	7284.469256
B18-7	8944.427621	7498.428	
B19-7	11065.40854	9619.409	9736.379815
B20-7	11299.35109	9853.351	
B21-7	16725.03601	15279.04	16523.72192
B22-7	19214.40782	17768.41	

B3-14	7832.097231	6386.097	6227.512277
B4-14	7514.927324	6068.927	
B5-14	12860.11122	11414.11	11431.56517
B6-14	12895.01913	11449.02	
B7-14	15743.49333	14297.49	14507.46737
B8-14	16163.44142	14717.44	
B9-14	18548.99249	17102.99	18452.86384
B10-14	21248.73519	19802.74	
B11-14	6433.604439	4987.604	6373.834092
B12-14	9206.063746	7760.064	
B13-14	13817.82606	12371.83	10141.76843
B14-14	9357.710803	7911.711	
B15-14	5615.999367	4169.999	4131.600046
B16-14	5539.200725	4093.201	
B17-14	9646.283384	8200.283	9490.642604
B18-14	12227.00182	10781	
B19-14	12091.8459	10645.85	10286.48953
B20-14	11373.13315	9927.133	
B21-14	16356.83897	14910.84	15135.23112
B22-14	16805.62327	15359.62	

C3-2	6499.877959	5494.878	5414.929569
C4-2	6339.981178	5334.981	





C5-2	12148.22932	11143.23	10629.93235
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C7-2	13266.59601	12261.6	11824.34922
C8-2	12392.10244	11387.1	
C9-2	13605.64686	12600.65	12709.60515
C10-2	13823.56343	12818.56	
C11-2	5077.474134	4072.474	4067.530693
C12-2	5067.587252	4062.587	
C13-2	8311.715213	7306.715	7114.0156
C14-2	7926.315986	6921.316	
C15-2	4299.581235	3294.581	3223.692522
C16-2	4157.803809	3152.804	
C17-2	6866.250206	5861.25	6171.854263
C18-2	7487.45832	6482.458	
C19-2	9912.374081	8907.374	8443.15327
C20-2	8983.932459	7978.932	
C21-2	13680.16338	12675.16	13008.18611
C22-2	14346.20884	13341.21	
C3-7	7665.761768	6660.762	6684.247933
C4-7	7712.734097	6707.734	
C5-7	12367.33243	11362.33	10888.27907
C6-7	11419.2257	10414.23	
C7-7	12672.18732	11667.19	11656.80965
C8-7	12651.43198	11646.43	
C9-7	15170.2323	14165.23	14051.38908
C10-7	14942.54586	13937.55	
C11-7	4788.507582	3783.508	3897.82117
C12-7	5017.134758	4012.135	
C13-7	6981.130203	5976.13	7034.834787
C14-7	9098.539371	8093.539	
C15-7	4251.213928	3246.214	3443.385048
C16-7	4645.556168	3640.556	
C17-7	6699.908735	5694.909	6019.528251
C18-7	7349.147767	6344.148	
C19-7	10272.38972	9267.39	8832.818808
C20-7	9403.247897	8398.248	
C21-7	13421.53461	12416.53	12782.18219
C22-7	14152.82978	13147.83	
C3-14	6297.837106	5292.837	5268.794145
C4-14	6249.751184	5244.751	
C5-14	10572.70475	9567.705	9488.182349
C6-14	10413.65994	9408.66	
C7-14	11839.07819	10834.08	11217.89809
C8-14	12606.71798	11601.72	
C9-14	13673.87469	12668.87	12480.44041
C10-14	13297.00614	12292.01	
C11-14	4778.529562	3773.53	3679.677936
C12-14	4590.826309	3585.826	
C13-14	7922.222887	6917.223	7185.086121
C14-14	8457.949355	7452.949	
C15-14	4138.475739	3133.476	3186.778449
C16-14	4245.08116	3240.081	
C17-14	7453.97506	6448.975	6587.459265
C18-14	7730.943471	6725.943	
C19-14	10278.73352	9273.734	8909.455663
C20-14	9550.177809	8545.178	
C21-14	13234.44617	12229.45	12617.05963
C22-14	14009.67309	13004.67	

QA/QC

NIST2710A	1030.993916
NIST2710-B	924.1649828
NIST2710-C	984.9442911
NIST2710-D	988.4272434
NIST2710-E	1034.053033
NIST2711-A	797.6081218
NIST2711-C	756.5814502
NIST2711-D	792.5612815
NIST2711-E	802.2486385
NISY2711-B	751.890606
PR BLANK-1	0.025
PR BLANK-2	0.012
PR BLANK-3	0.026
PR BLANK-4	-0.008
SC 5PPM	4.87
SC 5PPM	5.031
STAND 20 PPM	19.437
STAND 20 PPM	19.983
STAND 20 PPM	19.077
STAND 20PPM	19.449
STAND 20PPM	19.381
STAND 20PPM	19.284
STAND 20PPM	19.724
STAND 20PPM	20.273
STAND 20PPM	20.151
STAND 20PPM	20.499
STAND 20PPM	19.629
STAND-20PPM	19.705
STAND-20PPM	20.257
BLANK	0.041
BLANK	0.052
BLANK	0.036
BLANK	0.061
BLANK	0.07
BLANK	0.051
BLANK	0.051
BLANK	0.06
BLANK	0.001
BLANK	0.015
BLANK	0.019
BLANK	-0.007
BLANK	0.03
BLANK	0.015
BLANK	0.031
BLANK	-0.002

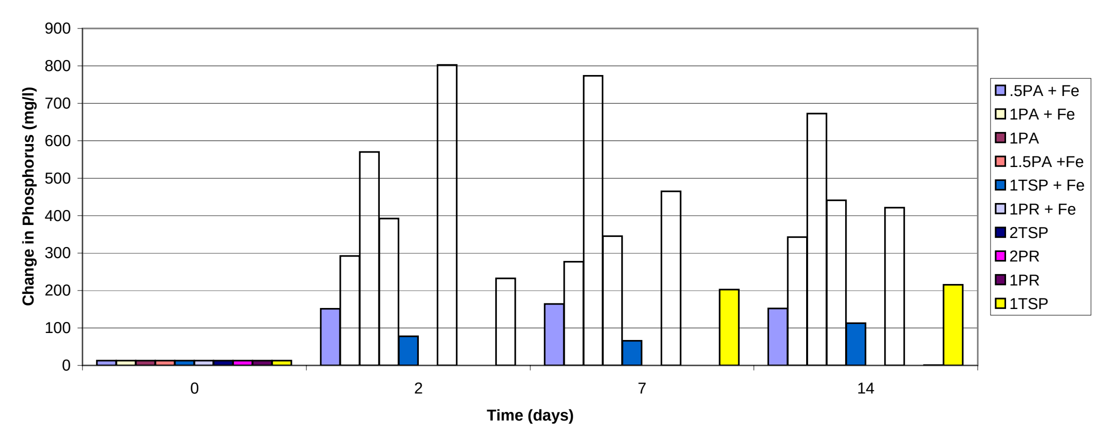
	P ppm	Exchangable P	Change in P	Average Change
MDL	**0.062**			
A3-2	175.860		163.160	151.685
A4-2	152.910		140.210	
A5-2	323.010		310.310	292.61
A6-2	287.610		274.910	
A7-2	606.41		593.710	570.485
A8-2	559.960		547.260	
A9-2	398.470		385.770	392.22
A10-2	411.37		398.670	
A11-2	217.52		204.820	232.265
A12-2	272.41		259.710	
A13-2	9.96		-2.740	-2.475
A14-2	10.49		-2.210	
A15-2	86.72		74.020	77.47
A16-2	93.62		80.920	
A17-2	1		-11.700	-11.555
A18-2	1.29		-11.410	
A19-2	822.61		809.910	802.215
A20-2	807.22		794.520	
A21-2	10.24		-2.460	-2.1
A22-2	10.96		-1.740	
A3-7	168.52		155.820	163.925
A4-7	184.73		172.030	
A5-7	316.67		303.970	276.795
A6-7	262.32		249.620	
A7-7	730.8		718.100	773.1
A8-7	840.8		828.100	
A9-7	379.33		366.630	345.205
A10-7	336.48		323.780	
A11-7	211.86		199.160	202.445
A12-7	218.43		205.730	
A13-7	10.75		-1.950	-1.48
A14-7	11.69		-1.010	
A15-7	75.92		63.220	65.485
A16-7	80.45		67.750	
A17-7	1		-11.700	-11.7
A18-7	1		-11.700	
A19-7	471.97		459.270	464.705
A20-7	482.84		470.140	
A21-7	9.66		-3.040	-2.17
A22-7	11.4		-1.300	
A3-14	179.48		166.780	152.095
A4-14	150.11		137.410	
A5-14	389.12		376.420	342.42
A6-14	321.12		308.420	
A7-14	683.45		670.750	673.045
A8-14	688.04		675.340	
A9-14	472.3		459.600	440.815
A10-14	434.73		422.030	
A11-14	238.26		225.560	215.36
A12-14	217.86		205.160	
A13-14	15.55		2.850	1.2
A14-14	12.25		-0.450	
A15-14	128.01		115.310	112.95
A16-14	123.29		110.590	
A17-14	3.72		-8.980	-9.47
A18-14	2.74		-9.960	
A19-14	433.84		421.140	421.79
A20-14	435.14		422.440	
A21-14	12.48		-0.220	-0.895
A22-14	11.13		-1.570	
B3-2	163.24		149.840	144.52
B4-2	152.6		139.200	
B5-2	331.35		317.950	312.69
B6-2	320.83		307.430	
B7-2	639.95		626.550	646.275
B8-2	679.4		666.000	
B9-2	464.43		451.030	423.475
B10-2	409.32		395.920	
B11-2	263.97		250.570	240.98
B12-2	244.79		231.390	
B13-2	11.06		-2.340	-2.275
B14-2	11.19		-2.210	
B15-2	92.47		79.070	92.945

Control	
A1-2	12.36
A2-2	11.570
A1-7	11.91
A2-7	13.8
A-1-14	13.1
A-2-14	13.41
Average	**12.69167**
Stdev	**0.882075**
B1-2	13.13
B2-2	12.5
B1-7	13.21
B2-7	13.02
B1-14	13.88
B2-14	14.55
Average	**13.38167**
Stdev	**0.723088**
C1-2	6.52
C2-2	6.66
C1-7	6.34
C2-7	4.64
C1-14	6.92
C2-14	7.19
Average	**6.378333**
Stdev	**0.902761**

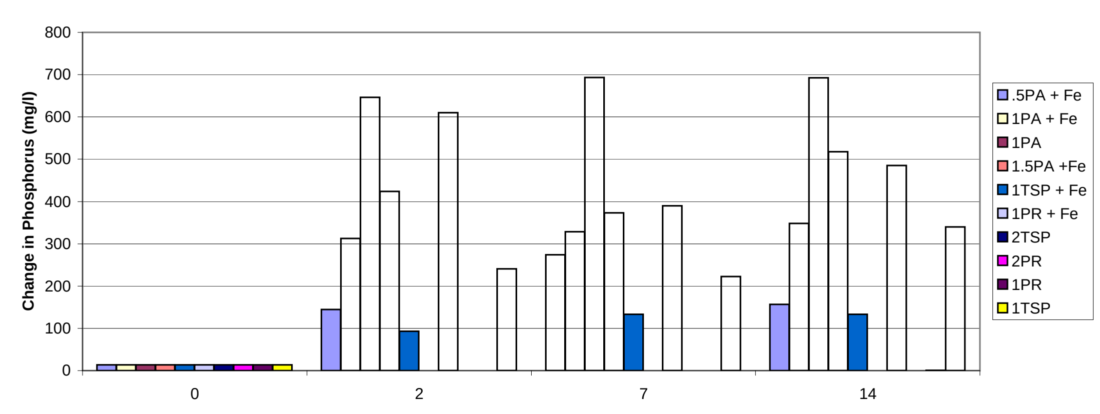
Phosphorous

		A				B				C			
		0	2	7	14	0	2	7	14	0	2	7	14
Series 1	.5PA + Fe	**12.69167**	151.685	163.93	152.10	**13.38167**	144.52	273.75	156.32	**6.38**	192.98	208.58	139.86
Series 3	1PA + Fe	**12.69167**	292.61	276.80	342.42	**13.38167**	312.69	328.15	347.85	**6.38**	365.76	356.19	309.29
Series 5	1PA	**12.69167**	570.485	773.10	673.05	**13.38167**	646.28	693.44	692.67	**6.38**	721.10	485.25	599.30
Series 7	1.5PA +Fe	**12.69167**	392.22	345.21	440.82	**13.38167**	423.48	372.89	517.88	**6.38**	438.83	430.11	444.69
Series 9	1TSP	**12.69167**	232.265	202.45	215.36	**13.38167**	240.98	222.82	339.62	**6.38**	247.20	216.00	253.78
Series 11	1PR	**12.69167**	-2.475	-1.48	1.20	**13.38167**	-2.28	-2.29	0.86	**6.38**	-0.04	-0.18	0.54
Series 13	1TSP + Fe	**12.69167**	77.47	65.49	112.95	**13.38167**	92.95	132.85	133.10	**6.38**	101.35	89.84	118.92
Series 15	1PR + Fe	**12.69167**	-11.555	-11.70	-9.47	**13.38167**	-11.60	-13.00	-10.81	**6.38**	-5.32	-5.40	-5.07
Series 17	2TSP	**12.69167**	802.215	464.71	421.79	**13.38167**	610.15	389.60	485.09	**6.38**	508.07	375.92	487.13
Series 19	2PR	**12.69167**	-2.1	-2.17	-0.89	**13.38167**	-1.03	-1.69	-0.32	**6.38**	0.67	0.71	1.23
		0 day	2 day	7 day	14 day		2 day	7 day	14 day		2 day	7 day	14 day

Soil A Extractable



Soil B Extractable

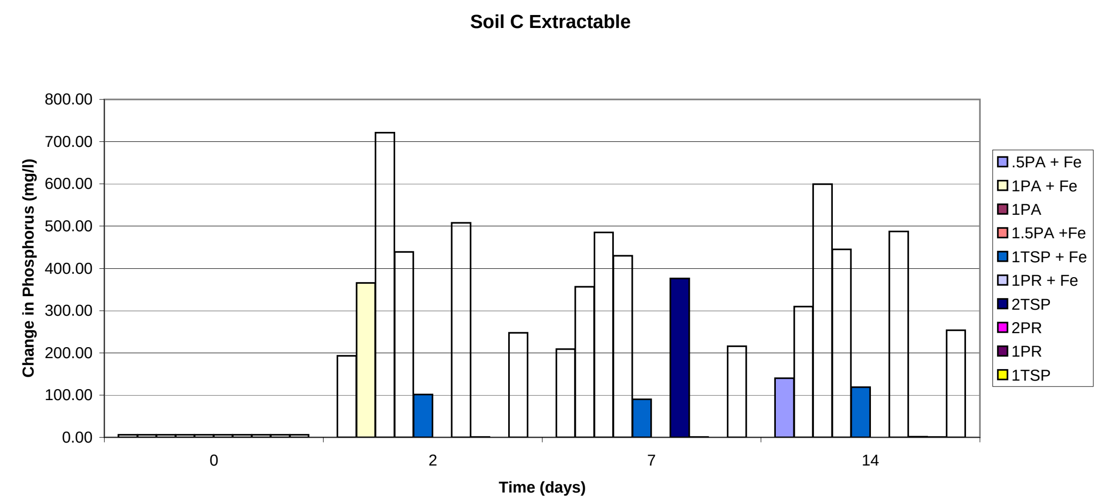


B16-2	120.22	106.820	
B17-2	1.99	-11.410	-11.6
B18-2	1.61	-11.790	
B19-2	676.07	662.670	610.15
B20-2	571.03	557.630	
B21-2	13.05	-0.350	-1.03
B22-2	11.69	-1.710	

B3-7	318.75	305.350	273.75
B4-7	255.55	242.150	
B5-7	339.22	325.820	328.15
B6-7	343.88	330.480	
B7-7	812.01	798.610	693.44
B8-7	601.67	588.270	
B9-7	486.84	473.440	372.89
B10-7	285.74	272.340	
B11-7	227.55	214.150	222.815
B12-7	244.88	231.480	
B13-7	11.03	-2.370	-2.29
B14-7	11.19	-2.210	
B15-7	161.76	148.360	132.85
B16-7	130.74	117.340	
B17-7	0.38	-13.020	-13
B18-7	0.42	-12.980	
B19-7	413.22	399.820	389.6
B20-7	392.78	379.380	
B21-7	11.73	-1.670	-1.69
B22-7	11.69	-1.710	

B3-14	153.96	140.560	156.315
B4-14	185.47	172.070	
B5-14	340.17	326.770	347.85
B6-14	382.33	368.930	
B7-14	702.01	688.610	692.665
B8-14	710.12	696.720	
B9-14	557.79	544.390	517.875
B10-14	504.76	491.360	
B11-14	300.17	286.770	339.62
B12-14	405.87	392.470	
B13-14	13.5	0.100	0.86
B14-14	15.02	1.620	
B15-14	164.16	150.760	133.095
B16-14	128.83	115.430	
B17-14	3.48	-9.920	-10.81
B18-14	1.7	-11.700	
B19-14	495.02	481.620	485.085
B20-14	501.95	488.550	
B21-14	12.65	-0.750	-0.32
B22-14	13.51	0.110	

C3-2	188.83	182.430	192.975
C4-2	209.92	203.520	
C5-2	393.45	387.050	365.755
C6-2	350.86	344.460	
C7-2	802.2	795.800	721.095
C8-2	652.79	646.390	
C9-2	395.69	389.290	438.83
C10-2	494.77	488.370	
C11-2	250.13	243.730	247.2
C12-2	257.07	250.670	
C13-2	6.53	0.130	-0.04
C14-2	6.19	-0.210	
C15-2	110.91	104.510	101.345
C16-2	104.58	98.180	
C17-2	1.01	-5.390	-5.315
C18-2	1.16	-5.240	
C19-2	515.52	509.120	508.065
C20-2	513.41	507.010	
C21-2	6.92	0.520	0.665
C22-2	7.21	0.810	



C3-7	215.35	208.950	208.58
C4-7	214.61	208.210	
C5-7	384.39	377.990	356.185
C6-7	340.78	334.380	
C7-7	489.4	483.000	485.245
C8-7	493.89	487.490	
C9-7	465.24	458.840	430.105
C10-7	407.77	401.370	
C11-7	226.04	219.640	215.995
C12-7	218.75	212.350	
C13-7	5.71	-0.690	-0.18
C14-7	6.73	0.330	
C15-7	82.63	76.230	89.84
C16-7	109.85	103.450	
C17-7	1	-5.400	-5.4
C18-7	1	-5.400	
C19-7	396.27	389.870	375.915
C20-7	368.36	361.960	
C21-7	7.04	0.640	0.705
C22-7	7.17	0.770	

C3-14	150.47	144.070	139.86
C4-14	142.05	135.650	
C5-14	331.84	325.440	309.29
C6-14	299.54	293.140	
C7-14	543.65	537.250	599.3
C8-14	667.75	661.350	
C9-14	456.92	450.520	444.69
C10-14	445.26	438.860	
C11-14	247.45	241.050	253.775
C12-14	272.9	266.500	
C13-14	7.65	1.250	0.54
C14-14	6.23	-0.170	
C15-14	129.19	122.790	118.915
C16-14	121.44	115.040	
C17-14	1.42	-4.980	-5.07
C18-14	1.24	-5.160	
C19-14	510.67	504.270	487.125
C20-14	476.38	469.980	
C21-14	7.63	1.230	1.225
C22-14	7.62	1.220	

MDL	Pb ppb	Change in Pb	Average Change
	0.073		
A3-2	0.09	-5.75	-5.638025
A4-2	0.31	-5.53	
A5-2	0.22	-5.62	-5.72068
A6-2	0.02	-5.82	
A7-2	0.41	-5.43	-5.5359
A8-2	0.20	-5.64	
A9-2	0.20	-5.64	-5.65895
A10-2	0.17	-5.67	
A11-2	2.19	-3.65	-3.63205
A12-2	2.23	-3.61	
A13-2	17.80	11.96	4.197415
A14-2	2.27	-3.57	
A15-2	1.40	-4.44	-4.6705
A16-2	0.93	-4.91	
A17-2	4.37	-1.47	-1.4768
A18-2	4.36	-1.48	
A19-2	9.17	3.33	4.4693
A20-2	11.44	5.60	
A21-2	30.97	25.13	25.4172
A22-2	31.54	25.70	
A3-7	0.22	-5.62	-5.6668
A4-7	0.12	-5.72	
A5-7	0.13	-5.71	-5.77585
A6-7	0.00	-5.84	
A7-7	1.01	-4.83	-4.384
A8-7	1.90	-3.94	
A9-7	0.00	-5.84	-5.84
A10-7	0.00	-5.84	
A11-7	1.36	-4.48	-4.5841
A12-7	1.15	-4.69	
A13-7	16.96	11.12	9.6968
A14-7	14.11	8.27	
A15-7	0.54	-5.30	-4.82565
A16-7	1.49	-4.35	
A17-7	3.02	-2.82	-2.9601
A18-7	2.74	-3.10	
A19-7	5.41	-0.43	-0.77535
A20-7	4.72	-1.12	
A21-7	37.34	31.50	31.6904
A22-7	37.72	31.88	
A3-14	2.67	-3.17	-4.23656979
A4-14	0.53	-5.31	
A5-14	0.21	-5.63	-5.73480652
A6-14	0.00	-5.84	
A7-14	0.15	-5.69	-5.76488737
A8-14	0.00	-5.84	
A9-14	0.00	-5.84	-5.84
A10-14	0.00	-5.84	
A11-14	1.72	-4.12	-4.60690139
A12-14	0.74	-5.10	
A13-14	13.61	7.77	8.715021811
A14-14	15.50	9.66	
A15-14	0.36	-5.48	-5.47011261
A16-14	0.38	-5.46	
A17-14	4.18	-1.66	-1.45917889
A18-14	4.58	-1.26	
A19-14	6.59	0.75	-0.95963878
A20-14	3.17	-2.67	
A21-14	31.59	25.75	30.17552557
A22-14	40.44	34.60	
B3-2	0.59	-9.52	-9.37505
B4-2	0.88	-9.23	
B5-2	0.00	-10.11	-10.11
B6-2	0.00	-10.11	
B7-2	0.53	-9.58	-8.7054
B8-2	2.28	-7.83	
B9-2	0.00	-10.11	-10.11
B10-2	0.00	-10.11	
B11-2	4.21	-5.90	-6.09425
B12-2	3.82	-6.29	
B13-2	43.69	33.58	34.02935

Pb Concentrations

Controls

TSP leaches a lot of P

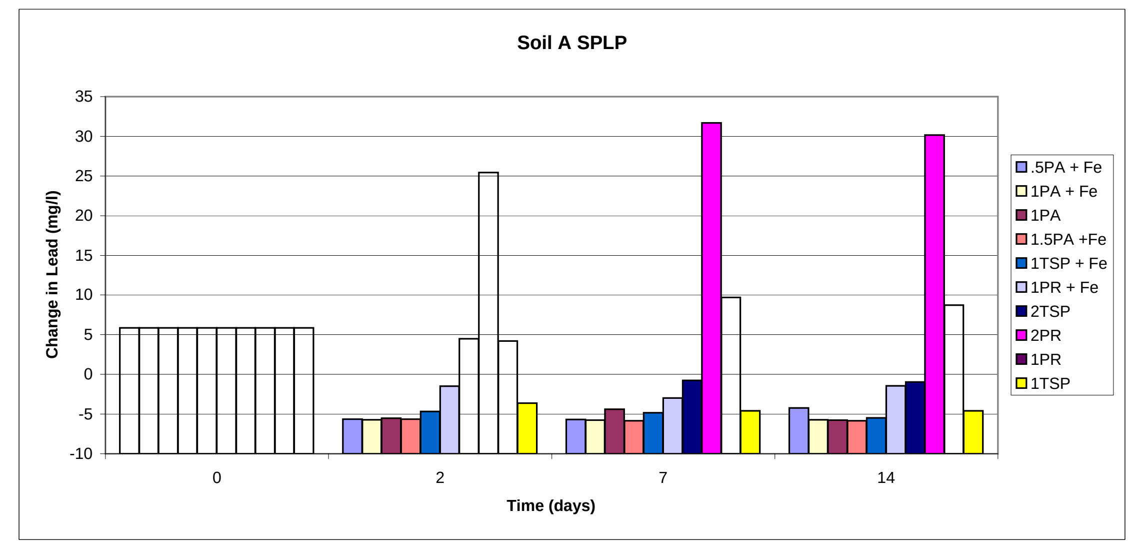
PR leaches Pb
P without Fe leaches As

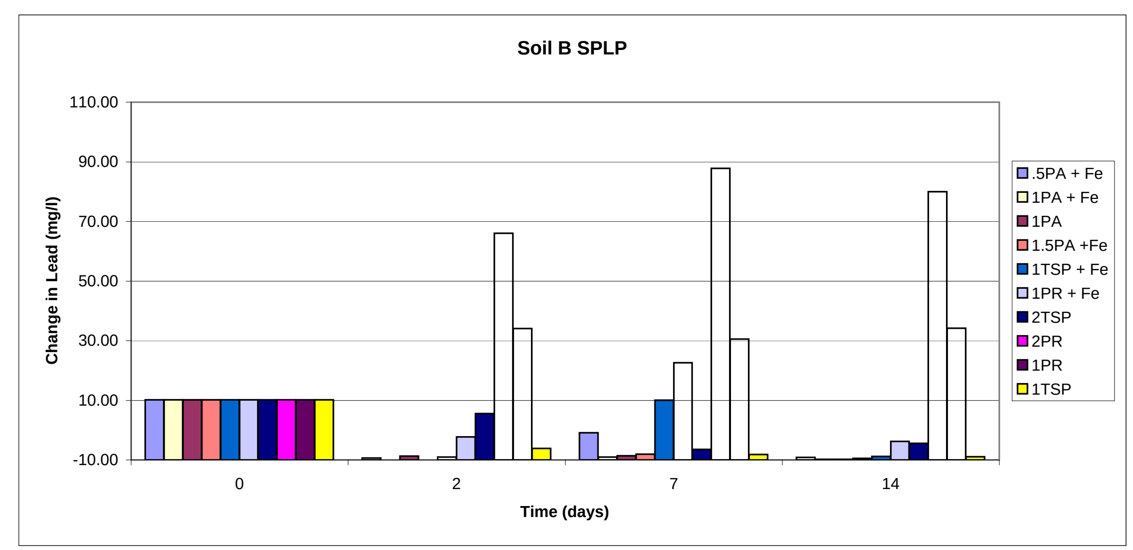
	ppb
Soil A	
A1-2	6.66
A2-2	7.23
A1-7	3.88
A2-7	4.66
A1-14	6.00
A2-14	6.26
D1	6.04
D2	6.03
Average	**5.843516**
Soil B	
B1-2	11.37
B2-2	11.61
B1-7	9.43
B2-7	7.64
B1-14	8.57
B2-14	8.82
D9	10.24
D10	13.20
Average	**10.11053**
Soil C	
C1-2	17.91
C2-2	16.09
C1-7	13.89
C2-7	15.34
C1-14	18.15
C2-14	16.24
D17	43.55
D18	24.58
Average	**20.719**

	Zn ppb	As ppb	Cd ppb	Pb ppb
A1-2	28.41	58.16	0.36	6.66
A2-2	29.23	56.55	0.32	7.23
A1-7	19.52	33.33	0.69	3.88
A2-7	18.46	57.75	0.37	4.66
A1-14	16.10	65.92	0.16	6.00
A2-14	18.93	58.52	0.16	6.26
D-1	19.83	53.79	0.19	6.04
D-2	19.55	55.93	0.16	6.03
Average	**21.25**	**54.99**	**0.30**	**5.84**
B1-2	25.50	42.51	0.26	11.37
B2-2	25.23	41.65	0.24	11.61
B1-7	26.10	44.53	0.91	9.43
B2-7	23.33	41.48	0.30	7.64
B1-14	22.19	40.90	0.25	8.57
B2-14	24.26	39.23	0.26	8.82
D-9	26.03	43.14	0.19	10.24
D-10	27.84	44.19	0.20	13.20
Average	**25.06**	**42.20**	**0.33**	**10.11**
C1-2	14.14	7.25	0.12	17.91
C2-2	12.87	6.51	0.12	16.09
C1-7	12.02	7.29	0.63	13.89

Lead

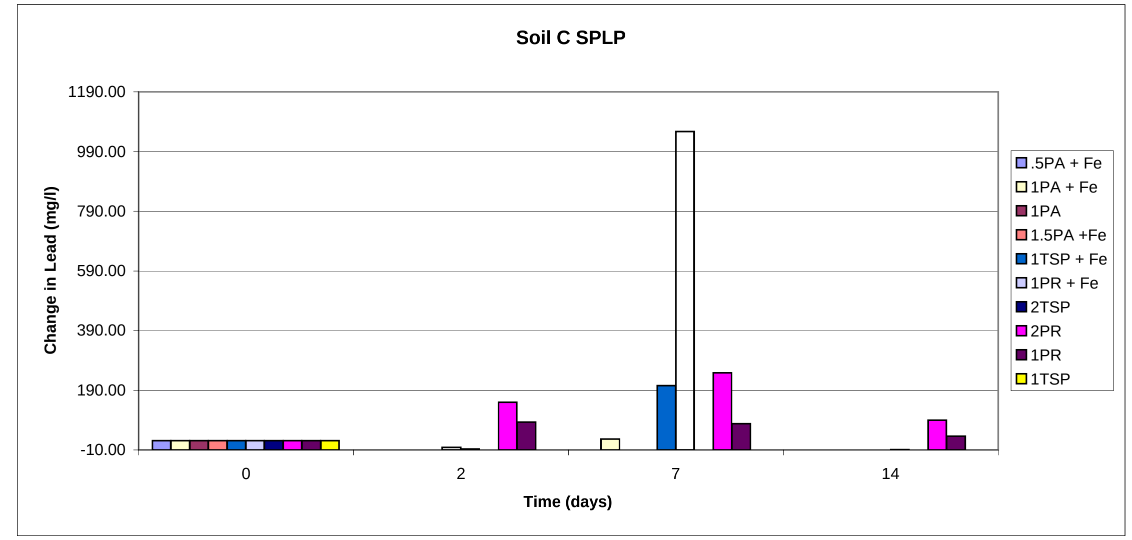
		A				B				C			
		0	2	7	14	0	2	7	14	0	2	7	14
Series 1	.5PA + Fe	**5.843516**	-5.638025	-5.67	-4.24	**10.11**	-9.38	-0.87	-9.10	**20.72**	-18.12	-12.65	-20.04
Series 3	1PA + Fe	**5.843516**	-5.72068	-5.78	-5.73	**10.11**	-10.11	-9.08	-9.74	**20.72**	-20.72	26.93	-20.65
Series 5	1PA	**5.843516**	-5.5359	-4.38	-5.76	**10.11**	-8.71	-8.62	-9.80	**20.72**	-20.63	-20.72	-20.72
Series 7	1.5PA +Fe	**5.843516**	-5.65895	-5.84	-5.84	**10.11**	-10.11	-8.08	-9.46	**20.72**	-20.72	-20.41	-20.68
Series 9	1TSP	**5.843516**	-3.63205	-4.58	-4.61	**10.11**	-6.09	-8.20	-8.90	**20.72**	-19.29	-19.66	-19.38
Series 11	1PR	**5.843516**	4.197415	9.70	8.72	**10.11**	34.03	30.56	34.23	**20.72**	83.81	77.93	36.23
Series 13	1TSP + Fe	**5.843516**	-4.6705	-4.83	-5.47	**10.11**	-9.05	10.02	-8.82	**20.72**	-1.48	205.87	-20.10
Series 15	1PR + Fe	**5.843516**	-1.4768	-2.96	-1.46	**10.11**	-2.32	22.61	-3.79	**20.72**	-7.17	1056.61	-8.99
Series 17	2TSP	**5.843516**	4.4693	-0.78	-0.96	**10.11**	5.53	-6.44	-4.42	**20.72**	-12.13	-10.95	-16.43
Series 19	2PR	**5.843516**	25.4172	31.69	30.18	**10.11**	66.04	87.77	79.95	**20.72**	149.98	248.43	89.60
		0 day	2 day	7 day	14 day		2 day	7 day	14 day		2 day	7 day	14 day





B14-2	44.59	34.48	
B15-2	1.16	-8.95	-9.04755
B16-2	0.96	-9.15	
B17-2	8.10	-2.01	-2.3222
B18-2	7.48	-2.63	
B19-2	9.69	-0.42	5.5318
B20-2	21.59	11.48	
B21-2	74.35	64.24	66.0403
B22-2	77.95	67.84	
B3-7	10.95	0.84	-0.87005
B4-7	7.53	-2.58	
B5-7	1.12	-8.99	-9.079
B6-7	0.94	-9.17	
B7-7	1.95	-8.16	-8.62325
B8-7	1.03	-9.08	
B9-7	0.82	-9.29	-8.0825
B10-7	3.23	-6.88	
B11-7	2.04	-8.07	-8.19875
B12-7	1.78	-8.33	
B13-7	33.61	23.50	30.5575
B14-7	47.73	37.62	
B15-7	17.01	6.90	10.0155
B16-7	23.24	13.13	
B17-7	32.76	22.65	22.6069
B18-7	32.67	22.56	
B19-7	4.11	-6.00	-6.4352
B20-7	3.24	-6.87	
B21-7	83.55	73.44	87.7659
B22-7	112.20	102.09	
B3-14	0.79	-9.32	-9.10004534
B4-14	1.23	-8.88	
B5-14	0.00	-10.11	-9.73893672
B6-14	0.74	-9.37	
B7-14	0.00	-10.11	-9.80332622
B8-14	0.61	-9.50	
B9-14	0.33	-9.78	-9.46201584
B10-14	0.97	-9.14	
B11-14	1.39	-8.72	-8.90043118
B12-14	1.03	-9.08	
B13-14	55.31	45.20	34.23274191
B14-14	33.38	23.27	
B15-14	2.14	-7.97	-8.82147319
B16-14	0.44	-9.67	
B17-14	6.61	-3.50	-3.79329062
B18-14	6.02	-4.09	
B19-14	7.01	-3.10	-4.42227095
B20-14	4.37	-5.74	
B21-14	104.74	94.63	79.95416809
B22-14	75.39	65.28	
C3-2	0.00	-20.72	-18.120691
C4-2	5.20	-15.52	
C5-2	0.00	-20.72	-20.72
C6-2	0.00	-20.72	
C7-2	0.17	-20.55	-20.634617
C8-2	0.00	-20.72	
C9-2	0.00	-20.72	-20.72
C10-2	0.00	-20.72	
C11-2	1.67	-19.05	-19.294406
C12-2	1.18	-19.54	
C13-2	117.65	96.93	83.80978
C14-2	91.41	70.69	
C15-2	1.01	-19.71	-1.475301
C16-2	37.48	16.76	
C17-2	14.34	-6.38	-7.16765
C18-2	12.76	-7.96	
C19-2	9.68	-11.04	-12.13245
C20-2	7.49	-13.23	
C21-2	171.47	150.75	149.97575
C22-2	169.92	149.20	
C3-7	3.45	-17.27	-12.64785
C4-7	12.70	-8.02	
C5-7	94.82	74.10	26.9333
C6-7	0.49	-20.23	
C7-7	0.00	-20.72	-20.72
C8-7	0.00	-20.72	
C9-7	0.34	-20.38	-20.40725

C2-7	12.83	7.60	0.18	15.34
C1-14	11.09	6.85	0.14	18.15
C2-14	12.43	6.98	0.15	16.24
D-17		6.42	0.19	43.55
D-18	14.06	6.05	0.15	24.58
Average	**12.78**	**6.87**	**0.21**	**20.72**
	141.26			



C10-7	0.29	-20.43	
C11-7	1.40	-19.32	-19.6564
C12-7	0.72	-20.00	
C13-7	68.90	48.18	77.9306
C14-7	128.41	107.69	
C15-7	29.33	8.61	205.8726
C16-7	423.86	403.14	
C17-7	1164.01	1143.29	1056.60755
C18-7	990.65	969.93	
C19-7	12.13	-8.59	-10.9525
C20-7	7.41	-13.31	
C21-7	254.11	233.39	248.42595
C22-7	284.18	263.46	

C3-14	0.73	-19.99	-20.0409125
C4-14	0.62	-20.10	
C5-14	0.00	-20.72	-20.6523275
C6-14	0.14	-20.58	
C7-14	0.00	-20.72	-20.72
C8-14	0.00	-20.72	
C9-14	0.00	-20.72	-20.6758955
C10-14	0.09	-20.63	
C11-14	1.35	-19.37	-19.3839696
C12-14	1.32	-19.40	
C13-14	66.35	45.63	36.23203512
C14-14	47.56	26.84	
C15-14	0.78	-19.94	-20.0971487
C16-14	0.46	-20.26	
C17-14	12.13	-8.59	-8.98610003
C18-14	11.34	-9.38	
C19-14	3.71	-17.01	-16.4303768
C20-14	4.87	-15.85	
C21-14	90.75	70.03	89.59660953
C22-14	129.88	109.16	

MDL	As ppb	Change in As	Average Change
	0.073		
A3-2	2.90	-52.10	-38.20507
A4-2	30.69	-24.31	
A5-2	32.63	-22.37	-37.497635
A6-2	2.38	-52.62	
A7-2	176.21	121.21	118.23675
A8-2	170.27	115.27	
A9-2	44.08	-10.92	-10.9545
A10-2	44.01	-10.99	
A11-2	166.76	111.76	126.65775
A12-2	196.55	141.55	
A13-2	48.75	-6.26	-28.4667
A14-2	4.32	-50.68	
A15-2	20.01	-34.99	-35.5422
A16-2	18.91	-36.09	
A17-2	1.58	-53.42	-52.86865
A18-2	2.68	-52.32	
A19-2	321.11	266.11	259.41785
A20-2	307.73	252.73	
A21-2	48.64	-6.36	-8.38905
A22-2	44.59	-10.41	
A3-7	18.75	-36.25	-37.3183
A4-7	16.62	-38.38	
A5-7	13.42	-41.58	-43.75655
A6-7	9.06	-45.94	
A7-7	177.31	122.31	127.6763
A8-7	188.04	133.04	
A9-7	14.54	-40.46	-42.25995
A10-7	10.94	-44.06	
A11-7	185.17	130.17	133.1005
A12-7	191.03	136.03	
A13-7	61.67	6.67	4.2425
A14-7	56.81	1.81	
A15-7	17.04	-37.96	-39.82725
A16-7	13.31	-41.69	
A17-7	1.53	-53.47	-53.6241
A18-7	1.23	-53.77	
A19-7	253.62	198.62	197.06295
A20-7	250.50	195.50	
A21-7	47.69	-7.31	-8.65815
A22-7	44.99	-10.01	
A3-14	14.10	-40.90	-40.0526543
A4-14	15.79	-39.21	
A5-14	33.13	-21.87	-23.837564
A6-14	29.19	-25.81	
A7-14	185.58	130.58	136.4563566
A8-14	197.33	142.33	
A9-14	45.56	-9.44	-9.78899386
A10-14	44.86	-10.14	
A11-14	174.00	119.00	92.93629456
A12-14	121.88	66.88	
A13-14	67.67	12.67	11.33629784
A14-14	65.00	10.00	
A15-14	13.14	-41.86	-42.6761558
A16-14	11.51	-43.49	
A17-14	2.89	-52.11	-51.7537771
A18-14	3.60	-51.40	
A19-14	298.43	243.43	232.2329355
A20-14	276.03	221.03	
A21-14	54.90	-0.10	-5.59694005
A22-14	43.91	-11.09	
B3-2	19.93	-22.07	-20.146
B4-2	23.78	-18.22	
B5-2	23.49	-18.51	-17.7479
B6-2	25.02	-16.98	
B7-2	165.48	123.48	133.3472
B8-2	185.22	143.22	
B9-2	37.40	-4.60	-10.0236
B10-2	26.55	-15.45	
B11-2	177.25	135.25	133.6462
B12-2	174.04	132.04	
B13-2	47.16	5.16	5.1944

As Concentrations

Controls

	ppb
Soil A	
A1-2	58.16
A2-2	56.55
A1-7	33.33
A2-7	57.75
A1-14	65.92
A2-14	58.52
D1	53.79
D2	55.93
Average	**54.99292**
Soil B	
B1-2	42.51
B2-2	41.65
B1-7	44.53
B2-7	41.48
B1-14	40.90
B2-14	39.23
D9	43.14
D10	44.19
Average	**42.20394**
Soil C	
C1-2	7.25
C2-2	6.51
C1-7	7.29
C2-7	7.60
C1-14	6.85
C2-14	6.98
D17	6.42
D18	6.05
Average	**6.868433**

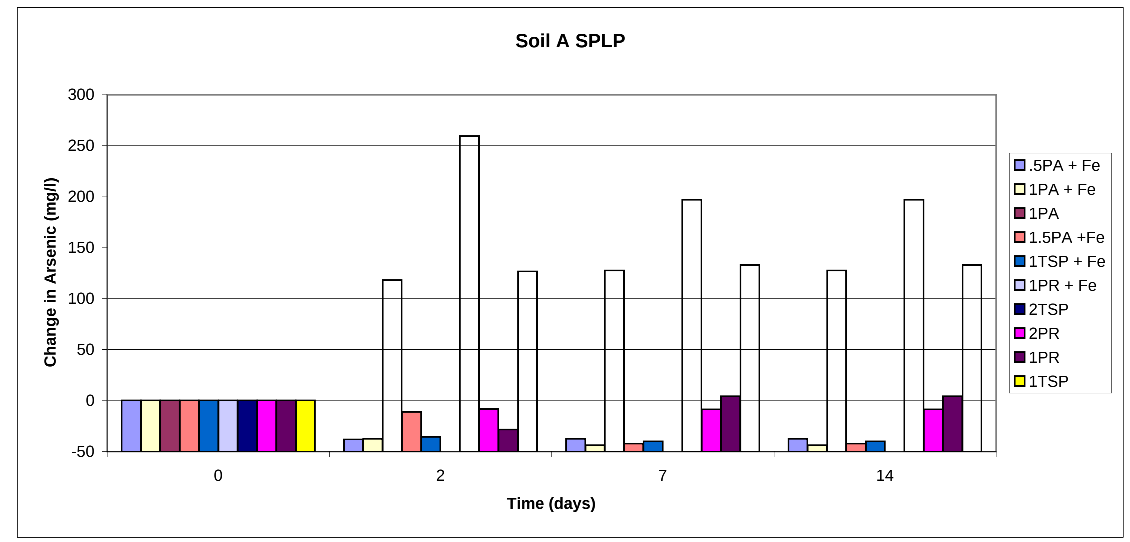
TSP leaches a lot of P

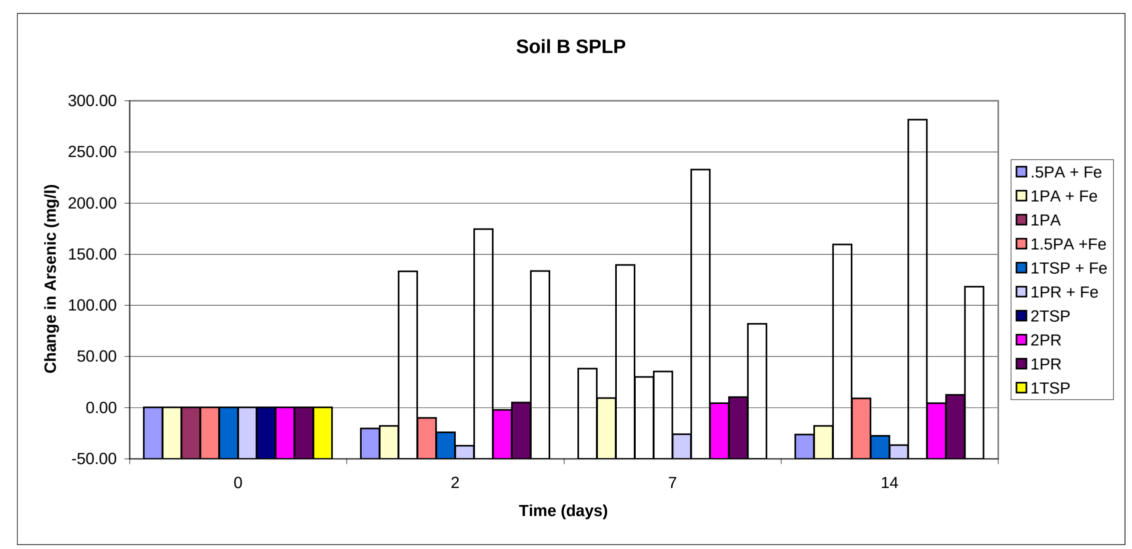
PR leaches Pb
P without Fe leaches As

	Zn ppb	As ppb	Cd ppb	Pb ppb
A1-2	28.41	58.16	0.36	6.66
A2-2	29.23	56.55	0.32	7.23
A1-7	19.52	33.33	0.69	3.88
A2-7	18.46	57.75	0.37	4.66
A1-14	16.10	65.92	0.16	6.00
A2-14	18.93	58.52	0.16	6.26
D-1	19.83	53.79	0.19	6.04
D-2	19.55	55.93	0.16	6.03
Average	**21.25**	**54.99**	**0.30**	**5.84**
B1-2	25.50	42.51	0.26	11.37
B2-2	25.23	41.65	0.24	11.61
B1-7	26.10	44.53	0.91	9.43
B2-7	23.33	41.48	0.30	7.64
B1-14	22.19	40.90	0.25	8.57
B2-14	24.26	39.23	0.26	8.82
D-9	26.03	43.14	0.19	10.24
D-10	27.84	44.19	0.20	13.20
Average	**25.06**	**42.20**	**0.33**	**10.11**
C1-2	14.14	7.25	0.12	17.91
C2-2	12.87	6.51	0.12	16.09
C1-7	12.02	7.29	0.63	13.89

Arsenic

		A				B				C		
		0	2	7	14	0	2	7	14	0	2	7
Series 1	.5PA + Fe	**0.301482**	-38.20507	-37.32	-37.32	**0.33**	-20.15	38.13	-26.15	**0.21**	-2.04	16.71
Series 3	1PA + Fe	**0.301482**	-37.497635	-43.76	-43.76	**0.33**	-17.75	9.53	-17.72	**0.21**	0.18	16.61
Series 5	1PA	**0.301482**	118.23675	127.68	127.68	**0.33**	133.35	139.68	159.57	**0.21**	38.45	31.73
Series 7	1.5PA +Fe	**0.301482**	-10.9545	-42.26	-42.26	**0.33**	-10.02	29.97	9.14	**0.21**	1.37	19.49
Series 9	1TSP	**0.301482**	126.65775	133.10	133.10	**0.33**	133.65	82.08	118.29	**0.21**	35.74	28.88
Series 11	1PR	**0.301482**	-28.4667	4.24	4.24	**0.33**	5.19	10.29	12.62	**0.21**	1.99	4.18
Series 13	1TSP + Fe	**0.301482**	-35.5422	-39.83	-39.83	**0.33**	-24.15	35.38	-27.44	**0.21**	-1.55	23.53
Series 15	1PR + Fe	**0.301482**	-52.86865	-53.62	-53.62	**0.33**	-37.05	-25.86	-36.49	**0.21**	-6.90	9.45
Series 17	2TSP	**0.301482**	259.41785	197.06	197.06	**0.33**	174.63	232.60	281.39	**0.21**	43.35	51.03
Series 19	2PR	**0.301482**	-8.38905	-8.66	-8.66	**0.33**	-2.02	4.45	4.48	**0.21**	1.69	1.78
		0 day	2 day	7 day	14 day		2 day	7 day	14 day		2 day	7 day





B14-2	47.23	5.23	
B15-2	17.05	-24.95	-24.15405
B16-2	18.64	-23.36	
B17-2	5.48	-36.52	-37.05285
B18-2	4.41	-37.59	
B19-2	220.51	178.51	174.6254
B20-2	212.74	170.74	
B21-2	41.07	-0.93	-2.0216
B22-2	38.89	-3.11	

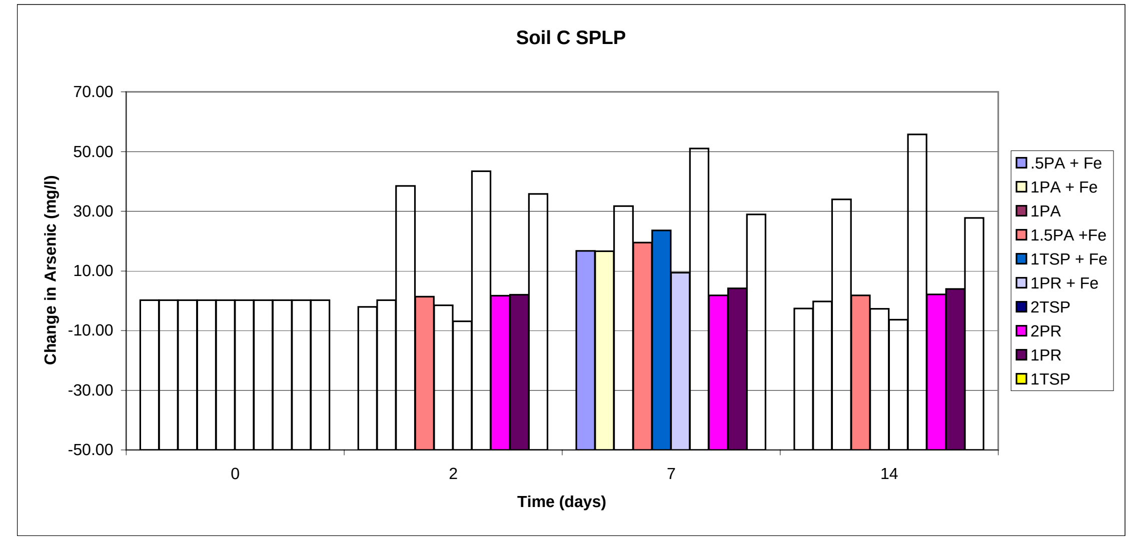
B3-7	81.98	39.98	38.12515
B4-7	78.27	36.27	
B5-7	51.81	9.81	9.53215
B6-7	51.26	9.26	
B7-7	193.97	151.97	139.68205
B8-7	169.39	127.39	
B9-7	73.95	31.95	29.9664
B10-7	69.98	27.98	
B11-7	105.94	63.94	82.07875
B12-7	142.22	100.22	
B13-7	54.26	12.26	10.2948
B14-7	50.33	8.33	
B15-7	76.62	34.62	35.38155
B16-7	78.15	36.15	
B17-7	17.22	-24.78	-25.86225
B18-7	15.06	-26.94	
B19-7	269.40	227.40	232.5999
B20-7	279.80	237.80	
B21-7	46.33	4.33	4.4496
B22-7	46.57	4.57	

B3-14	15.08	-26.92	-26.1497182
B4-14	16.62	-25.38	
B5-14	21.78	-20.22	-17.7225898
B6-14	26.78	-15.22	
B7-14	179.38	137.38	159.5669459
B8-14	223.75	181.75	
B9-14	61.38	19.38	9.13858619
B10-14	40.90	-1.10	
B11-14	161.02	119.02	118.2892487
B12-14	159.56	117.56	
B13-14	52.47	10.47	12.61759653
B14-14	56.77	14.77	
B15-14	16.84	-25.16	-27.4356743
B16-14	12.28	-29.72	
B17-14	6.12	-35.88	-36.4902164
B18-14	4.90	-37.10	
B19-14	336.71	294.71	281.3946014
B20-14	310.08	268.08	
B21-14	48.27	6.27	4.483235161
B22-14	44.70	2.70	

C3-2	4.05	-2.85	-2.0410898
C4-2	5.67	-1.23	
C5-2	7.13	0.23	0.1835712
C6-2	7.04	0.14	
C7-2	47.25	40.35	38.4471744
C8-2	43.44	36.54	
C9-2	7.80	0.90	1.3684416
C10-2	8.74	1.84	
C11-2	40.87	33.97	35.7435584
C12-2	44.42	37.52	
C13-2	9.36	2.46	1.9879104
C14-2	8.42	1.52	
C15-2	5.34	-1.56	-1.5461452
C16-2	5.37	-1.53	
C17-2	0.00	-6.90	-6.9
C18-2	0.00	-6.90	
C19-2	53.38	46.48	43.35455
C20-2	47.13	40.23	
C21-2	8.87	1.97	1.69225
C22-2	8.31	1.41	

C3-7	20.42	13.52	16.7067
C4-7	26.80	19.90	
C5-7	23.58	16.68	16.6113
C6-7	23.44	16.54	
C7-7	35.55	28.65	31.73305
C8-7	41.71	34.81	
C9-7	30.08	23.18	19.4915

C2-7	12.83	7.60	0.18	15.34
C1-14	11.09	6.85	0.14	18.15
C2-14	12.43	6.98	0.15	16.24
D-17		6.42	0.19	43.55
D-18	14.06	6.05	0.15	24.58
Average	**12.78**	**6.87**	**0.21**	**20.72**
	141.26			



C10-7	22.70	15.80	
C11-7	39.58	32.68	28.8822
C12-7	31.99	25.09	
C13-7	10.89	3.99	4.1766
C14-7	11.27	4.37	
C15-7	27.53	20.63	23.5275
C16-7	33.33	26.43	
C17-7	15.33	8.43	9.44615
C18-7	17.36	10.46	
C19-7	57.47	50.57	51.03455
C20-7	58.40	51.50	
C21-7	8.28	1.38	1.7758
C22-7	9.07	2.17	

C3-14	4.02	-2.88	-2.57684192
C4-14	4.63	-2.27	
C5-14	5.23	-1.67	-0.19718147
C6-14	8.18	1.28	
C7-14	40.24	33.34	33.93622787
C8-14	41.43	34.53	
C9-14	7.85	0.95	1.800762449
C10-14	9.55	2.65	
C11-14	34.19	27.29	27.71721365
C12-14	35.04	28.14	
C13-14	11.46	4.56	3.902684587
C14-14	10.15	3.25	
C15-14	4.09	-2.81	-2.66877487
C16-14	4.37	-2.53	
C17-14	0.00	-6.90	-6.32192737
C18-14	1.16	-5.74	
C19-14	70.07	63.17	55.76947272
C20-14	55.27	48.37	
C21-14	8.03	1.13	2.156717484
C22-14	10.09	3.19	

MDL	P ppm	Change in P	Average Change
	0.073		
A3-2	4.498	3.56575	2.89175
A4-2	3.15	2.21775	
A5-2	8.333	7.40075	6.58775
A6-2	6.707	5.77475	
A7-2	25.653	24.72075	23.16875
A8-2	22.549	21.61675	
A9-2	15.08	14.14775	13.46825
A10-2	13.721	12.78875	
A11-2	28.809	27.87675	36.36225
A12-2	45.78	44.84775	
A13-2	0.624	-0.30825	-0.25925
A14-2	0.722	-0.21025	
A15-2	8.562	7.62975	8.28775
A16-2	9.878	8.94575	
A17-2	0.225	-0.70725	-0.72925
A18-2	0.181	-0.75125	
A19-2	240.21	239.27775	237.04225
A20-2	235.739	234.80675	
A21-2	0.864	-0.06825	-0.12325
A22-2	0.754	-0.17825	
A3-7	2.285	1.35275	1.64475
A4-7	2.869	1.93675	
A5-7	3.052	2.11975	1.12875
A6-7	1.07	0.13775	
A7-7	38.323	37.39075	38.83475
A8-7	41.211	40.27875	
A9-7	2.109	1.17675	0.86475
A10-7	1.485	0.55275	
A11-7	22.834	21.90175	24.76825
A12-7	28.567	27.63475	
A13-7	0.761	-0.17125	-0.14725
A14-7	0.809	-0.12325	
A15-7	5.464	4.53175	5.50475
A16-7	7.41	6.47775	
A17-7	0.12	-0.81225	-0.81675
A18-7	0.111	-0.82125	
A19-7	113.963	113.03075	105.12275
A20-7	98.147	97.21475	
A21-7	0.762	-0.17025	-0.19525
A22-7	0.712	-0.22025	
A3-14	1.508	0.57575	0.63775
A4-14	1.632	0.69975	
A5-14	10.348	9.41575	6.69575
A6-14	4.908	3.97575	
A7-14	19.103	18.17075	18.48375
A8-14	19.729	18.79675	
A9-14	16.233	15.30075	15.34075
A10-14	16.313	15.38075	
A11-14	11.817	10.88475	6.66475
A12-14	3.377	2.44475	
A13-14	0.771	-0.16125	-0.18825
A14-14	0.717	-0.21525	
A15-14	3.578	2.64575	2.23575
A16-14	2.758	1.82575	
A17-14	0.21	-0.72225	-0.73025
A18-14	0.194	-0.73825	
A19-14	59.574	58.64175	54.82125
A20-14	51.933	51.00075	
A21-14	0.736	-0.19625	-0.28225
A22-14	0.564	-0.36825	
B3-2	2.455	1.74575	1.86775
B4-2	2.699	1.98975	
B5-2	8.396	7.68675	7.51275
B6-2	8.048	7.33875	
B7-2	26.194	25.48475	25.10725
B8-2	25.439	24.72975	
B9-2	20.375	19.66575	15.72725
B10-2	12.498	11.78875	
B11-2	31.159	30.44975	30.99675
B12-2	32.253	31.54375	
B13-2	0.719	0.00975	0.01275

P Concentrations

Controls

	ppm
Soil A	
A1-14	1.036
A2-14	0.915
A1-2	1.02
A2-2	0.986
A1-7	0.649
A2-7	0.906
Average	**0.918667**
Stdev	**0.142452**
Soil B	
B1-14	0.688
B2-14	0.652
B1-2	0.711
B2-2	0.68
B1-7	0.73
B2-7	0.668
Average	**0.688167**
Stdev	**0.02847**
Soil C	
C1-14	0.283
C2-14	0.295
C1-2	0.298
C2-2	0.309
C1-7	0.359
C2-7	0.37
Average	**0.319**
Stdev	**0.03637**

TSP leaches a lot of P

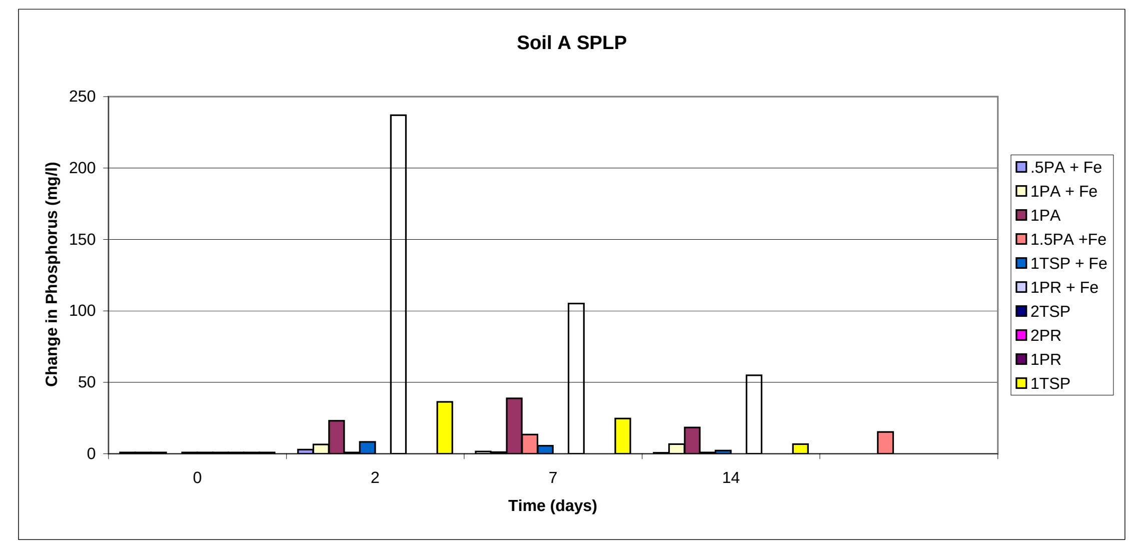
PR leaches Pb

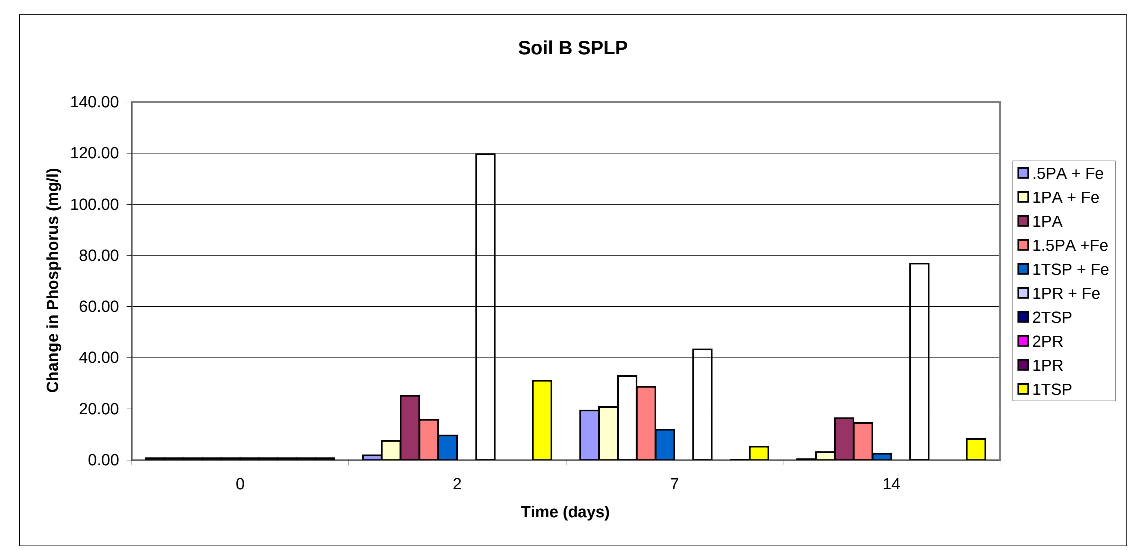
P without Fe leaches As

	Zn ppb	As ppb	Cd ppb	Pb ppb
A1-2	28.41	58.16	0.36	6.66
A2-2	29.23	56.55	0.32	7.23
A1-7	19.52	33.33	0.69	3.88
A2-7	18.46	57.75	0.37	4.66
A1-14	16.10	65.92	0.16	6.00
A2-14	18.93	58.52	0.16	6.26
D-1	19.83	53.79	0.19	6.04
D-2	19.55	55.93	0.16	6.03
Average	**21.25**	**54.99**	**0.30**	**5.84**
B1-2	25.50	42.51	0.26	11.37
B2-2	25.23	41.65	0.24	11.61
B1-7	26.10	44.53	0.91	9.43
B2-7	23.33	41.48	0.30	7.64
B1-14	22.19	40.90	0.25	8.57
B2-14	24.26	39.23	0.26	8.82
D-9	26.03	43.14	0.19	10.24
D-10	27.84	44.19	0.20	13.20
Average	**25.06**	**42.20**	**0.33**	**10.11**
C1-2	14.14	7.25	0.12	17.91
C2-2	12.87	6.51	0.12	16.09
C1-7	12.02	7.29	0.63	13.89

Phosphorous

		A				B				C			
		0	2	7	14	0	2	7	14	0	2	7	14
Series 1	.5PA + Fe	**0.93225**	2.89175	1.64	0.64	**0.71**	1.87	19.35	0.43	**0.32**	2.16	7.42	0.54
Series 3	1PA + Fe	**0.93225**	6.58775	1.13	6.70	**0.71**	7.51	20.82	3.19	**0.32**	6.02	20.80	2.71
Series 5	1PA	**0.93225**	23.16875	38.83	18.48	**0.71**	25.11	32.91	16.39	**0.32**	28.45	9.39	11.20
Series 7	1.5PA +Fe	**0.93225**	13.46825	0.86	15.34	**0.71**	15.73	28.70	14.47	**0.32**	9.57	30.09	4.80
Series 9	1TSP	**0.93225**	36.36225	24.77	6.66	**0.71**	31.00	5.22	8.28	**0.32**	37.78	9.19	6.84
Series 11	1PR	**0.93225**	-0.25925	-0.15	-0.19	**0.71**	0.01	0.07	-0.06	**0.32**	0.06	0.11	0.03
Series 13	1TSP + Fe	**0.93225**	8.28775	5.50	2.24	**0.71**	9.65	11.84	2.48	**0.32**	7.19	13.34	1.47
Series 15	1PR + Fe	**0.93225**	-0.72925	-0.82	-0.73	**0.71**	-0.50	-0.03	-0.53	**0.32**	-0.21	1.91	-0.22
Series 17	2TSP	**0.93225**	237.04225	105.12	54.82	**0.71**	119.62	43.30	76.81	**0.32**	106.15	25.64	70.64
Series 19	2PR	**0.93225**	-0.12325	-0.20	-0.28	**0.71**	0.00	0.01	-0.08	**0.32**	0.12	0.07	0.01
		0 day	2 day	7 day	14 day		2 day	7 day	14 day		2 day	7 day	14 day





B14-2	0.725	0.01575	
B15-2	8.322	7.61275	9.64675
B16-2	12.39	11.68075	
B17-2	0.197	-0.51225	-0.49825
B18-2	0.225	-0.48425	
B19-2	118.67	117.96075	119.61625
B20-2	121.981	121.27175	
B21-2	0.732	0.02275	-0.00075
B22-2	0.685	-0.02425	

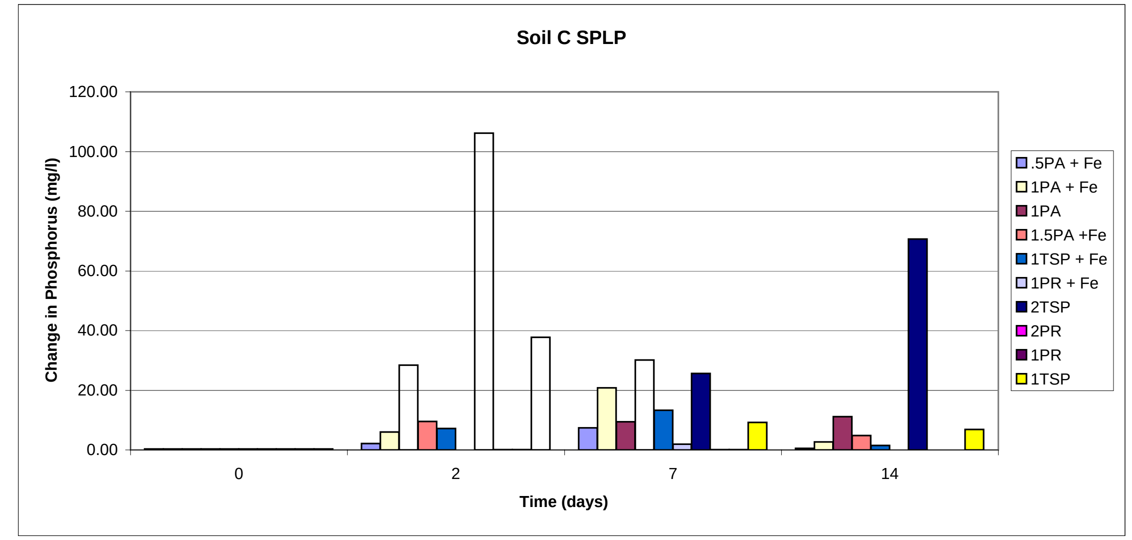
B3-7	23.816	23.10675	19.35125
B4-7	16.305	15.59575	
B5-7	24.184	23.47475	20.82325
B6-7	18.881	18.17175	
B7-7	37.428	36.71875	32.91425
B8-7	29.819	29.10975	
B9-7	45.264	44.55475	28.69925
B10-7	13.553	12.84375	
B11-7	3.516	2.80675	5.21725
B12-7	8.337	7.62775	
B13-7	0.817	0.10775	0.06525
B14-7	0.732	0.02275	
B15-7	13.258	12.54875	11.84225
B16-7	11.845	11.13575	
B17-7	0.694	-0.01525	-0.02625
B18-7	0.672	-0.03725	
B19-7	46.641	45.93175	43.29525
B20-7	41.368	40.65875	
B21-7	0.707	-0.00225	0.01175
B22-7	0.735	0.02575	

B3-14	0.962	0.25275	0.42525
B4-14	1.307	0.59775	
B5-14	2.989	2.27975	3.18775
B6-14	4.805	4.09575	
B7-14	13.077	12.36775	16.39225
B8-14	21.126	20.41675	
B9-14	19.151	18.44175	14.46625
B10-14	11.2	10.49075	
B11-14	8.904	8.19475	8.28075
B12-14	9.076	8.36675	
B13-14	0.661	-0.04825	-0.06025
B14-14	0.637	-0.07225	
B15-14	4.094	3.38475	2.48225
B16-14	2.289	1.57975	
B17-14	0.161	-0.54825	-0.53175
B18-14	0.194	-0.51525	
B19-14	89.257	88.54775	76.80625
B20-14	65.774	65.06475	
B21-14	0.629	-0.08025	-0.07625
B22-14	0.637	-0.07225	

C3-2	2.275	1.95575	2.15525
C4-2	2.674	2.35475	
C5-2	6.868	6.54875	6.01825
C6-2	5.807	5.48775	
C7-2	28.356	28.03675	28.44875
C8-2	29.18	28.86075	
C9-2	7.973	7.65375	9.56575
C10-2	11.797	11.47775	
C11-2	38.237	37.91775	37.77525
C12-2	37.952	37.63275	
C13-2	0.402	0.08275	0.06425
C14-2	0.365	0.04575	
C15-2	6.668	6.34875	7.18675
C16-2	8.344	8.02475	
C17-2	0.102	-0.21725	-0.21425
C18-2	0.108	-0.21125	
C19-2	119.842	119.52275	106.15275
C20-2	93.102	92.78275	
C21-2	0.445	0.12575	0.12075
C22-2	0.435	0.11575	

C3-7	6.252	5.93275	7.42275
C4-7	9.232	8.91275	
C5-7	23.203	22.88375	20.79975
C6-7	19.035	18.71575	
C7-7	7.579	7.25975	9.39425
C8-7	11.848	11.52875	
C9-7	35.21	34.89075	30.09025

C2-7	12.83	7.60	0.18	15.34
C1-14	11.09	6.85	0.14	18.15
C2-14	12.43	6.98	0.15	16.24
D-17		6.42	0.19	43.55
D-18	14.06	6.05	0.15	24.58
Average	**12.78**	**6.87**	**0.21**	**20.72**
	141.26			



C10-7	25.609	25.28975	
C11-7	10.883	10.56375	9.18975
C12-7	8.135	7.81575	
C13-7	0.415	0.09575	0.11325
C14-7	0.45	0.13075	
C15-7	12.767	12.44775	13.34475
C16-7	14.561	14.24175	
C17-7	2.266	1.94675	1.90675
C18-7	2.186	1.86675	
C19-7	25.994	25.67475	25.63825
C20-7	25.921	25.60175	
C21-7	0.401	0.08175	0.07325
C22-7	0.384	0.06475	

C3-14	0.862	0.54275	0.53825
C4-14	0.853	0.53375	
C5-14	2.464	2.14475	2.70775
C6-14	3.59	3.27075	
C7-14	10.711	10.39175	11.20225
C8-14	12.332	12.01275	
C9-14	5.029	4.70975	4.80075
C10-14	5.211	4.89175	
C11-14	7.417	7.09775	6.84275
C12-14	6.907	6.58775	
C13-14	0.373	0.05375	0.03075
C14-14	0.327	0.00775	
C15-14	1.258	0.93875	1.46975
C16-14	2.32	2.00075	
C17-14	0.085	-0.23425	-0.22075
C18-14	0.112	-0.20725	
C19-14	57.335	57.01575	70.63575
C20-14	84.575	84.25575	
C21-14	0.306	-0.01325	0.00775
C22-14	0.348	0.02875	

In Vitro-Pb pH1.5

	%IVBA	Change in IVBA	Average Change
A-3-2 1.5	81.4	1.9	3.7
A-4-2 1.5	85.1	5.6	
A-5-2 1.5	77.5	-2.0	1.7
A-6-2 1.5	85.0	5.4	
A-7-2 1.5	90.6	11.1	11.1
A-8-2 1.5	90.6	11.1	
A-9-2 1.5	82.2	2.7	2.1
A-10-2 1.5	81.1	1.5	
A-11-2 1.5	88.4	8.8	7.7
A-12-2 1.5	86.1	6.6	
A-13-2 1.5	93.8	14.3	10.8
A-14-2 1.5	86.8	7.3	
A-15-2 1.5	85.7	6.2	3.9
A-16-2 1.5	81.1	1.6	
A-17-2 1.5	82.0	2.5	2.5
A-18-2 1.5	82.0	2.5	
A-19-2 1.5	88.9	9.4	10.5
A-20-2 1.5	91.1	11.6	
A-21-2 1.5	85.9	6.4	7
A-22-2 1.5	87.2	7.6	
A3-7 1.5	88.8	9.2	5.9
A4-7 1.5	82.2	2.6	
A5-7 1.5	82.8	3.3	1.6
A6-7 1.5	79.4	-0.1	
A7-7 1.5	86.0	6.5	7
A8-7 1.5	87.2	7.6	
A9-7 1.5	79.0	-0.5	-0.5
A10-7 1.5	79.0	-0.5	
A11-7 1.5	87.7	8.2	8.3
A12-7 1.5	88.0	8.5	
A13-7 1.5	88.7	9.1	5.8
A14-7 1.5	82.0	2.5	
A15-7 1.5	84.1	4.6	4.6
A16-7 1.5			
A17-7 1.5	87.3	7.8	4.6
A18-7 1.5	81.0	1.5	
A19-7 1.5	81.2	1.7	4.3
A20-7 1.5	86.5	6.9	
A21-7 1.5	89.4	9.9	8.3
A22-7 1.5	86.2	6.7	
A3-14 1.5	80.2	0.6	-2
A4-14 1.5	74.8	-4.7	
A5-14 1.5	73.1	-6.4	-7.2
A6-14 1.5	71.5	-8.0	
A7-14 1.5	72.6	-6.9	-3.3
A8-14 1.5	79.8	0.3	
A9-14 1.5	60.4	-19.1	-20.3
A10-14 1.5	57.9	-21.6	
A11-14 1.5	74.3	-5.3	-3.2
A12-14 1.5	78.3	-1.2	
A13-14 1.5	79.6	0.1	0.75
A14-14 1.5	80.9	1.4	
A15-14 1.5	76.7	-2.9	-1.4
A16-14 1.5	79.6	0.1	
A17-14 1.5	76.8	-2.7	-0.75
A18-14 1.5	80.8	1.2	
A19-14 1.5	80.3	0.8	-1.6
A20-14 1.5	75.4	-4.1	
A21-14 1.5	79.9	0.4	-0.45
A22-14 1.5	78.2	-1.3	

93205 400-800ppm Pb

Controls

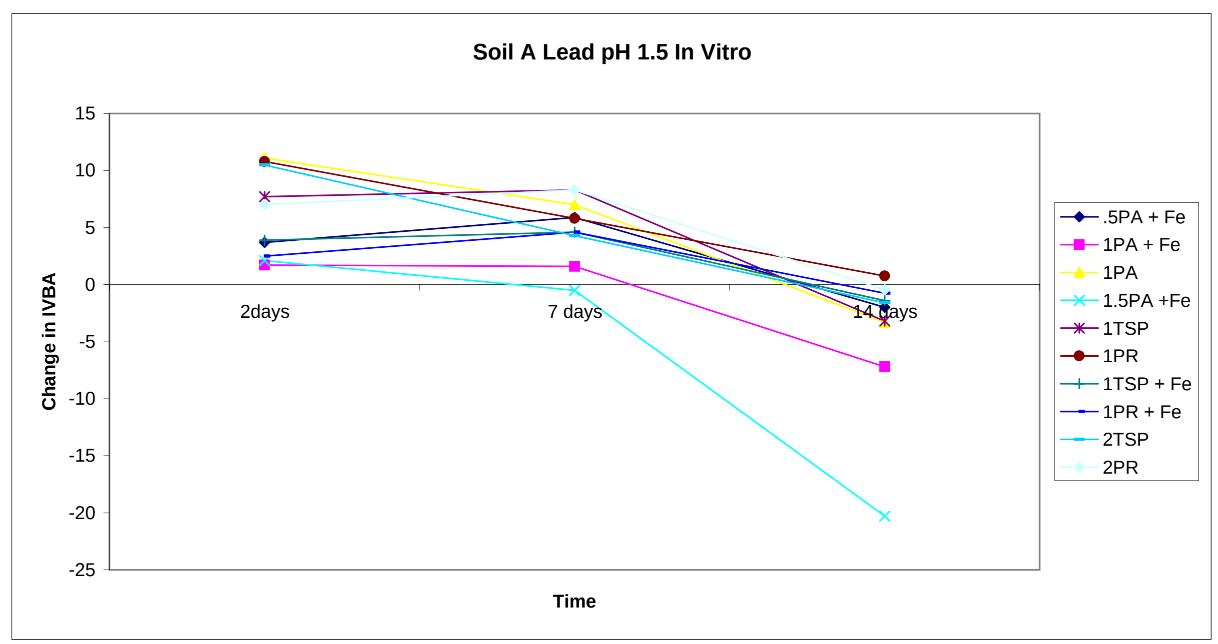
In Vitro-Pb pH1.5

A-1-2 1.5	83.5
A-2-2 1.5	80.6
A1-7 1.5	82.6
A2-7 1.5	77.8
A1-14 1.5	76.8
A2-14 1.5	76.9
D-1 1.5	79.4
D-2 1.5	78.7
Average	**79.5**
Standard Dev.	**2.530773**

In Vitro-Pb pH 2.5

A1-2 2.5	42.0
A2-2 2.5	42.9
A1-7 2.5	37.6
A2-7 2.5	36.9
A1-14 2.5	43
A2-14 2.5	41
D-1	40.3
D-2	40.3
Average	**40.5**
Standard Dev.	**2.246352**

	pH 1.5			pH 2.5		
.5PA + Fe	3.7	5.9	-2	-3.7	-7.8	-2
1PA + Fe	1.7	1.6	-7.2	-15.4	-17.4	-14.4
1PA	11.1	7	-3.3	-12.8	-22	-15.4
1.5PA +Fe	2.1	-0.5	-20.3	-22.8	-24	-26
1TSP	7.7	8.3	-3.2	3	-0.25	2.5
1PR	10.8	5.8	0.75	7.8	0.8	5.35
1TSP + Fe	3.9	4.6	-1.4	-2.9	-2.2	0.2
1PR + Fe	2.5	4.6	-0.75	-2	-3.3	2.3
2TSP	10.5	4.3	-1.6	2.8	-1.2	-0.5
2PR	7	8.3	-0.45	7.6	2	2.7
	2days	7 days	14 days			

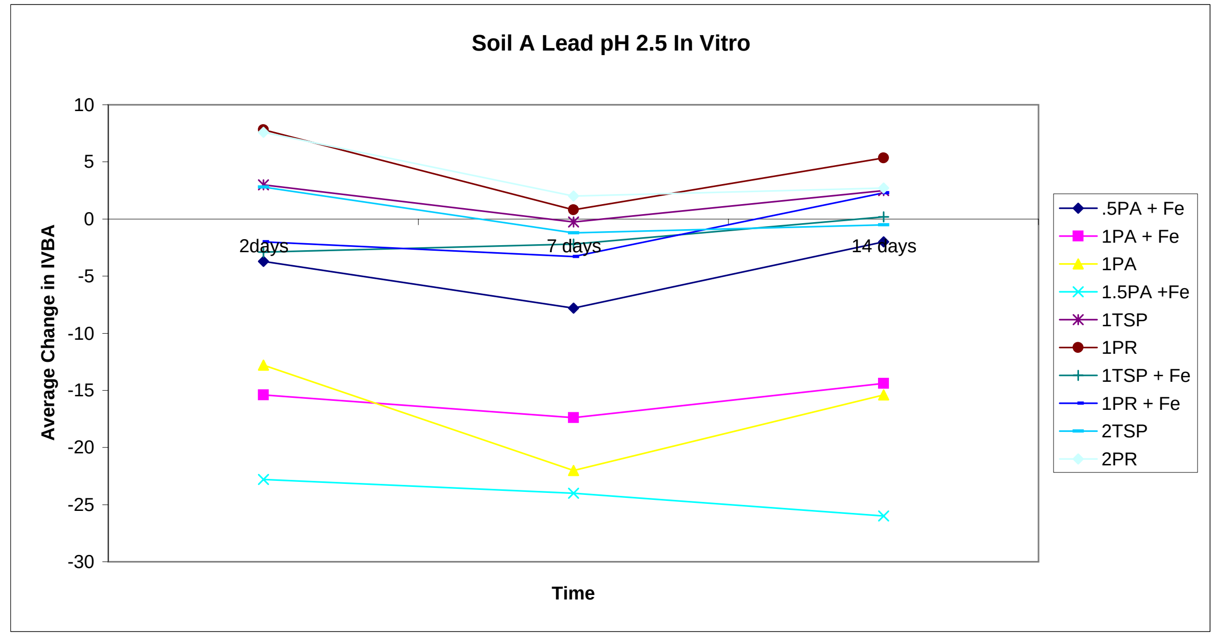


In Vitro-Pb pH 2.5

A3-2 2.5	36.9	-3.5	-3.7
A4-2 2.5	36.5	-3.9	
A5-2 2.5	25.8	-14.6	-15.4
A6-2 2.5	24.4	-16.1	
A7-2 2.5	28.4	-12.1	-12.8
A8-2 2.5	27.1	-13.4	
A9-2 2.5	18.0	-22.4	-22.8
A10-2 2.5	17.2	-23.3	
A11-2 2.5	42.7	2.3	3
A12-2 2.5	44.2	3.7	
A13-2 2.5	48.8	8.3	7.8
A14-2 2.5	47.8	7.3	
A15-2 2.5	38.2	-2.2	-2.9
A16-2 2.5	37.0	-3.5	
A17-2 2.5	38.0	-2.5	-2
A18-2 2.5	39.1	-1.4	
A-19-2 2.5	36.3	-4.1	2.8
A-20-2 2.5	38.9	-1.5	
A-21-2 2.5	46.9	6.4	7.6
A-22-2 2.5	49.3	8.8	

A3-7 2.5	34.8	-5.6	-7.8
A4-7 2.5	30.4	-10.1	
A5-7 2.5	22.1	-18.4	-17.4
A6-7 2.5	24.0	-16.5	
A7-7 2.5	19.6	-20.9	-22
A8-7 2.5	17.3	-23.1	
A9-7 2.5	15.2	-25.3	-24
A10-7 2.5	17.5	-23.0	
A11-7 2.5	40.4	-0.1	-0.25
A12-7 2.5	40.0	-0.4	
A13-7 2.5	43.1	2.7	0.8
A14-7 2.5	39.4	-1.1	
A15-7 2.5	37.1	-3.4	-2.2
A16-7 2.5	37.8	-2.7	
A17-7 2.5	37.3	-3.1	-3.3
A18-7 2.5	36.8	-3.7	
A19-7 2.5	38.8	-1.7	-1.2
A20-7 2.5	39.9	-0.6	
A21-7 2.5	45.1	4.7	2
A22-7 2.5	43.6	3.1	

A3-14 2.5	37	-3.1	-2
A4-14 2.5	39	-1.0	
A5-14 2.5	25	-15.0	-14.4
A6-14 2.5	27	-13.8	
A7-14 2.5	22	-18.0	-15.4
A8-14 2.5	28	-12.9	
A9-14 2.5	14	-26.9	-26
A10-14 2.5	15	-25.1	
A11-14 2.5	42	1.6	2.5
A12-14 2.5	44	3.4	
A13-14 2.5	46	5.4	5.35
A14-14 2.5	46	5.3	
A15-14 2.5	40	-0.6	0.2
A16-14 2.5	41	1.0	
A17-14 2.5	43	2.5	2.3
A18-14 2.5	43	2.1	
A19-14 2.5	41	0.3	-0.5
A20-14 2.5	39	-1.3	
A21-14 2.5	45	4.5	2.7
A22-14 2.5	41	0.9	



In Vitro-Pb pH 1.5

	%IVBA	Change in IVBA	Average Change
B-3-2 1.5	82.5	-3.2	-2.3
B-4-2 1.5	84.2	-1.5	
B-5-2 1.5	85.8	0.1	-2.5
B-6-2 1.5	80.6	-5.1	
B-7-2 1.5	88.5	2.8	0.65
B-8-2 1.5	84.2	-1.5	
B-9-2 1.5	78.1	-7.6	-6.4
B-10-2 1.5	80.5	-5.2	
B-11-2 1.5	85.0	-0.7	1.1
B-12-2 1.5	88.7	3.0	
B-13-2 1.5	85.7	0.0	2.5
B-14-2 1.5	90.6	4.9	
B-15-2 1.5	87.0	1.3	-0.75
B-16-2 1.5	82.9	-2.8	
B-17-2 1.5	86.8	1.1	0.6
B-18-2 1.5	85.8	0.1	
B-19-2 1.5	90.2	4.5	0.85
B-20-2 1.5	82.9	-2.8	
B-21-2 1.5	89.2	3.4	3.3
B-22-2 1.5	88.9	3.2	
B3-7 1.5	83.6	-2.1	-1.1
B4-7 1.5	85.7	0.0	
B5-7 1.5	80.6	-5.1	-4.2
B6-7 1.5	82.4	-3.3	
B7-7 1.5	84.7	-1.0	-2.1
B8-7 1.5	82.4	-3.3	
B9-7 1.5	82.9	-2.8	-5.3
B10-7 1.5	77.8	-7.9	
B11-7 1.5	80.5	-5.3	-2.1
B12-7 1.5	86.9	1.1	
B13-7 1.5	85.1	-0.6	-0.55
B14-7 1.5	85.2	-0.5	
B15-7 1.5	84.3	-1.4	-3.5
B16-7 1.5	80.2	-5.5	
B17-7 1.5	81.9	-3.8	-7.3
B18-7 1.5	74.8	-10.9	
B19-7 1.5	79.6	-6.1	-5.5
B20-7 1.5	80.8	-4.9	
B21-7 1.5	79.4	-6.3	-4.9
B22-7 1.5	82.1	-3.6	
B3-14 1.5	83.4	-2.3	-3.1
B4-14 1.5	81.9	-3.8	
B5-14 1.5	85.1	-0.7	-1.25
B6-14 1.5	83.9	-1.8	
B7-14 1.5	94.7	9.0	5.3
B8-14 1.5	87.3	1.6	
B9-14 1.5	71.5	-14.2	-16
B10-14 1.5	67.8	-17.9	
B11-14 1.5	91.2	5.5	5.2
B12-14 1.5	90.7	5.0	
B13-14 1.5	91.5	5.8	4.4
B14-14 1.5	88.7	3.0	
B15-14 1.5	87.6	1.9	0.4
B16-14 1.5	84.6	-1.1	
B17-14 1.5	85.3	-0.4	-0.3
B18-14 1.5	85.5	-0.2	
B19-14 1.5	88.9	3.2	4.5
B20-14 1.5	91.6	5.9	

93206 >1000 PPM Pb

Controls

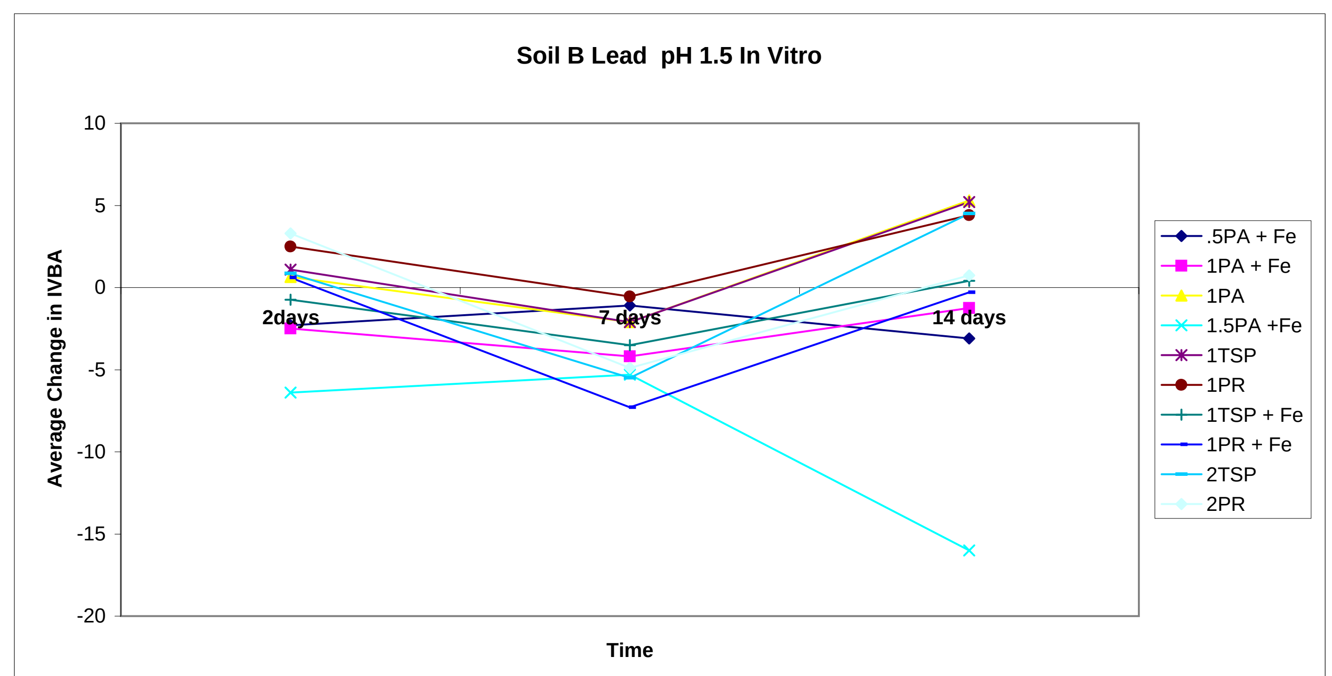
In Vitro-Pb pH1.5

B-1-2 1.5	82.2
B-2-2 1.5	90.6
B1-7 1.5	87.7
B2-7 1.5	84.8
B1-14 1.5	86.1
B2-14 1.5	83.3
D-9 1.5	74.7
D-10 1.5	96.3
Average	**85.7**
Standard Dev.	**6.318617**

In Vitro-Pb pH 2.5

B-1-2 2.5	50.7
B-2-2 2.5	53.3
B1-7 2.5	44.2
B2-7 2.5	44.2
B1-14 2.5	49.7
B2-14 2.5	50.3
D-9 2.5	46.9
D-10 2.5	55.8
Average	**49.4**
Standard Dev.	**4.11063**

	pH 1.5			**pH 2.5**		
.5PA + Fe	-2.3	-1.1	-3.1	-8.4	-16.3	-9.4
1PA + Fe	-2.5	-4.2	-1.25	-22	-25.7	-20.1
1PA	0.65	-2.1	5.3	-24	-29.2	-26
1.5PA +Fe	-6.4	-5.3	-16	-29.4	-32	-37.7
1TSP	1.1	-2.1	5.2	1.1	-7.5	-0.45
1PR	2.5	-0.55	4.4	6.3	-2.6	4.6
1TSP + Fe	-0.75	-3.5	0.4	-4.5	-10.6	-2.7
1PR + Fe	0.6	-7.3	-0.3	-2.9	-11.8	-2.2
2TSP	0.85	-5.5	4.5	-8.7	-8	-4.3
2PR	3.3	-4.9	0.75	1.8	-3.1	-1.5
	2days	7 days	14 days			



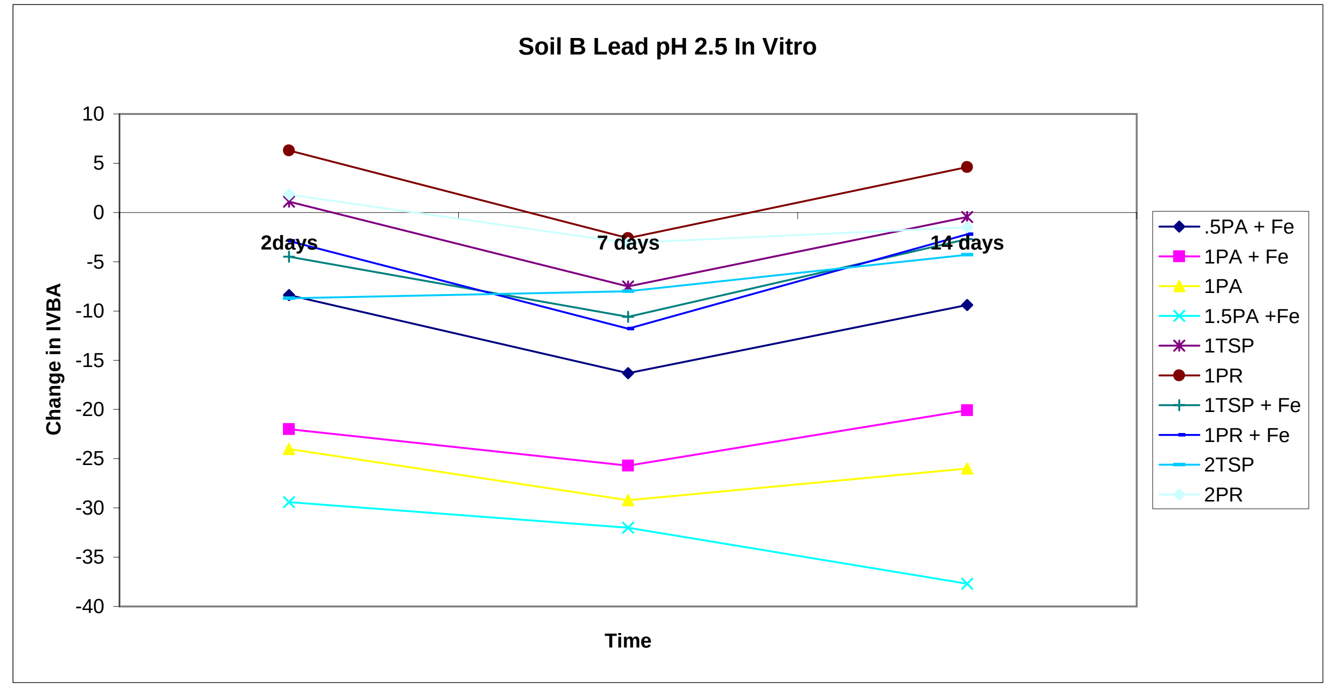
B21-14 1.5	87.2	1.5	0.75
B22-14 1.5	85.7	0.0	

In Vitro-Pb pH 2.5

B-3-2 2.5	38.9	-10.5	-8.4
B-4-2 2.5	43.0	-6.3	
B-5-2 2.5	28.5	-20.9	-22
B-6-2 2.5	26.2	-23.2	
B-7-2 2.5	25.2	-24.2	-24
B-8-2 2.5	25.3	-24.1	
B-9-2 2.5	19.5	-29.9	-29.4
B-10-2 2.5	20.4	-29.0	
B-11-2 2.5	49.1	-0.3	1.1
B-12-2 2.5	51.8	2.4	
B-13-2 2.5	53.8	4.4	6.3
B-14-2 2.5	57.7	8.3	
B-15-2 2.5	46.7	-2.7	-4.5
B-16-2 2.5	43.1	-6.3	
B-17-2 2.5	47.1	-2.2	-2.9
B-18-2 2.5	45.8	-3.6	
B-19-2 2.5	42.2	-7.1	-8.7
B-20-2 2.5	39.1	-10.3	
B-21-2 2.5	50.6	1.2	1.8
B-22-2 2.5	51.9	2.5	

B3-7 2.5	30.3	-19.1	-16.3
B4-7 2.5	35.7	-13.6	
B5-7 2.5	22.0	-27.4	-25.7
B6-7 2.5	25.3	-24.1	
B7-7 2.5	19.3	-30.1	-29.2
B8-7 2.5	21.1	-28.3	
B9-7 2.5	13.4	-36.0	-32
B10-7 2.5	21.4	-28.0	
B11-7 2.5	40.7	-8.7	-7.5
B12-7 2.5	43.1	-6.3	
B13-7 2.5	45.6	-3.8	-2.6
B14-7 2.5	48.0	-1.4	
B15-7 2.5	37.3	-12.1	-10.6
B16-7 2.5	40.1	-9.2	
B17-7 2.5	37.3	-12.1	-11.8
B18-7 2.5	37.8	-11.6	
B19-7 2.5	41.5	-7.9	-8
B20-7 2.5	41.2	-8.2	
B21-7 2.5	47.0	-2.3	-3.1
B22-7 2.5	45.4	-3.9	

B3-14 2.5	40.2	-9.2	-9.4
B4-14 2.5	39.7	-9.7	
B5-15 2.5	29.7	-19.7	-20.1
B6-14 2.5	28.9	-20.5	
B7-14 2.5	24.1	-25.3	-26
B8-14 2.5	22.6	-26.8	
B9-14 2.5	13.5	-35.9	-37.7
B10-14 2.5	10.0	-39.4	
B11-14 2.5	50.2	0.8	-0.45
B12-14 2.5	47.7	-1.7	
B13-14 2.5	53.9	4.5	4.6
B14-14 2.5	54.1	4.7	
B15-14 2.5	47.4	-1.9	-2.7
B16-14 2.5	45.8	-3.6	



B17-14 2.5	47.6	-1.8	-2.2
B18-14 2.5	46.8	-2.5	
B19-14 2.5	44.8	-4.6	-4.3
B20-14 2.5	45.4	-4.0	
B21-14-2.5	49.1	-0.3	-1.5
B22-14 2.5	46.7	-2.7	

In Vitro-Pb pH1.5

	%IVBA	Change in IVBA	Average Change
C-3-2 1.5	92.7	3.9	2.2
C-4-2 1.5	89.4	0.5	
C-5-2 1.5	86.0	-2.8	-3
C-6-2 1.5	85.6	-3.2	
C-7-2 1.5	92.8	4.0	2.6
C-8-2 1.5	90.2	1.3	
C-9-2 1.5	84.1	-4.8	-3.6
C-10-2 1.5	86.5	-2.4	
C-11-2 1.5	96.5	7.6	3.8
C-12-2 1.5	88.9	0.0	
C-13-2 1.5	93.7	4.9	3.4
C-14-2 1.5	90.8	1.9	
C15-2 1.5	84.8	-4.0	-3.15
C-16-2 1.5	86.6	-2.3	
C17-2 1.5	90.0	1.1	1.8
C-18-2 1.5	91.4	2.6	
C19-2 1.5	92.8	4.0	4.3
C-20-2 1.5	93.5	4.7	
C21-2 1.5	94.0	5.2	5.2
C-22-2 1.5	94.1	5.2	
C3-7 1.5	80.3	-8.5	-8.9
C4-7 1.5	79.5	-9.3	
C5-7 1.5	88.8	0.0	-5.3
C6-7 1.5	78.2	-10.7	
C7-7 1.5	77.1	-11.7	-11.8
C8-7 1.5	76.9	-12.0	
C9-7 1.5	69.6	-19.3	-14
C10-7 1.5	80.1	-8.7	
C11-7 1.5	81.3	-7.5	-4.6
C12-7 1.5	87.2	-1.6	
C13-7 1.5	98.4	9.5	6.7
C14-7 1.5	92.8	4.0	
C15-7 1.5	88.7	-0.1	0.6
C16-7 1.5	90.1	1.3	
C17-7 1.5	83.2	-5.7	-8.8
C18-7 1.5	76.9	-11.9	
C19-7 1.5	91.1	2.3	0.45
C20-7 1.5	87.4	-1.4	
C21-7 1.5	90.3	1.4	3.8
C22-7 1.5	95.0	6.1	
C3-14 1.5	93.2	4.4	4.1
C4-14 1.5	92.7	3.8	
C5-14 1.5	92.6	3.8	4.1
C6-14 1.5	93.3	4.4	
C7-14 1.5	92.3	3.5	3.6
C8-14 1.5	92.5	3.7	
C9-14 1.5	90.2	1.4	1.5
C10-14 1.5	90.4	1.6	
C11-14 1.5	95.1	6.3	3.6
C12-14 1.5	89.8	0.9	
C13-14 1.5	86.7	-2.1	1.6
C14-14 1.5	94.1	5.2	
C15-14 1.5	90.0	1.2	0.45
C16-14 1.5	88.5	-0.3	
C17-14 1.5	87.6	-1.2	2.3
C18-14 1.5	94.6	5.8	
C19-14 1.5	92.3	3.5	0.9
C20-14 1.5	87.2	-1.7	
C21-14 1.5	92.4	3.6	4.2
C22-14 1.5	93.5	4.7	

93207 DRIPLINE

Controls

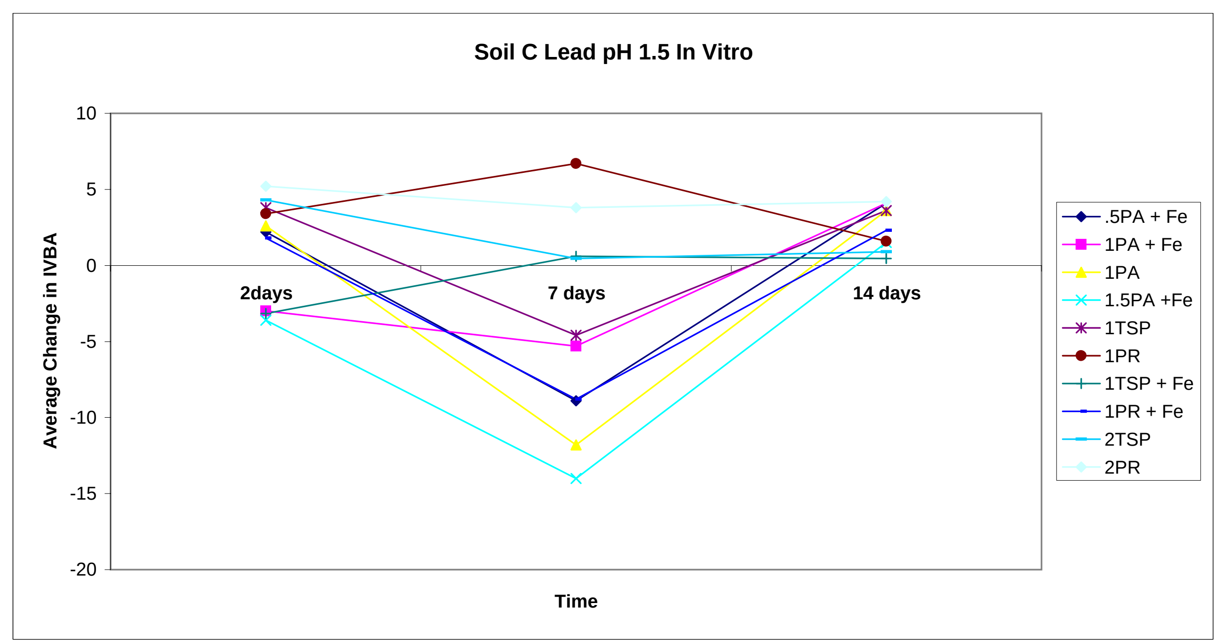
In Vitro-Pb pH1.5

C-1-2 1.5	88.7
C-2-2 1.5	90.4
C1-7 1.5	79.9
C2-7 1.5	81.8
C1-14 1.5	94.0
C2-14 1.5	95.0
D-17 1.5	89.1
D-18 1.5	91.9
Average	**88.8**
Standard Dev.	**5.4281**

In Vitro-Pb pH 2.5

C1-2 2.5	58.7
C2-2 2.5	60.0
C1-7 2.5	56.6
C2-7 2.5	57.7
C1-14 2.5	66.7
C2-14 2.5	62.9
D-17 2.5	57.9
D-18 2.5	63.5
Average	**60.5**
Standard Dev.	**3.508048**

	pH 1.5			**pH 2.5**		
.5PA + Fe	2.2	-8.9	4.1	-16	-18.8	-7.7
1PA + Fe	-3	-5.3	4.1	-31.6	-27.2	-18.7
1PA	2.6	-11.8	3.6	-26.4	-29.8	-20.7
1.5PA +Fe	-3.6	-14	1.5	-36	-33	-31.3
1TSP	3.8	-4.6	3.6	-4	-5.7	-1.1
1PR	3.4	6.7	1.6	2.5	2.8	4.6
1TSP + Fe	-3.15	0.6	0.45	-9.2	-10.4	-4.4
1PR + Fe	1.8	-8.8	2.3	-2.2	-9.4	-3.9
2TSP	4.3	0.45	0.9	-11	-15.5	-14.8
2PR	5.2	3.8	4.2	0.3	-1	-0.4
	2days	7 days	14 days			

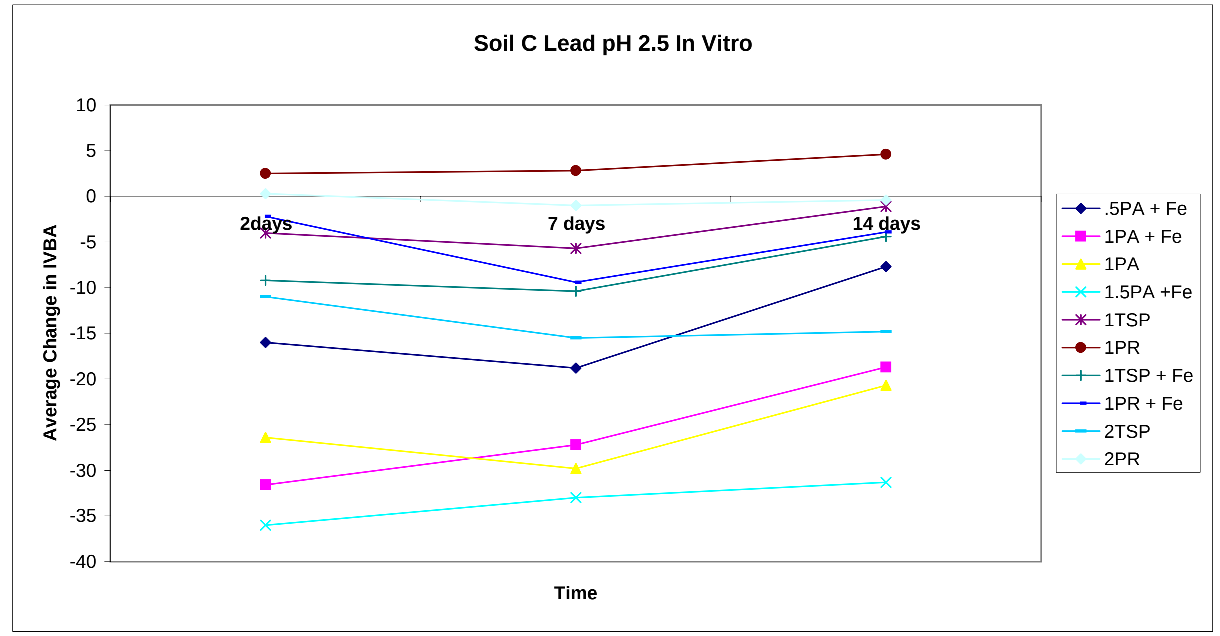


In Vitro-Pb pH2.5

C3-2 2.5	44.6	-15.9	-16
C4-2 2.5	44.4	-16.1	
C5-2 2.5	27.5	-33.0	-31.6
C6-2 2.5	30.3	-30.2	
C7-2 2.5	33.2	-27.3	-26.4
C8-2 2.5	35.1	-25.4	
C9-2 2.5	24.6	-35.9	-36
C10-2 2.5	24.4	-36.1	
C11-2 2.5	58.6	-1.9	-4
C12-2 2.5	54.5	-6.0	
C13-2 2.5	62.6	2.1	2.5
C14-2 2.5	63.3	2.8	
C15-2 2.5	52.5	-8.0	-9.2
C16-2 2.5	50.1	-10.4	
C17-2 2.5	58.8	-1.7	-2.2
C18-2 2.5	57.9	-2.6	
C19-2 2.5	49.5	-11.0	-11
C20-2 2.5	49.4	-11.1	
C21-2 2.5	60.1	-0.4	0.3
C22-2 2.5	61.5	1.0	

C3-7 2.5	42.0	-18.5	-18.8
C4-7 2.5	41.3	-19.2	
C5-7 2.5	33.2	-27.3	-27.2
C6-7 2.5	33.5	-27.0	
C7-7 2.5	31.0	-29.5	-29.8
C8-7 2.5	30.4	-30.1	
C9-7 2.5	25.4	-35.1	-33
C10-7 2.5	29.6	-30.9	
C11-7 2.5	54.8	-5.7	-5.7
C12-7 2.5	54.8	-5.7	
C13-7 2.5	65.1	4.6	2.8
C14-7 2.5	61.5	1.0	
C15-7 2.5	52.6	-7.9	-10.4
C16-7 2.5	47.6	-12.9	
C17-7 2.5	54.0	-6.5	-9.4
C18-7 2.5	48.3	-12.2	
C19-7 2.5	41.5	-19.0	-15.5
C20-7 2.5	48.6	-11.9	
C21-7 2.5	58.8	-1.7	-1
C22-7 2.5	60.2	-0.3	

C3-14 2.5	52.5	-8.0	-7.7
C4-14 2.5	53.1	-7.4	
C5-14 2.5	42.1	-18.4	-18.7
C6-14 2.5	41.6	-18.9	
C7-14 2.5	39.4	-21.1	-20.7
C8-14 2.5	40.2	-20.3	
		-32.4	-31.3
C10-14 2.5	30.2	-30.3	
C11-14 2.5	60.4	-0.1	-1.1
C12-14 2.5	58.4	-2.1	
C13-14 2.5	67.2	6.7	4.6
C14-14 2.5	63.0	2.5	
C15-14 2.5	57.1	-3.4	-4.4
C16-14 2.5	55.1	-5.4	
C17-14 2.5	55.1	-5.4	-3.9
C18-14 2.5	58.1	-2.4	
C19-14 2.5 28.1	46.4	-14.1	-14.8
C20-14 2.5	45.0	-15.5	
C21-14 2.5	61.1	0.6	-0.4
C22-14 2.5	59.1	-1.4	



EPA Treatability	SLIP Weight g
C1-14	3.01577
C2-14	2.98856
C3-14	3.05678
C4-14	3.04297
C5-14	3.01133
C6-14	3.02897
C7-14	3.04651
C8-14	3.01664
blank	
blank-spk	
C9-14	2.98185
C10-14	3.04541
C11-14	2.99749
C12-14	3.02553
C13-14	2.93872
C14-14	2.98046
C15-14	3.03046
C16-14	3.00308
C17-14	3.04722
C18-14	2.9874
C19-14	3.041
C20-14	3.02527
C21-14	3.0023
C22-14	3.08371
blank	
B1-14-SPK	
B1-14	3.00942
B2-14	3.02608
B3-14	3.06777
B4-14	3.07012
B5-14	3.02635
B6-14	3.00702
B7-14	3.03832
B8-14	3.00751
B9-14	3.0705
B10-14	3.04674
B11-14	3.03746
B11-14-SPK	
blank	
B12-14	2.93661
B13-14	2.97482
B14-14	3.08998
B15-14	2.97975
B16-14	2.93596
B17-14	2.92812
B18-14	2.94624
B19-14	3.14309
B20-14	2.99659

EPA Treatability	SLIP Weight g
B21-14	2.99651
B22-14	3.01592
Blank	
A1-14	3.03551
A2-14	3.04561
A3-14	3.02515
A4-14	3.06913
A5-14	2.98259
A6-14	2.99486
A7-14	2.93192
A8-14	2.94584
A9-14	2.98538
A10-14	3.00874
BLANK	
A10-14-SPK	
A11-14	3.08209
A12-14	2.99797
A13-14	2.92858
A14-14	3.03507
A15-14	3.00825
A16-14	3.05932
A17-14	2.96728
A18-14	2.97178
A19-14	3.07439
A20-14	3.01505
A21-14	3.08169
A22-14	2.99005
BLANK	
BLANK-SPK	
A1-7	2.99057
A2-7	2.97962
A3-7	2.98793
A4-7	2.96624
A5-7	3.02566
A6-7	2.95351
A7-7	2.99065
A8-7	2.99665
A9-7	2.9609
A10-7	3.02913
A10-7-SPK	
BLANK	
A11-7	2.97091
A12-7	3.00411
A13-7	3.01274
A14-7	3.04122
A15-7	2.99404
A16-7	2.97656
A17-7	3.03602
A18-7	3.04733

EPA Treatability	SLIP Weight g
A19-7	3.05565
A20-7	3.01418
A21-7	3.01267
A22-7	3.01033
BLANK	
BLANK-SPK	
B1-7	3.12861
B2-7	3.01936
B3-7	2.97349
B4-7	2.98607
B5-7	3.01736
B6-7	2.97332
B7-7	3.00017
B8-7	3.02748
B9-7	3.06166
B10-7	3.02019
B10-7-SPK	
BLANK	
B11-7	3.04957
B12-7	3.04211
B13-7	2.92252
B14-7	3.07833
B15-7	3.0462
B16-7	2.99797
B17-7	3.04541
B18-7	2.99546
B19-7	3.01385
B20-7	3.01617
B21-7	3.01452
B22-7	3.01336
BLANK	
BLANK-SPK	
C1-7	3.00744
C2-7	3.00068
C3-7	2.95978
C4-7	2.98323
C5-7	2.97709
C6-7	3.00008
C7-7	3.05846
C8-7	3.0175
C9-7	3.05028
C10-7	3.02484
BLANK	
BLANK-SPK	
C11-7	3.03975
C12-7	3.01075
C13-7	3.00409
C14-7	3.03782
C15-7	2.96595

EPA Treatability	SLIP Weight g
C16-7	2.99863
C17-7	3.00964
C18-7	3.00364
C19-7	3.02725
C20-7	3.05541
C21-7	2.98178
C22-7	3.00082
C22-7-SPK	
BLANK	
D-1	3.08543
D-2	2.98302
D-3	2.99965
D-4	2.98849
D-5	2.99971
D-6	3.02166
D-7	2.99455
D-8	3.00934
D-9	3.03444
D-10	3.02303
BLANK	
BLANK-SPK	
D-11	3.00303
D-12	3.04847
D-13	3.00597
D-14	3.01831
D-15	2.98646
D-16	3.01367
D-17	3.00163
D-18	3.0165
D-19	2.98902
D-20	3.03471
D-20-SPK	
BLANK	
D-21	3.00342
D-22	2.99035
D-23	2.99648
D-24	3.0768
C1-2	3.08992
C2-2	3.01445
C3-2	2.98734
C4-2	3.03344
C5-2	3.03028
C6-2	3.01207
BLANK	
BLANK-SPK	
C7-2	2.997
C8-2	3.00665
C9-2	3.03904
C10-2	3.03412

EPA Treatability	SLIP Weight g
C11-2	2.98365
C12-2	3.06347
C13-2	3.07967
C14-2	3.03716
C15-2	3.06814
C-15-2-SPK	
C16-2	3.02345
BLANK	
C17-2	3.04784
C18-2	3.03255
C19-2	3.01667
C20-2	3.0381
C21-2	3.0184
C22-2	2.9814
B1-2	2.99443
B2-2	3.02321
B3-2	3.01254
B4-2	3.03166
B5-2	3.01726
B6-2	2.9881
B7-2	3.05718
B8-2	3.0374
B9-2	3.04539
B10-2	2.97086
BLANK	
BLANK-SPK	
B11-2	3.04305
B12-2	3.0109
B13-2	2.9891
B14-2	3.08576
B15-2	3.00822
B16-2	3.02334
B17-2	3.04636
B18-2	3.05837
B19-2	3.00047
B20-2	3.02577
B21-2	3.01952
B22-2	3.01674
B22-2-SPK	
BLANK	
A1-2	3.05893
A2-2	3.05298
A3-2	3.01737
A4-2	3.02973
A5-2	3.02682
A6-2	3.00512
A7-2	3.04433
A8-2	2.99848
A9-2	3.0217

EPA Treatability	SLIP Weight g
A10-2	2.99491
BLANK	
BLANK-SPK	
A11-2	3.02993
A12-2	2.99687
A13-2	3.01643
A14-2	3.04355
A15-2	2.99633
A16-2	3.02947
A17-2	2.99036
A18-2	2.99569
A19-2	2.9951
A20-2	2.99491
A21-2	3.01556
A22-2	3.05801
BLANK	
A22-2-SPK	
BLANK-SPK	

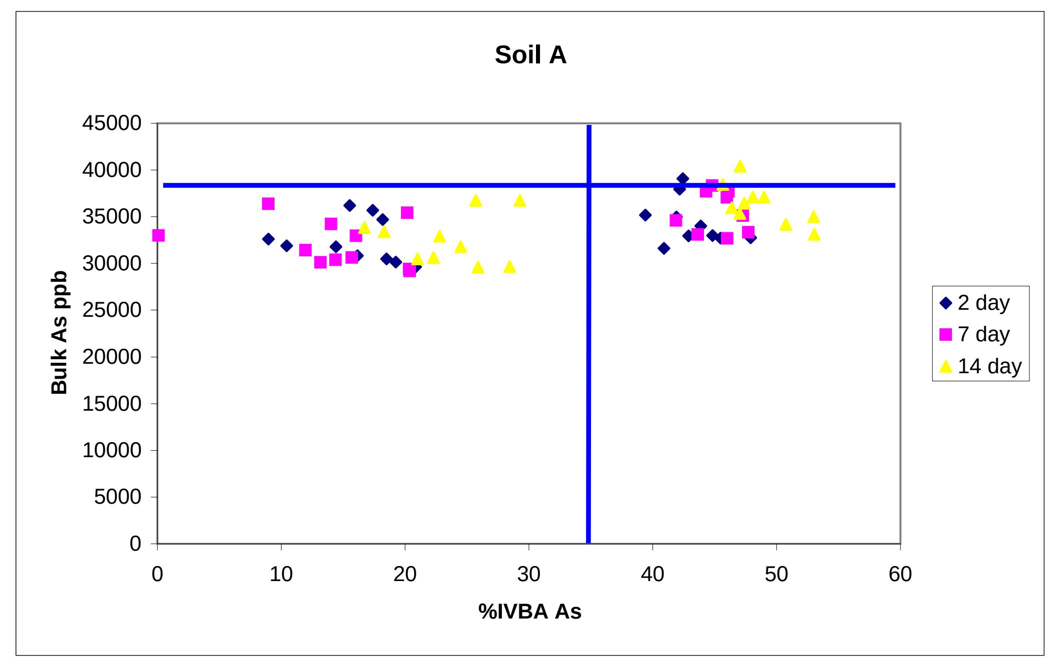
	Pb IVBA			As IVBA	
pH	1.5	2.5	pH	1.5	2.5
Soil A	84	42	**Soil A**	33	27
	81	43		33	26
	83	38		33	23
	78	37		34	23
	77	43		40	27
	77	41		39	24
Average	80.0	40.7		35.3	25.0
StDev	3.098387	2.581989		3.265986	1.897367
	831 mg/kg +/- 20			**37 mg/kg +/- 0.5**	
	82	51	**Soil B**	34	25
	91	53		34	26
Soil B	88	44		39	22
	85	44		36	22
	86	50		41	25
	83	50		43	26
Average	85.8	48.7		37.8	24.3
StDev	3.311596	3.777124		3.763863	1.861899
	1406 mg/kg +/- 93			**43 mg/kg +/- 0.8**	
	89	59	**Soil C**	22	15
	90	60		22	14
Soil C	80	57		38	19
	82	58		35	16
	94	67		39	18
	95	63		40	18
Average	88.3	60.7		32.7	16.7
StDev	6.15359	3.723797		8.430105	1.966384
	2284 mg/kg +/- 130			**15 mg/kg +/- 0.3**	

TABLE 2 . Preliminary Summary Of In Vitro Bioassay Results

As IVBA generally increases 10% w/ phosphate ---no change with Solucorp

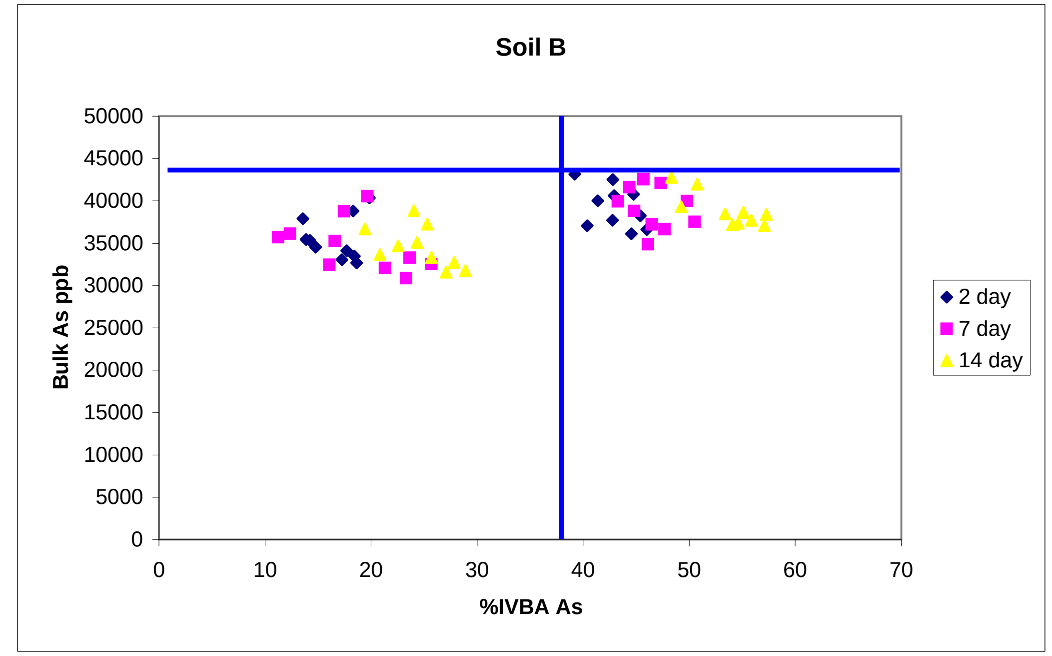
Sample	ID	As in <250u bulk soil µg/kg	mass soil (g)	calc As #1	ICP As (µg/l)	solution amt (l)	% Relative As Bioavailability
A-1-2 1.5		36964	1.0008	36.99	120	0.1	33
A-2-2 1.5		37051	1.00044	37.07	121	0.1	33
A-3-2 1.5		31785	1.00028	31.79	46	0.1	14
A-4-2 1.5		34690	1.00039	34.70	63	0.1	18
A-5-2 1.5		30480	1.00098	30.51	56	0.1	19
A-6-2 1.5		30824	1.00056	30.84	50	0.1	16
A-7-2 1.5		32725	1.0007	32.75	149	0.1	45
A-8-2 1.5		32764	1.00026	32.77	157	0.1	48
A-9-2 1.5		30159	1.00041	30.17	58	0.1	19
A-10-2 1.5		29645	1.00111	29.68	62	0.1	21
A-11-2 1.5		35193	1.00058	35.21	139	0.1	39
A-12-2 1.5		32984	1.00093	33.01	148	0.1	45
A-13-2 1.5		34032	1.00137	34.08	150	0.1	44
A-14-2 1.5		34973	1.00095	35.01	147	0.1	42
A-15-2 1.5		31903	1.00046	31.92	33	0.1	10
A-16-2 1.5		32629	1.00104	32.66	29	0.1	9
A-17-2 1.5		35688	1.00048	35.71	62	0.1	17
A-18-2 1.5		36214	1.00021	36.22	56	0.1	16
A-19-2 1.5		32962	1.00072	32.99	141	0.1	43
A-20-2 1.5		31624	1.00015	31.63	129	0.1	41
A-21-2 1.5		39070	1.00027	39.08	166	0.1	42
A-22-2 1.5		37956	1.00073	37.98	160	0.1	42
A1-7 1.5		36861	1.01195	37.30	124	0.1	33
A2-7 1.5		37956	1.00367	38.10	128	0.1	34
A3-7 1.5		30121	1.00685	30.33	40	0.1	13
A4-7 1.5		31408	0.99967	31.40	38	0.1	12
A5-7 1.5		30385	1.02156	31.04	45	0.1	14
A6-7 1.5		30629	1.02473	31.39	49	0.1	16
A7-7 1.5		32680	0.98472	32.18	148	0.1	46
A8-7 1.5		33096	1.00873	33.38	146	0.1	44
A9-7 1.5		29186	1.00031	29.20	60	0.1	20
A10-7 1.5		29380	1.00916	29.65	60	0.1	20
A11-7 1.5		35107	1.02114	35.85	170	0.1	47
A12-7 1.5		33329	1.01487	33.82	161	0.1	48
A13-7 1.5		37056	1.01979	37.79	174	0.1	46
A14-7 1.5		38319	1.01045	38.72	174	0.1	45
A15-7 1.5		34237	1.01394	34.71	49	0.1	14
A16-7 1.5		32992	1.01478	33.48	0	0.1	0
A17-7 1.5		36379	1.02301	37.22	33	0.1	9
A18-7 1.5		35403	1.0035	35.53	72	0.1	20
A19-7 1.5		32968	0.99547	32.82	53	0.1	16

Control	Soil A	Soil B	Soil C
	36963.69905	42744	14962
	37050.91192	42000	14551
	36861	41570	14968
	37956	42860	15091
	36476	43234	14102
	36571	43870	14398
Average	**36980**	**42713**	**14679**
stdev	**528**	**830**	**366**

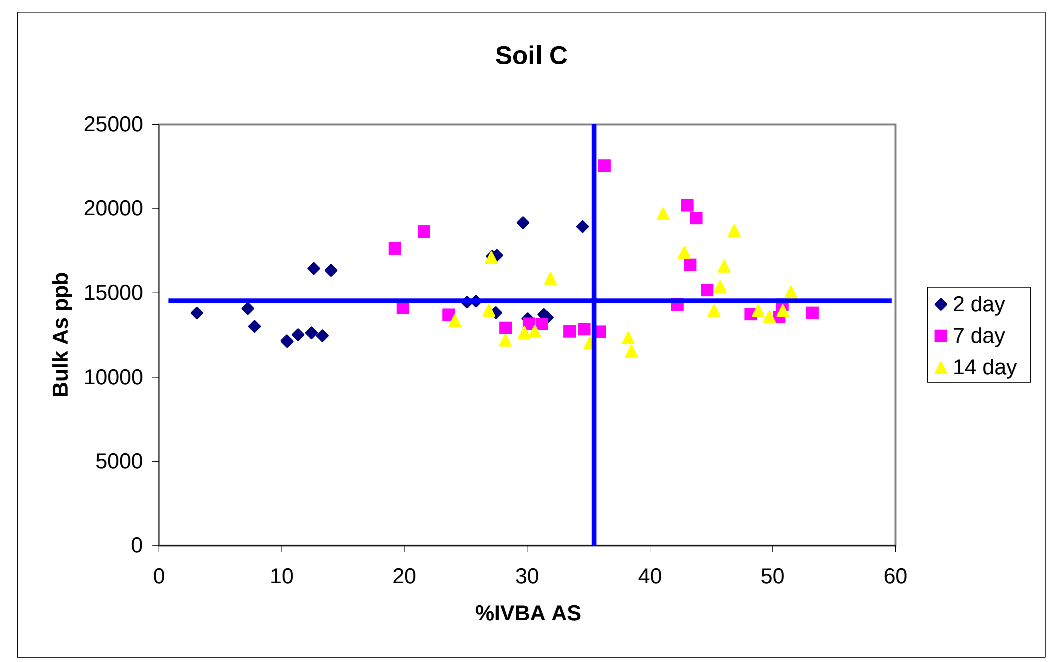


A20-7 1.5	34608	1.0217	35.36	148	0.1	42
A21-7 1.5	37696	1.00871	38.02	175	0.1	46
A22-7 1.5	37714	1.01221	38.17	169	0.1	44

A1-14 1.5	36476	1.02006	37.21	147	0.1	40
A2-14 1.5	36571	1.01951	37.28	145	0.1	39
A3-14 1.5	30622	1.02389	31.35	70	0.1	22
A4-14 1.5	30495	0.99949	30.48	64	0.1	21
A5-14 1.5	31792	1.00800	32.05	78	0.1	24
A6-14 1.5	29588	1.02223	30.25	78	0.1	26
A7-14 1.5	34169	1.00226	34.25	174	0.1	51
A8-14 1.5	33130	1.02185	33.85	180	0.1	53
A9-14 1.5	29664	0.99555	29.53	84	0.1	28
A10-14 1.5	32907	1.00151	32.96	75	0.1	23
A11-14 1.5	35961	1.00967	36.31	168	0.1	46
A12-14 1.5	36453	1.02391	37.32	177	0.1	47
A13-14 1.5	37095	1.01109	37.51	184	0.1	49
A14-14 1.5	37089	0.99744	36.99	178	0.1	48
A15-14 1.5	33850	1.02161	34.58	58	0.1	17
A16-14 1.5	33385	1.01654	33.94	62	0.1	18
A17-14 1.5	36767	1.01034	37.15	96	0.1	26
A18-14 1.5	36753	1.00930	37.10	109	0.1	29
A19-14 1.5	35013	0.99377	34.80	184	0.1	53
A20-14 1.5	35354	1.02636	36.29	171	0.1	47
A21-14 1.5	38466	1.02824	39.55	181	0.1	46
A22-14 1.5	40410	1.02256	41.32	194	0.1	47



B-1-2 1.5	42744	1.00157	42.81	148	0.1	34
B-2-2 1.5	42000	1.00082	42.03	143	0.1	34
B-3-2 1.5	35342	1.00128	35.39	50	0.1	14
B-4-2 1.5	34538	1.00054	34.56	51	0.1	15
B-5-2 1.5	33463	1.02483	34.29	63	0.1	18
B-6-2 1.5	34131	1.00879	34.43	61	0.1	18
B-7-2 1.5	36614	1.00898	36.94	170	0.1	46
B-8-2 1.5	36116	1.01777	36.76	164	0.1	45
B-9-2 1.5	32684	1.00740	32.93	61	0.1	19
B-10-2 1.5	33072	1.00087	33.10	57	0.1	17
B-11-2 1.5	40021	1.00965	40.41	167	0.1	41
B-12-2 1.5	37726	1.00695	37.99	162	0.1	43
B-13-2 1.5	40607	1.00669	40.88	175	0.1	43
B-14-2 1.5	40765	1.01098	41.21	184	0.1	45
B-15-2 1.5	35457	1.02827	36.46	51	0.1	14
B-16-2 1.5	37912	1.02665	38.92	53	0.1	14
B-17-2 1.5	38800	1.01727	39.47	72	0.1	18
B-18-2 1.5	40344	1.00788	40.66	81	0.1	20
B-19-2 1.5	38234	1.01275	38.72	176	0.1	45
B-20-2 1.5	37075	1.01397	37.59	152	0.1	40
B-21-2 1.5	43171	1.01160	43.67	171	0.1	39
B-22-2 1.5	42521	1.00379	42.68	183	0.1	43



B1-7 1.5	41570	1.00697	41.86	163	0.1	39
B2-7 1.5	42860	1.01990	43.71	158	0.1	36
B3-7 1.5	33282	1.00400	33.42	79	0.1	24
B4-7 1.5	32516	1.01051	32.86	84	0.1	26
B5-7 1.5	35252	1.00692	35.50	59	0.1	17
B6-7 1.5	32465	1.02285	33.21	53	0.1	16
B7-7 1.5	34867	1.01840	35.51	164	0.1	46

B8-7 1.5	36640	1.00969	37.00	176	0.1	48
B9-7 1.5	32088	1.01627	32.61	70	0.1	21
B10-7 1.5	30875	0.99483	30.71	72	0.1	23
B11-7 1.5	38818	0.99694	38.70	173	0.1	45
B12-7 1.5	37225	1.00000	37.22	173	0.1	46
B13-7 1.5	41615	1.01111	42.08	187	0.1	44
B14-7 1.5	39928	1.01311	40.45	175	0.1	43
B15-7 1.5	36123	1.00030	36.13	45	0.1	12
B16-7 1.5	35698	0.99206	35.41	40	0.1	11
B17-7 1.5	38777	1.00888	39.12	68	0.1	17
B18-7 1.5	40530	1.01495	41.14	81	0.1	20
B19-7 1.5	39993	1.01901	40.75	203	0.1	50
B20-7 1.5	37520	1.01198	37.97	192	0.1	51
B21-7 1.5	42561	1.00643	42.83	196	0.1	46
B22-7 1.5	42079	1.00682	42.37	201	0.1	47
B1-14 1.5	43234	1.01482	43.87	179	0.1	41
B2-14 1.5	43870	1.01687	44.61	192	0.1	43
B3-14 1.5	35104	1.00365	35.23	86	0.1	24
B4-14 1.5	34682	1.00195	34.75	78	0.1	23
B5-14 1.5	32719	1.01729	33.29	93	0.1	28
B6-14 1.5	33330	1.01794	33.93	87	0.1	26
B7-14 1.5	38370	1.01314	38.87	223	0.1	57
B8-14 1.5	37374	1.00289	37.48	205	0.1	55
B9-14 1.5	31768	1.00905	32.06	93	0.1	29
B10-14 1.5	31580	1.02882	32.49	88	0.1	27
B11-14 1.5	38449	1.00466	38.63	206	0.1	53
B12-14 1.5	37715	1.00954	38.07	213	0.1	56
B13-14 1.5	38640	1.00409	38.80	214	0.1	55
B14-14 1.5	39281	1.02546	40.28	198	0.1	49
B15-14 1.5	33644	1.00592	33.84	71	0.1	21
B16-14 1.5	36675	0.9975	36.58	71	0.1	19
B17-14 1.5	38845	1.01239	39.33	94	0.1	24
B18-14 1.5	37269	1.02849	38.33	97	0.1	25
B19-14 1.5	37194	1.01619	37.80	204	0.1	54
B20-14 1.5	37075	1.00994	37.44	214	0.1	57
B21-14 1.5	41973	1.00732	42.28	215	0.1	51
B22-14 1.5	42779	1.03438	44.25	214	0.1	48
C-1-2 1.5	14962	1.01940	15.25	33	0.1	22
C-2-2 1.5	14551	0.99509	14.48	32	0.1	22
C-3-2 1.5	12627	1.00867	12.74	16	0.1	12
C-4-2 1.5	13015	1.01274	13.18	10	0.1	8
C-5-2 1.5	12519	1.00999	12.64	14	0.1	11
C-6-2 1.5	12458	1.01251	12.61	17	0.1	13
C-7-2 1.5	13722	1.00474	13.79	43	0.1	31
C-8-2 1.5	13475	1.04266	14.05	42	0.1	30
C-9-2 1.5	12167	1.01257	12.32	13	0.1	10
C-10-2 1.5	12129	1.00045	12.13	13	0.1	10
C-11-2 1.5	13832	1.00284	13.87	38	0.1	27
C-12-2 1.5	14513	1.03229	14.98	39	0.1	26
C-13-2 1.5	17234	1.01159	17.43	48	0.1	28
C-14-2 1.5	17166	1.01513	17.43	47	0.1	27
C15-2 1.5	13817	1.02624	14.18	4	0.1	3
C-16-2 1.5	14069	1.00222	14.10	10	0.1	7
C17-2 1.5	16461	0.99887	16.44	21	0.1	13
C-18-2 1.5	16342	1.01065	16.52	23	0.1	14
C19-2 1.5	14452	1.03255	14.92	37	0.1	25
C-20-2 1.5	13550	1.01731	13.78	44	0.1	32
C21-2 1.5	18940	1.03489	19.60	68	0.1	35
C-22-2 1.5	19163	1.00355	19.23	57	0.1	30

C1-7 1.5	14968	1.02015	15.27	58	0.1	38
C2-7 1.5	15091	0.99581	15.03	53	0.1	35
C3-7 1.5	12844	1.01443	13.03	45	0.1	35
C4-7 1.5	12709	1.00685	12.80	43	0.1	33
C5-7 1.5	13141	0.99714	13.10	41	0.1	31
C6-7 1.5	12926	1.00586	13.00	37	0.1	28
C7-7 1.5	13732	1.01120	13.89	67	0.1	48
C8-7 1.5	13573	0.99641	13.52	68	0.1	51
C9-7 1.5	12695	1.02239	12.98	47	0.1	36
C10-7 1.5	13173	0.99954	13.17	40	0.1	30
C11-7 1.5	15150	1.01679	15.40	69	0.1	45
C12-7 1.5	14314	1.03645	14.84	63	0.1	42
C13-7 1.5	16658	1.00701	16.78	73	0.1	43
C14-7 1.5	19441	1.01855	19.80	87	0.1	44
C15-7 1.5	13695	1.01425	13.89	33	0.1	24
C16-7 1.5	14102	1.00658	14.19	28	0.1	20
C17-7 1.5	17630	1.01524	17.90	34	0.1	19
C18-7 1.5	18641	1.01286	18.88	41	0.1	22
C19-7 1.5	13811	1.02005	14.09	75	0.1	53
C20-7 1.5	14294	1.01343	14.49	74	0.1	51
C21-7 1.5	22559	1.01541	22.91	83	0.1	36
C22-7 1.5	20189	1.02043	20.60	89	0.1	43
C1-14 1.5	14102	1.00901	14.23	56	0.1	39
C2-14 1.5	14398	1.00960	14.54	58	0.1	40
C3-14 1.5	12733	1.01282	12.90	39	0.1	31
C4-14 1.5	12645	1.00968	12.77	38	0.1	30
C5-14 1.5	12199	1.00980	12.32	35	0.1	28
C6-14 1.5	12026	1.02624	12.34	43	0.1	35
C7-14 1.5	13940	1.01290	14.12	72	0.1	51
C8-14 1.5	13589	1.00170	13.61	68	0.1	50
C9-14 1.5	12334	1.01042	12.46	48	0.1	38
C10-14 1.5	11535	1.02472	11.82	45	0.1	38
C11-14 1.5	13935	1.00590	14.02	68	0.1	49
C12-14 1.5	13936	1.01772	14.18	64	0.1	45
C13-14 1.5	17402	1.01368	17.64	75	0.1	43
C14-14 1.5	16578	1.00843	16.72	77	0.1	46
C15-14 1.5	13348	1.02248	13.65	33	0.1	24
C16-14 1.5	13972	1.01363	14.16	38	0.1	27
C17-14 1.5	17095	1.01271	17.31	47	0.1	27
C18-14 1.5	15861	1.01168	16.05	51	0.1	32
C19-14 1.5	15045	1.02435	15.41	79	0.1	51
C20-14 1.5	15370	1.00170	15.40	70	0.1	46
C21-14 1.5	18685	1.00485	18.78	88	0.1	47
C22-14 1.5	19694	1.00617	19.82	81	0.1	41

QA/QC

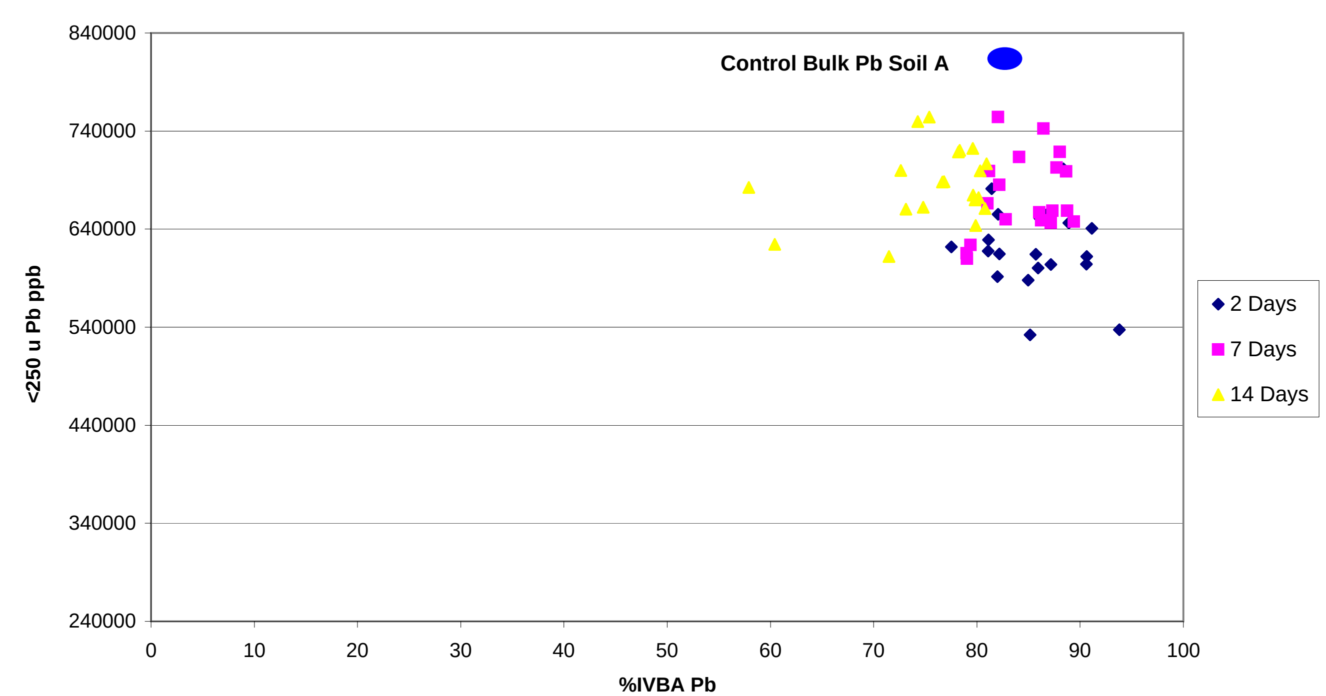
blank				1	0.1	
blank-spk (2500 ppb)				2627	0.1	
Nist-2711-E	105000	1.0268	107.81	575	0.1	53
blank				0	0.1	
blank-spk (2500 ppb)				2479	0.1	

Blank				-0.05842	0.1		
blank-spk (2500 ppb)				2540.541	0.1		
blank				0	0.1		
blank-spk (2500 ppb)				2454	0.1		
Nist2711-C	105000	1.02615	107.75	604	0.1	56	average IVBA vlaue for NIST 2711=59
blank				0	0.1		
blank-spk (2500 ppb)				2382	0.1		
Nist2711-B	105000	1.03082	108.24	560	0.1	52	
blank				-0.01005	0.1		
blank-spk (2500 ppb)				2439.721	0.1		
Nist2711-A	105000	1.01566	106.64	544.1155	0.1	51	
blank				0.006423	0.1		
blank-spk (2500 ppb)				2405.322	0.1		
Nist2711-D	105000	1.01633	106.71	566	0.1	53	
blank				0	0.1		
blank-spk (2500 ppb)				2437	0.1		
Nist2710-E	626000	1.02091	639.09	3266	0.1	51	average IVBA value for NIST 2710 =55
blank				0	0.1		
blank-spk (2500 ppb)				2502	0.1		
nist2710-D	626000	1.02203	639.79	3689.488	0.1	58	
blank				-0.15678	0.1		
blank-spk (2500 ppb)				2463.724	0.1		
nist-2710-C	626000	1.00193	627.21	3605.394	0.1	57	
Blank				-0.07225	0.1		
blank-spk (2500 ppb)				2404.512	0.1		
Nist-2710-B	626000	1.0255	641.96	3569.82	0.1	56	
NIST-2710-A	626000	1.00278	627.74	3624.683	0.1	58	
Blank				-0.06013	0.1		
blank-spk (2500 ppb)				2373.31	0.1		
Blank				-0.07259	0.1		
blank-spk (2500 ppb)				2369.278	0.1		
Blank				-0.13046	0.1		
blank-spk (2500 ppb)				2430.357	0.1		

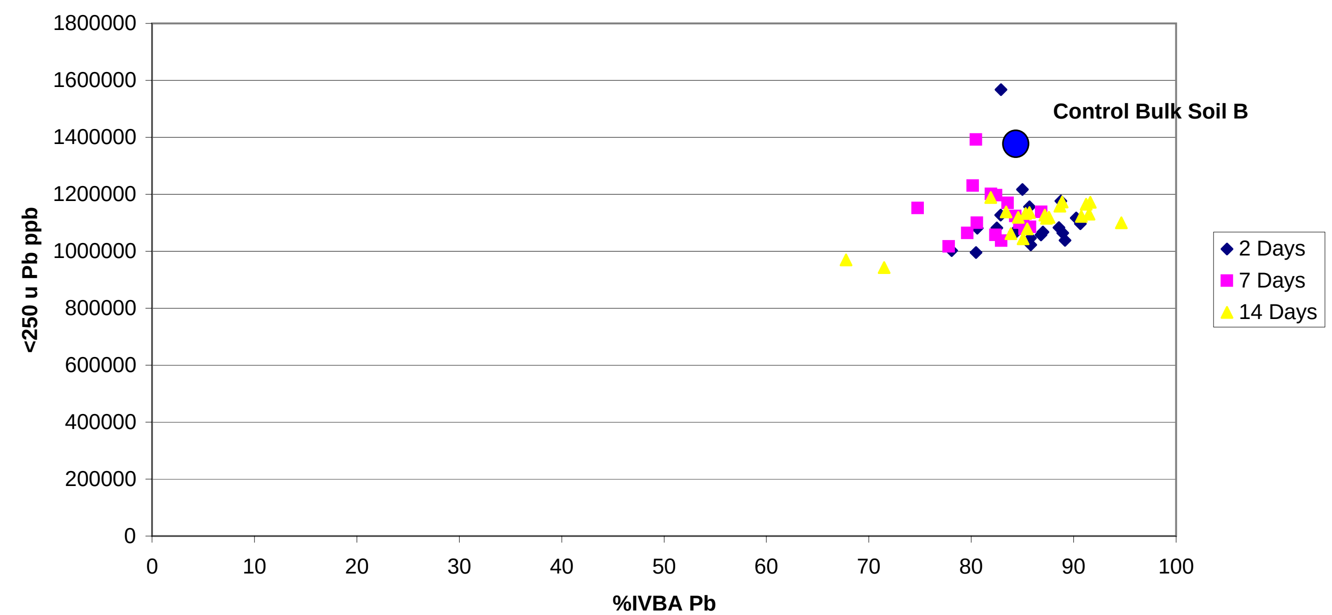
TABLE 2 . Preliminary Summary Of In Vitro Bioassay Results

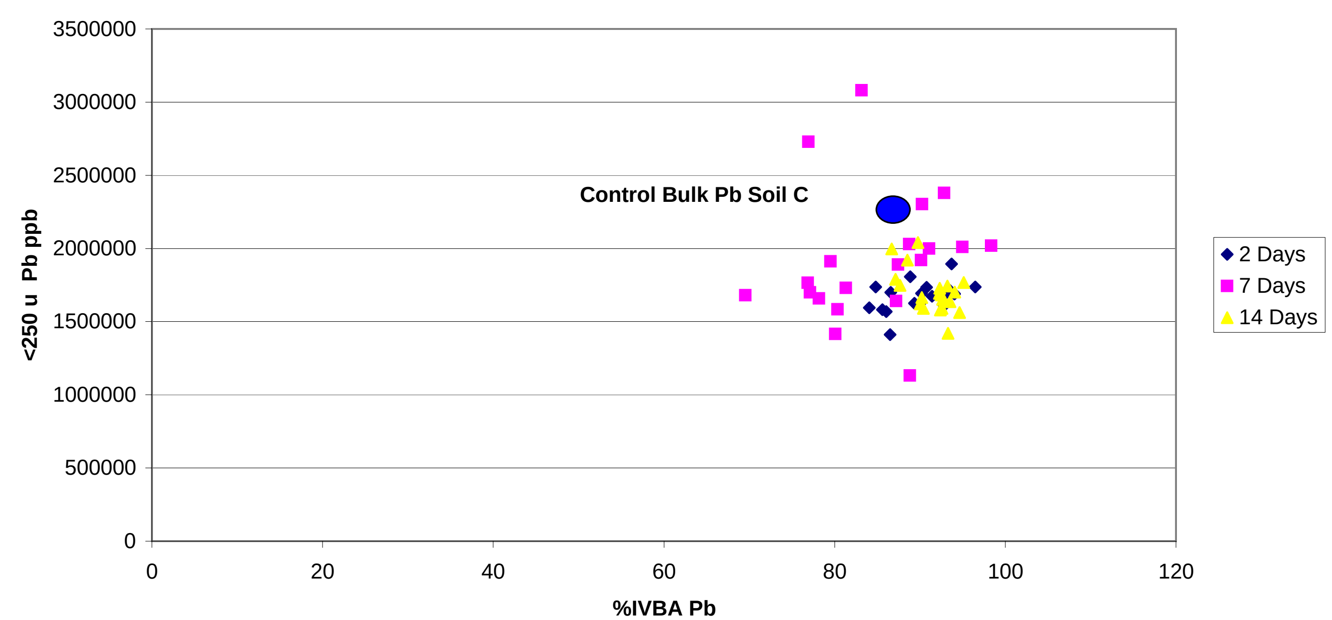
Sample	ID	Pb in <250u bulk soil µg/kg	mass soil (g)	calc Pb #1	ICP Pb (µg/l)	solution amt (l)	% Relative Pb Bioavailability	
A-1-2 1.5		805137	1.0008	805.78	6731	0.1	84	
A-2-2 1.5		808650	1.00044	809.01	6521	0.1	81	
A-3-2 1.5		681294	1.00028	681.48	5549	0.1	81	**81**
A-4-2 1.5		532026	1.00039	532.23	4532	0.1	85	
A-5-2 1.5		621795	1.00098	622.40	4826	0.1	78	
A-6-2 1.5		587869	1.00056	588.20	4998	0.1	85	
A-7-2 1.5		611942	1.0007	612.37	5551	0.1	91	
A-8-2 1.5		604253	1.00026	604.41	5476	0.1	91	
A-9-2 1.5		614677	1.00041	614.93	5054	0.1	82	
A-10-2 1.5		617640	1.00111	618.33	5013	0.1	81	
A-11-2 1.5		701391	1.00058	701.80	6202	0.1	88	
A-12-2 1.5		650821	1.00093	651.43	5609	0.1	86	
A-13-2 1.5		537240	1.00137	537.98	5047	0.1	94	
A-14-2 1.5		654949	1.00095	655.57	5690	0.1	87	
A-15-2 1.5		614403	1.00046	614.69	5268	0.1	86	
A-16-2 1.5		629066	1.00104	629.72	5108	0.1	81	
A-17-2 1.5		591390	1.00048	591.67	4852	0.1	82	
A-18-2 1.5		655213	1.00021	655.35	5377	0.1	82	
A-19-2 1.5		646260	1.00072	646.73	5750	0.1	89	
A-20-2 1.5		640882	1.00015	640.98	5842	0.1	91	
A-21-2 1.5		600208	1.00027	600.37	5160	0.1	86	
A-22-2 1.5		603908	1.00073	604.35	5269	0.1	87	
B-1-2 1.5		1377381	1.00157	1379.54	11343	0.1	82	
B-2-2 1.5		1311224	1.00082	1312.30	11892	0.1	91	
B-3-2 1.5		1082182	1.00128	1083.57	8939	0.1	82	
B-4-2 1.5		1062169	1.00054	1062.74	8948	0.1	84	
B-5-2 1.5		1046255	1.02483	1072.23	9197	0.1	86	
B-6-2 1.5		1080661	1.00879	1090.16	8786	0.1	81	
B-7-2 1.5		1083535	1.00898	1093.27	9680	0.1	89	
B-8-2 1.5		1067811	1.01777	1086.79	9153	0.1	84	
B-9-2 1.5		1002386	1.0074	1009.80	7886	0.1	78	
B-10-2 1.5		995630	1.00087	996.50	8018	0.1	80	
B-11-2 1.5		1217070	1.00965	1228.81	10444	0.1	85	
B-12-2 1.5		1176734	1.00695	1184.91	10515	0.1	89	

	Soil A	Soil B	Soil C
Control Bulk Pb	ppb		
	805137.5	1377381	2220312
	808649.9	1311224	2157539
	827954	1427932	2330276
	844000	1448251	2365095
	827083	1436138	2169086
	828561	1439339	2194213
	865589	1557081	2295361
	847586	1250712	2546670
Average	831820	1406007	2284819
StDev	20121	93371	130468



B-13-2 1.5	1155706	1.00669	1163.44	9967	0.1	86
B-14-2 1.5	1096131	1.01098	1108.17	10045	0.1	91
B-15-2 1.5	1067154	1.02827	1097.32	9545	0.1	87
B-16-2 1.5	1127347	1.02665	1157.39	9593	0.1	83
B-17-2 1.5	1057823	1.01727	1076.09	9340	0.1	87
B-18-2 1.5	1022882	1.00788	1030.94	8847	0.1	86
B-19-2 1.5	1117094	1.01275	1131.34	10210	0.1	90
B-20-2 1.5	1567277	1.01397	1589.17	13175	0.1	83
B-21-2 1.5	1037699	1.0116	1049.74	9358	0.1	89
B-22-2 1.5	1064065	1.00379	1068.10	9498	0.1	89
C-1-2 1.5	2220312	1.0194	2263.39	20068	0.1	89
C-2-2 1.5	2157539	0.99509	2146.95	19410	0.1	90
C-3-2 1.5	1618747	1.00867	1632.78	15136	0.1	93
C-4-2 1.5	1625407	1.01274	1646.11	14709	0.1	89
C-5-2 1.5	1568554	1.00999	1584.22	13630	0.1	86
C-6-2 1.5	1582247	1.01251	1602.04	13713	0.1	86
C-7-2 1.5	1609242	1.00474	1616.87	15009	0.1	93
C-8-2 1.5	1693382	1.04266	1765.62	15923	0.1	90
C-9-2 1.5	1594532	1.01257	1614.58	13571	0.1	84
C-10-2 1.5	1412139	1.00045	1412.77	12218	0.1	86
C-11-2 1.5	1736799	1.00284	1741.73	16805	0.1	96
C-12-2 1.5	1806966	1.03229	1865.31	16576	0.1	89
C-13-2 1.5	1893764	1.01159	1915.71	17949	0.1	94
C-14-2 1.5	1735079	1.01513	1761.33	15988	0.1	91
C15-2 1.5	1737645	1.02624	1783.24	15125	0.1	85
C-16-2 1.5	1700083	1.00222	1703.86	14749	0.1	87
C17-2 1.5	1623469	0.99887	1621.63	14593	0.1	90
C-18-2 1.5	1673180	1.01065	1691.00	15458	0.1	91
C19-2 1.5	1681157	1.03255	1735.88	16108	0.1	93
C-20-2 1.5	1713476	1.01731	1743.14	16300	0.1	94
C21-2 1.5	1689139	1.03489	1748.07	16437	0.1	94
C-22-2 1.5	1690294	1.00355	1696.29	15955	0.1	94
A1-7 1.5	827954	1.01195	837.85	6919	0.1	83
A2-7 1.5	844000	1.00367	847.10	6588	0.1	78
A3-7 1.5	658684	1.00685	663.20	5886	0.1	89
A4-7 1.5	685079	0.99967	684.85	5628	0.1	82
A5-7 1.5	649964	1.02156	663.98	5498	0.1	83
A6-7 1.5	623924	1.02473	639.35	5076	0.1	79
A7-7 1.5	656944	0.98472	646.91	5566	0.1	86
A8-7 1.5	646450	1.00873	652.09	5684	0.1	87
A9-7 1.5	609855	1.00031	610.04	4821	0.1	79
A10-7 1.5	615261	1.00916	620.90	4906	0.1	79
A11-7 1.5	702865	1.02114	717.72	6296	0.1	88
A12-7 1.5	718707	1.01487	729.39	6421	0.1	88
A137-7 1.5	698685	1.01979	712.51	6318	0.1	89
A14-7 1.5	754238	1.01045	762.12	6252	0.1	82
A15-7 1.5	713505	1.01394	723.45	6084	0.1	84
A17-7 1.5	658857	1.02301	674.02	5886	0.1	87
A18-7 1.5	666174	1.0035	668.51	5417	0.1	81
A19-7 1.5	699173	0.99547	696.01	5651	0.1	81
A20-7 1.5	742458	1.0217	758.57	6559	0.1	86
A21-7 1.5	647617	1.00871	653.26	5840	0.1	89
A22-7 1.5	648775	1.01221	656.70	5662	0.1	86





B1-7 1.5	1427932	1.00697	1437.88	12610	0.1	88
B2-7 1.5	1448251	1.0199	1477.07	12519	0.1	85
B3-7 1.5	1169929	1.004	1174.61	9816	0.1	84
B4-7 1.5	1085163	1.01051	1096.57	9402	0.1	86
B5-7 1.5	1099567	1.00692	1107.18	8920	0.1	81
B6-7 1.5	1056847	1.02285	1081.00	8905	0.1	82
B7-7 1.5	1099673	1.0184	1119.91	9486	0.1	85
B8-7 1.5	1196311	1.00969	1207.90	9957	0.1	82
B9-7 1.5	1036598	1.01627	1053.46	8735	0.1	83
B10-7 1.5	1016903	0.99483	1011.65	7872	0.1	78
B11-7 1.5	1299449	0.99694	1295.47	10422	0.1	80
B12-7 1.5	1139335	1.00000	1139.34	9896	0.1	87
B13-7 1.5	1176003	1.01111	1189.07	10117	0.1	85
B14-7 1.5	1392479	1.01311	1410.73	12023	0.1	85
B15-7 1.5	1137812	1.0003	1138.15	9596	0.1	84
B16-7 1.5	1108866	0.99206	1100.06	8818	0.1	80
B17-7 1.5	1078790	1.00888	1088.37	8917	0.1	82
B18-7 1.5	1124049	1.01495	1140.85	8531	0.1	75
B19-7 1.5	1230887	1.01901	1254.29	9986	0.1	80
B20-7 1.5	1200982	1.01198	1215.37	9816	0.1	81
B21-7 1.5	1151611	1.00643	1159.02	9203	0.1	79
B22-7 1.5	1064332	1.00682	1071.59	8801	0.1	82
C1-7 1.5	2330276	1.02015	2377.23	18998	0.1	80
C2-7 1.5	2365095	0.99581	2355.19	19257	0.1	82
C3-7 1.5	1584236	1.01443	1607.10	12910	0.1	80
C4-7 1.5	1912556	1.00685	1925.66	15315	0.1	80
C5-7 1.5	1132165	0.99714	1128.93	10027	0.1	89
C6-7 1.5	1658073	1.00586	1667.79	13035	0.1	78
C7-7 1.5	1700748	1.0112	1719.80	13262	0.1	77
C8-7 1.5	1764689	0.99641	1758.35	13516	0.1	77
C9-7 1.5	1680722	1.02239	1718.35	11953	0.1	70
C10-7 1.5	1415041	0.99954	1414.39	11329	0.1	80
C11-7 1.5	1729932	1.01679	1758.98	14307	0.1	81
C12-7 1.5	1639902	1.03645	1699.68	14824	0.1	87
C13-7 1.5	2019028	1.00701	2033.18	20000	0.1	98
C14-7 1.5	2378515	1.01855	2422.64	22492	0.1	93
C15-7 1.5	2028967	1.01425	2057.88	18263	0.1	89
C16-7 1.5	1919677	1.00658	1932.31	17419	0.1	90
C17-7 1.5	3080028	1.01524	3126.97	26006	0.1	83
C18-7 1.5	2729021	1.01286	2764.12	21262	0.1	77
C19-7 1.5	1998361	1.02005	2038.43	18568	0.1	91
C20-7 1.5	1889105	1.01343	1914.48	16738	0.1	87
C21-7 1.5	2301750	1.01541	2337.22	21097	0.1	90
C22-7 1.5	2009449	1.02043	2050.50	19473	0.1	95
C1-14 1.5	2169086	1.00901	2188.63	20569	0.1	94
C2-14 1.5	2194213	1.0096	2215.28	21051	0.1	95
C3-14 1.5	1742609	1.01282	1764.95	16454	0.1	93
C4-14 1.5	1652061	1.00968	1668.05	15457	0.1	93
C5-14 1.5	1590131	1.0098	1605.71	14868	0.1	93
C6-14 1.5	1420552	1.02624	1457.83	13599	0.1	93
C7-14 1.5	1692734	1.0129	1714.57	15824	0.1	92

C8-14 1.5	1681235	1.0017	1684.09	15576	0.1	92
C9-14 1.5	1665741	1.01042	1683.10	15187	0.1	90
C10-14 1.5	1591136	1.02472	1630.47	14739	0.1	90
C11-14 1.5	1768201	1.0059	1778.63	16920	0.1	95
C12-14 1.5	2039655	1.01772	2075.80	18631	0.1	90
C13-14 1.5	1997255	1.01368	2024.58	17551	0.1	87
C14-14 1.5	1701493	1.00843	1715.84	16144	0.1	94
C15-14 1.5	1621237	1.02248	1657.68	14923	0.1	90
C16-14 1.5	1921166	1.01363	1947.35	17237	0.1	89
C17-14 1.5	1746869	1.01271	1769.07	15505	0.1	88
C18-14 1.5	1562146	1.01168	1580.39	14954	0.1	95
C19-14 1.5	1728690	1.02435	1770.78	16348	0.1	92
C20-14 1.5	1790238	1.0017	1793.28	15630	0.1	87
C21-14 1.5	1579062	1.00485	1586.72	14661	0.1	92
C22-14 1.5	1635866	1.00617	1645.96	15391	0.1	94
B1-14 1.5	1436138	1.01482	1457.42	12542	0.1	86
B2-14 1.5	1439339	1.01687	1463.62	12189	0.1	83
B3-14 1.5	1138105	1.00365	1142.26	9528	0.1	83
B4-14 1.5	1188256	1.00195	1190.57	9750	0.1	82
B5-14 1.5	1044157	1.01729	1062.21	9035	0.1	85
B6-14 1.5	1062344	1.01794	1081.40	9069	0.1	84
B7-14 1.5	1099800	1.01314	1114.25	10548	0.1	95
B8-14 1.5	1115837	1.00289	1119.06	9774	0.1	87
B9-14 1.5	942462	1.00905	950.99	6798	0.1	71
B10-14 1.5	970125	1.02882	998.08	6763	0.1	68
B11-14 1.5	1165078	1.00466	1170.51	10678	0.1	91
B12-14 1.5	1122074	1.00954	1132.78	10279	0.1	91
B13-14 1.5	1130880	1.00409	1135.51	10390	0.1	91
B14-14 1.5	1158275	1.02546	1187.76	10531	0.1	89
B15-14 1.5	1119399	1.00592	1126.03	9862	0.1	88
B16-14 1.5	1118696	0.9975	1115.90	9440	0.1	85
B17-14 1.5	1132633	1.01239	1146.67	9781	0.1	85
B18-14 1.5	1078621	1.02849	1109.35	9481	0.1	85
B19-14 1.5	1173586	1.01619	1192.59	10597	0.1	89
B20-14 1.5	1171676	1.00994	1183.32	10843	0.1	92
B21-14 1.5	1126662	1.00732	1134.91	9896	0.1	87
B22-14 1.5	1135944	1.03438	1175.00	10066	0.1	86
A1-14 1.5	827083	1.02006	843.67	6476	0.1	77
A2-14 1.5	828561	1.01951	844.73	6497	0.1	77
A3-14 1.5	672190	1.02389	688.25	5517	0.1	80
A4-14 1.5	662275	0.99949	661.94	4951	0.1	75
A5-14 1.5	660231	1.008	665.51	4867	0.1	73
A6-14 1.5	612198	1.02223	625.81	4474	0.1	71
A7-14 1.5	699693	1.00226	701.27	5093	0.1	73
A8-14 1.5	669668	1.02185	684.30	5463	0.1	80
A9-14 1.5	624309	0.99555	621.53	3756	0.1	60
A10-14 1.5	682428	1.00151	683.46	3957	0.1	58
A11-14 1.5	749581	1.00967	756.83	5622	0.1	74
A12-14 1.5	720232	1.02391	737.45	5777	0.1	78
A13-14 1.5	722377	1.01109	730.39	5815	0.1	80
A14-14 1.5	706748	0.99744	704.94	5706	0.1	81
A15-14 1.5	688054	1.02161	702.92	5389	0.1	77
A16-14 1.5	674617	1.01654	685.78	5462	0.1	80
A17-14 1.5	688336	1.01034	695.45	5342	0.1	77
A18-14 1.5	661108	1.0093	667.26	5390	0.1	81
A19-14 1.5	699407	0.99377	695.05	5583	0.1	80
A20-14 1.5	754132	1.02636	774.01	5835	0.1	75
A21-14 1.5	643645	1.02824	661.82	5288	0.1	80

A22-14 1.5	718730	1.02256	734.94	5747	0.1	78	
blank					0.1		
blank-spk (2500 ppb)				2571	0.1		
Nist-2711-E	1162000	1.0268	1193.14	9797	0.1	82	
blank					0.1		
blank-spk (2500 ppb)				2416	0.1		
			0				
Nist2710-E	5532000	1.02091	5647.67	46181	0.1	82	
Blank			0		0.1		
blank-spk (2500 ppb)				2450.219	0.1		
Blank				-0.33483	0.1		
blank-spk (2500 ppb)			-0.20815	2392.72	0.1		
A16-7 1.5	686585	1.01478	696.73	-2.36156	0.1		
blank					0.1		
blank-spk (2500 ppb)				2426	0.1		
blank				-0.0069	0.1		average IVBA values for NIST 2711 =84
blank-spk (2500 ppb)				2346.681	0.1		
Nist2711-A	1162000	1.01566	1180.20	9726.621	0.1	82	
Blank				-0.30102	0.1		
blank-spk (2500 ppb)				2370.786	0.1		
blank					0.1		
blank-spk (2500 ppb)				2443	0.1		
Nist2711-D	1162000	1.01633	1180.98	9829	0.1	83	
blank					0.1		
blank-spk (2500 ppb)			0	2418	0.1		
Nist2711-C	1162000	1.02615	1192.39	10099	0.1	85	
blank					0.1		
blank-spk (2500 ppb)			0	2346	0.1		
Nist2711-B	1162000	1.03082	1197.81	9601	0.1	80	
blank				-0.03037	0.1		average IVBA values for NIST 2710 = 75
blank-spk (2500 ppb)			0	2368.692	0.1		
nist2710-D	5532000	1.02203	5653.87	42220.26	0.1	75	
blank				-0.03244	0.1		
blank-spk (2500 ppb)				2414.094	0.1		
nist-2710-C	5532000	1.00193	5542.68	41403.8	0.1	75	
Blank				-0.36673	0.1		
blank-spk (2500 ppb)				2413.644	0.1		
Nist-2710-B	5532000	1.0255	5673.07	40687.22	0.1	72	
NIST-2710-A	5532000	1.00278	5547.38	40225.56	0.1	73	
Blank					0.1		
blank-spk (2500 ppb)				2352.26	0.1		
			-0.32308				

	Soil A	Soil B	Soil C
Amended	681293.8	1082182	1618747
	532026.5	1062169	1625407
	621795.4	1046255	1568554
	587868.7	1080661	1582247
	611941.5	1083535	1609242
	604252.9	1067811	1693382
	614676.7	1002386	1594532
	617640.1	995630	1412139
	701391.3	1217070	1736799
	650820.7	1176734	1806966
	537239.9	1155706	1893764
	654948.7	1096131	1735079
	614402.6	1067154	1737645
	629066.3	1127347	1700083
	591390	1057823	1623469
	655213.5	1022882	1673180
	646259.9	1117094	1681157
	640881.8	1567277	1713476
	600207.9	1037699	1689139
	603908.3	1064065	1690294
	658684	1169929	1584236
	685079	1085163	1912556
	649964	1099567	1132165
	623924	1056847	1658073
	656944	1099673	1700748
	646450	1196311	1764689
	609855	1036598	1680722
	615261	1016903	1415041
	702865	1299449	1729932
	718707	1139335	1639902
	698685	1176003	2019028
	754238	1392479	2378515
	713505	1137812	2028967
	658857	1108866	1919677
	666174	1078790	3080028
	699173	1124049	2729021
	742458	1230887	1998361
	647617	1200982	1889105
	648775	1151611	2301750
	672190	1064332	2009449
	662275	1138105	1742609

	660231	1188256	1652061
	612198	1044157	1590131
	699693	1062344	1420552
	669668	1099800	1692734
	624309	1115837	1681235
	682428	942462	1665741
	749581	970125	1591136
	720232	1165078	1768201
	722377	1122074	2039655
	706748	1130880	1997255
	688054	1158275	1701493
	674617	1119399	1621237
	688336	1118696	1921166
	661108	1132633	1746869
	699407	1078621	1562146
	754132	1173586	1728690
	643645	1171676	1790238
	718730	1126662	1579062
		1135944	1635866
Average	659397	1119523	1770330
StDev	48803	95795	295592
%Difference from Control	20.73%	20.38%	22.52%

TABLE 2 . Preliminary Summary Of In Vitro Bioassay Results

Sample	ID	As in <250u bulk soil μg/kg	mass soil (g)	calc As #1	ICP As (μg/l)	solution amt (l)	% Relative As Bioavailability
A1-2 2.5		36964	1.00261	37.06	99	0.1	27
A2-2 2.5		37051	1.01143	37.47	96	0.1	26
A3-2 2.5		31785	1.00697	32.01	41	0.1	13
A4-2 2.5		34690	1.00531	34.87	50	0.1	14
A5-2 2.5		30480	1.01436	30.92	43	0.1	14
A6-2 2.5		30824	1.01914	31.41	39	0.1	12
A7-2 2.5		32725	1.00358	32.84	128	0.1	39
A8-2 2.5		32764	1.02226	33.49	142	0.1	43
A9-2 2.5		30159	1.02134	30.80	47	0.1	15
A10-2 2.5		29645	1.00691	29.85	46	0.1	15
Blank					0		
Blank-spk (2500 ppb)					2446		
A11-2 2.5		35193	1.00798	35.47	112	0.1	32
A12-2 2.5		32984	1.00277	33.08	119	0.1	36
A13-2 2.5		34032	1.02274	34.81	118	0.1	34
A14-2 2.5		34973	1.00438	35.13	102	0.1	29
A15-2 2.5		31903	1.01092	32.25	25	0.1	8
A16-2 2.5		32629	1.00027	32.64	29	0.1	9
A17-2 2.5		35688	1.01574	36.25	33	0.1	9
A18-2 2.5		36214	1.02124	36.98	32	0.1	9
A-19-2 2.5		32962	1.00376	33.09	118	0.1	36
A-20-2 2.5		31624	1.00669	31.84	114	0.1	36
Blank					0		
Blank-spk (2500 ppb)					2479		
A-21-2 2.5		39070	1.00625	39.31	124	0.1	31
A-22-2 2.5		37956	0.99986	37.95	125	0.1	33
B-1-2 2.5		42744	1.02734	43.91	112	0.1	25
B-2-2 2.5		42000	1.01229	42.52	112	0.1	26
B-3-2 2.5		35342	1.01167	35.75	36	0.1	10
B-4-2 2.5		34538	1.01162	34.94	34	0.1	10
B-5-2 2.5		33463	1.00419	33.60	38	0.1	11
B-6-2 2.5		34131	1.04282	35.59	43	0.1	12
B-7-2 2.5		36614	1.01164	37.04	127	0.1	34
B-8-2 2.5		36116	1.01433	36.63	127	0.1	35
B-9-2 2.5		32684	1.00073	32.71	40	0.1	12
B-10-2 2.5		33072	1.01823	33.68	39	0.1	11
B-11-2 2.5		40021	1.01617	40.67	122	0.1	30
B-12-2 2.5		37726	1.00145	37.78	123	0.1	33
Blank					0		
Blank-spk (2500 ppb)					2507		
B-13-2 2.5		40607	1.01026	41.02	135	0.1	33
B-14-2 2.5		40765	0.99633	40.62	126	0.1	31
B-15-2 2.5		35457	1.01067	35.83	33	0.1	9
B-16-2 2.5		37912	1.01375	38.43	36	0.1	9

B-17-2 2.5	38800	1.01457	39.37	36	0.1	9
B-18-2 2.5	40344	1.00814	40.67	35	0.1	9
B-19-2 2.5	38234	1.01069	38.64	108	0.1	28
B-20-2 2.5	37075	1.01084	37.48	109	0.1	29
B-21-2 2.5	43171	1.00891	43.56	122	0.1	28
B-22-2 2.5	42521	1.01446	43.14	125	0.1	29
Blank				0		
Blank-spk (2500 ppb)				2491		
C1-2 2.5	14962	1.01991	15.26	22	0.1	15
C2-2 2.5	14551	1.0099	14.70	20	0.1	14
C3-2 2.5	12627	0.99335	12.54	0	0.1	0
C4-2 2.5	13015	1.02134	13.29	3	0.1	2
C5-2 2.5	12519	1.02697	12.86	1	0.1	0
C6-2 2.5	12458	1.02033	12.71	3	0.1	3
C7-2 2.5	13722	1.01778	13.97	25	0.1	18
C8-2 2.5	13475	1.01738	13.71	25	0.1	18
C9-2 2.5	12167	1.0245	12.46	7	0.1	6
C10-2 2.5	12129	0.98456	11.94	6	0.1	5
Blank				0		
Blank-spk (2500 ppb)				2446		
C11-2 2.5	13832	1.014	14.03	30	0.1	21
C12-2 2.5	14513	1.01252	14.70	30	0.1	20
C13-2 2.5	17234	1.00698	17.35	28	0.1	16
C14-2 2.5	17166	0.99933	17.15	28	0.1	16
C15-2 2.5	13817	1.01003	13.96	4	0.1	3
C16-2 2.5	14069	1.01541	14.29	2	0.1	1
C17-2 2.5	16461	1.02764	16.92	7	0.1	4
C18-2 2.5	16342	1.02436	16.74	5	0.1	3
C19-2 2.5	14452	1.02365	14.79	29	0.1	19
C20-2 2.5	13550	1.02686	13.91	28	0.1	20
C21-2 2.5	18940	1.02329	19.38	32	0.1	16
C22-2 2.5	19163	1.00876	19.33	34	0.1	18
Blank				0		
Blank-spk (2500 ppb)				2523		
Blank				0		
Blank-spk (2500 ppb)				2517		
Blank				0		
Blank-spk (2500 ppb)				2317		
A1-7 2.5	36861	1.01122	37.28	84	0.1	23
A2-7 2.5	37956	1.00614	38.19	90	0.1	23
A3-7 2.5	30121	1.0154	30.58	30	0.1	10
A4-7 2.5	31408	1.0043	31.54	28	0.1	9
A5-7 2.5	30385	1.00287	30.47	32	0.1	10
A6-7 2.5	30629	1.02663	31.45	33	0.1	11
A7-7 2.5	32680	1.00666	32.90	112	0.1	34
A8-7 2.5	33096	1.01203	33.49	116	0.1	35
A9-7 2.5	29186	1.00882	29.44	40	0.1	13
A10-7 2.5	29380	1.01022	29.68	36	0.1	12
A11-7 2.5	35107	1.01419	35.61	103	0.1	29
A12-7 2.5	33329	1.01167	33.72	105	0.1	31
A13-7 2.5	37056	1.02031	37.81	116	0.1	31
A14-7 2.5	38319	1.01358	38.84	108	0.1	28
A15-7 2.5	34237	1.01641	34.80	20	0.1	6
A16-7 2.5	32992	0.99871	32.95	15	0.1	5
A17-7 2.5	36379	1.00909	36.71	35	0.1	10
A18-7 2.5	35403	1.01088	35.79	21	0.1	6
A19-7 2.5	32968	1.01687	33.52	104	0.1	31
A20-7 2.5	34608	1.00376	34.74	102	0.1	29
A21-7 2.5	37696	1.01044	38.09	112	0.1	29
A22-7 2.5	37714	1.00093	37.75	109	0.1	29
blank				0		
Blank-spk (2500 ppb)				2298		
B1-7 2.5	41570	1.00238	41.67	92	0.1	22
B2-7 2.5	42860	0.98795	42.34	93	0.1	22
B3-7 2.5	33282	1.01095	33.65	45	0.1	13
B4-7 2.5	32516	1.02084	33.19	43	0.1	13
B5-7 2.5	35252	1.00057	35.27	28	0.1	8
B6-7 2.5	32465	0.99931	32.44	26	0.1	8

B7-7 2.5	34867	0.99401	34.66	115	0.1	33
B8-7 2.5	36640	1.00477	36.81	112	0.1	31
B9-7 2.5	32088	0.99805	32.03	38	0.1	12
B10-7 2.5	30875	1.02573	31.67	49	0.1	16
blank				0		
Blank-spk (2500 ppb)				2278		
B11-7 2.5	38818	1.01728	39.49	106	0.1	27
B12-7 2.5	37225	1.0181	37.90	110	0.1	29
B13-7 2.5	41615	1.00774	41.94	100	0.1	24
B14-7 2.5	39928	1.01652	40.59	121	0.1	30
B15-7 2.5	36123	1.01348	36.61	29	0.1	8
B16-7 2.5	35698	0.99608	35.56	27	0.1	8
B17-7 2.5	38777	1.02249	39.65	29	0.1	7
B18-7 2.5	40530	1.00674	40.80	27	0.1	7
B19-7 2.5	39993	0.99828	39.92	147	0.1	37
B20-7 2.5	37520	1.01676	38.15	148	0.1	39
B21-7 2.5	42561	1.00743	42.88	143	0.1	33
B22-7 2.5	42079	1.02639	43.19	147	0.1	34
C1-7 2.5	14968	1.02206	15.30	30	0.1	19
C2-7 2.5	15091	1.02737	15.50	25	0.1	16
C3-7 2.5	12844	1.01688	13.06	16	0.1	12
C4-7 2.5	12709	1.01095	12.85	16	0.1	12
blank				-0.009		
Blank-spk (2500 ppb)				2658		
C5-7 2.5	13141	1.02358	13.45	11	0.1	8
C6-7 2.5	12926	0.99736	12.89	10	0.1	8
C7-7 2.5	13732	1.03088	14.16	33	0.1	23
C8-7 2.5	13573	1.03531	14.05	38	0.1	27
C9-7 2.5	12695	1.0152	12.89	11	0.1	9
C10-7 2.5	13173	0.99659	13.13	11	0.1	8
C11-7 2.5	15150	1.0001	15.15	31	0.1	21
C12-7 2.5	14314	1.01051	14.46	26	0.1	18
C13-7 2.5	16658	1.02583	17.09	37	0.1	21
C14-7 2.5	19441	1.01108	19.66	39	0.1	20
blank				0.081		
Blank-spk (2500 ppb)				2527		
C15-7 2.5	13695	1.00999	13.83	7	0.1	5
C16-7 2.5	14102	1.0151	14.31	4	0.1	3
C17-7 2.5	17630	1.01551	17.90	3	0.1	2
C18-7 2.5	18641	1.02369	19.08	4	0.1	2
C19-7 2.5	13811	1.01164	13.97	27	0.1	19
C20-7 2.5	14294	1.0007	14.30	36	0.1	25
C21-7 2.5	22559	1.01168	22.82	36	0.1	16
C22-7 2.5	20189	1.01702	20.53	36	0.1	18
C1-14 2.5	14102	1.03359	14.58	26	0.1	18
C2-14 2.5	14398	1.02164	14.71	26	0.1	18
BLANK				-0.075		
Blank-spk (2500 ppb)				2489		
C3-14 2.5	12733	0.98953	12.60	14	0.1	11
C4-14 2.5	12645	1.02045	12.90	10	0.1	8
C5-14 2.5	12199	0.99142	12.09	10	0.1	8
C6-14 2.5	12026	1.02455	12.32	10	0.1	8
C7-14 2.5	13940	1.01257	14.12	35	0.1	24
C8-14 2.5	13589	1.00931	13.72	39	0.1	28
C9-14 2.5	12334	1.02183	12.60	16	0.1	13
C10-14 2.5	11535	1.00022	11.54	14	0.1	12
C11-14 2.5	13935	1.0097	14.07	32	0.1	23
C12-14 2.5	13936	1.01039	14.08	35	0.1	25
C13-14 2.5	17402	1.02416	17.82	32	0.1	18
C14-14 2.5	16578	1.00033	16.58	30	0.1	18
C15-14 2.5	13348	0.99398	13.27	6	0.1	4
C16-14 2.5	13972	1.02127	14.27	7	0.1	5
blank				-0.061		
Blank-spk (2500 ppb)				2446		
C17-14 2.5	17095	1.01703	17.39	9	0.1	5
C18-14 2.5	15861	1.01095	16.03	9	0.1	6
C19-14 2.5	15045	1.01426	15.26	35	0.1	23
C20-14 2.5	15370	1.03026	15.84	30	0.1	19

C21-14 2.5	18685	1.0102	18.88	33	0.1	17
C22-14 2.5	19694	1.00137	19.72	38	0.1	19
B1-14 2.5	43234	1.00467	43.44	108	0.1	25
B2-14 2.5	43870	1.02777	45.09	115	0.1	26
B3-14 2.5	35104	1.0161	35.67	41	0.1	11
B4-14 2.5	34682	1.01896	35.34	42	0.1	12
blank				-0.013		
Blank-spk (2500 ppb)				2621		
B5-15 2.5	32719	1.01325	33.15	46	0.1	14
B6-14 2.5	33330	1.01056	33.68	43	0.1	13
B7-14 2.5	38370	0.9929	38.10	145	0.1	38
B8-14 2.5	37374	0.98996	37.00	145	0.1	39
B9-14 2.5	31768	0.99431	31.59	50	0.1	16
B10-14 2.5	31580	0.99165	31.32	46	0.1	15
B11-14 2.5	38449	1.01285	38.94	133	0.1	34
B12-14 2.5	37715	1.01935	38.44	146	0.1	38
B13-14 2.5	38640	0.99962	38.63	127	0.1	33
B14-14 2.5	39281	1.01461	39.86	130	0.1	33
BLANK				-0.083		
Blank-spk (2500 ppb)				2600		
B15-14 2.5	33644	1.00465	33.80	30	0.1	9
B16-14 2.5	36675	0.99995	36.67	31	0.1	8
B17-14 2.5	38845	0.99897	38.81	41	0.1	11
B18-14 2.5	37269	1.01854	37.96	35	0.1	9
B19-14 2.5	37194	1.00389	37.34	139	0.1	37
B20-14 2.5	37075	1.01117	37.49	145	0.1	39
B21-14-2.5	41973	1.00605	42.23	131	0.1	31
B22-14 2.5	42779	1.02318	43.77	125	0.1	28
BLANK				-0.014		
Blank-spk (2500 ppb)				2604		
A1-14 2.5	36476	1.01622	37.07	102	0.1	27
A2-14 2.5	36571	1.03159	37.73	92	0.1	24
A3-14 2.5	30622	1.01873	31.20	36	0.1	11
A4-14 2.5	30495	0.98984	30.18	35	0.1	12
A5-14 2.5	31792	1.00899	32.08	37	0.1	12
A6-14 2.5	29588	0.99912	29.56	48	0.1	16
A7-14 2.5	34169	1.01343	34.63	134	0.1	39
A8-14 2.5	33130	1.00573	33.32	122	0.1	37
A9-14 2.5	29664	1.04499	31.00	45	0.1	15
A10-14 2.5	32907	1.00801	33.17	41	0.1	12
A11-14 2.5	35961	1.00485	36.14	112	0.1	31
A12-14 2.5	36453	1.01772	37.10	123	0.1	33
A13-14 2.5	37095	0.99729	36.99	122	0.1	33
A14-14 2.5	37089	1.014	37.61	124	0.1	33
A15-14 2.5	33850	1.01009	34.19	27	0.1	8
A16-14 2.5	33385	1.00055	33.40	24	0.1	7
A17-14 2.5	36767	1.00242	36.86	43	0.1	12
A18-14 2.5	36753	1.01796	37.41	47	0.1	13
A19-14 2.5	35013	1.01805	35.65	129	0.1	36
A20-14 2.5	35354	1.00641	35.58	124	0.1	35
A21-14 2.5	38466	1.01327	38.98	123	0.1	32
A22-14 2.5	40410	1.01352	40.96	116.46	0.1	28
BLANK				0.068		
Blank-spk (2500 ppb)				2636.235		

TABLE 2 . Preliminary Summary Of In Vitro Bioassay Results

Sample	ID	Pb in <250u bulk soil µg/kg	mass soil (g)	calc Pb #1	ICP Pb (µg/l)	solution amt (l)	% Relative Pb Bioavailability
A1-2 2.5		805137	1.00261	807.24	3389	0.1	42
A2-2 2.5		808650	1.01143	817.89	3507	0.1	43
A3-2 2.5		681294	1.00697	686.04	2534	0.1	37
A4-2 2.5		532026	1.00531	534.85	1954	0.1	37
A5-2 2.5		621795	1.01436	630.72	1630	0.1	26
A6-2 2.5		587869	1.01914	599.12	1463	0.1	24
A7-2 2.5		611942	1.00358	614.13	1745	0.1	28
A8-2 2.5		604253	1.02226	617.70	1674	0.1	27
A9-2 2.5		614677	1.02134	627.79	1132	0.1	18
A10-2 2.5		617640	1.00691	621.91	1068	0.1	17
Blank					0		
Blank Spike (2500 ppb)					2470		
A11-2 2.5		701391	1.00798	706.99	3022	0.1	43
A12-2 2.5		650821	1.00277	652.62	2883	0.1	44
A13-2 2.5		537240	1.02274	549.46	2682	0.1	49
A14-2 2.5		654949	1.00438	657.82	3142	0.1	48
A15-2 2.5		614403	1.01092	621.11	2375	0.1	38
A16-2 2.5		629066	1.00027	629.24	2328	0.1	37
A17-2 2.5		591390	1.01574	600.70	2281	0.1	38
A18-2 2.5		655213	1.02124	669.13	2615	0.1	39
A-19-2 2.5		646260	1.00376	648.69	2357	0.1	36
A-20-2 2.5		640882	1.00669	645.17	2512	0.1	39
Blank					0		
Blank Spike (2500 ppb)					2496		
A-21-2 2.5		600208	1.00625	603.96	2832	0.1	47
A-22-2 2.5		603908	0.99986	603.82	2977	0.1	49
B-1-2 2.5		1377381	1.02734	1415.04	7169	0.1	51
B-2-2 2.5		1311224	1.01229	1327.34	7075	0.1	53
B-3-2 2.5		1082182	1.01167	1094.81	4254	0.1	39
B-4-2 2.5		1062169	1.01162	1074.51	4625	0.1	43
B-5-2 2.5		1046255	1.00419	1050.64	2991	0.1	28
B-6-2 2.5		1080661	1.04282	1126.93	2955	0.1	26
B-7-2 2.5		1083535	1.01164	1096.15	2757	0.1	25
B-8-2 2.5		1067811	1.01433	1083.11	2737	0.1	25
B-9-2 2.5		1002386	1.00073	1003.12	1953	0.1	19
B-10-2 2.5		995630	1.01823	1013.78	2067	0.1	20
B-11-2 2.5		1217070	1.01617	1236.75	6075	0.1	49
B-12-2 2.5		1176734	1.00145	1178.44	6105	0.1	52
Blank					0		
Blank-spk (2500 ppb)					2612		

B-13-2 2.5	1155706	1.01026	1167.56	6285	0.1	54
B-14-2 2.5	1096131	0.99633	1092.11	6303	0.1	58
B-15-2 2.5	1067154	1.01067	1078.54	5039	0.1	47
B-16-2 2.5	1127347	1.01375	1142.85	4922	0.1	43
B-17-2 2.5	1057823	1.01457	1073.24	5060	0.1	47
B-18-2 2.5	1022882	1.00814	1031.21	4724	0.1	46
B-19-2 2.5	1117094	1.01069	1129.04	4769	0.1	42
B-20-2 2.5	1567277	1.01084	1584.27	6195	0.1	39
B-21-2 2.5	1037699	1.00891	1046.94	5300	0.1	51
B-22-2 2.5	1064065	1.01446	1079.45	5599	0.1	52
Blank				0		
Blank-spk (2500 ppb)				2583		
C1-2 2.5	2220312	1.01991	2264.52	13292	0.1	59
C2-2 2.5	2157539	1.0099	2178.90	13083	0.1	60
C3-2 2.5	1618747	0.99335	1607.98	7178	0.1	45
C4-2 2.5	1625407	1.02134	1660.09	7377	0.1	44
C5-2 2.5	1568554	1.02697	1610.86	4437	0.1	28
C6-2 2.5	1582247	1.02033	1614.41	4884	0.1	30
C7-2 2.5	1609242	1.01778	1637.85	5444	0.1	33
C8-2 2.5	1693382	1.01738	1722.81	6040	0.1	35
C9-2 2.5	1594532	1.0245	1633.60	4026	0.1	25
C10-2 2.5	1412139	0.98456	1390.34	3388	0.1	24
Blank				0		
Blank-spk (2500 ppb)				2521		
C11-2 2.5	1736799	1.014	1761.11	10314	0.1	59
C12-2 2.5	1806966	1.01252	1829.59	9979	0.1	55
C13-2 2.5	1893764	1.00698	1906.98	11947	0.1	63
C14-2 2.5	1735079	0.99933	1733.92	10975	0.1	63
C15-2 2.5	1737645	1.01003	1755.07	9209	0.1	52
C16-2 2.5	1700083	1.01541	1726.28	8642	0.1	50
C17-2 2.5	1623469	1.02764	1668.34	9804	0.1	59
C18-2 2.5	1673180	1.02436	1713.94	9927	0.1	58
C19-2 2.5	1681157	1.02365	1720.92	8526	0.1	50
C20-2 2.5	1713476	1.02686	1759.50	8699	0.1	49
C21-2 2.5	1689139	1.02329	1728.48	10385	0.1	60
C22-2 2.5	1690294	1.00876	1705.10	10482	0.1	61
Blank				0		
Blank-spk (2500 ppb)				2613		
Blank				0		
Blank-spk (2500 ppb)				2582		
Blank				0		
Blank-spk (2500 ppb)				2370		
A1-7 2.5	827954	1.01122	837.24	3149	0.1	38
A2-7 2.5	844000	1.00614	849.18	3133	0.1	37
A3-7 2.5	658684	1.0154	668.83	2330	0.1	35
A4-7 2.5	685079	1.0043	688.03	2089	0.1	30
A5-7 2.5	649964	1.00287	651.83	1438	0.1	22
A6-7 2.5	623924	1.02663	640.54	1534	0.1	24
A7-7 2.5	656944	1.00666	661.32	1294	0.1	20
A8-7 2.5	646450	1.01203	654.23	1134	0.1	17
A9-7 2.5	609855	1.00882	615.23	936	0.1	15
A10-7 2.5	615261	1.01022	621.55	1088	0.1	18
A11-7 2.5	702865	1.01419	712.84	2880	0.1	40
A12-7 2.5	718707	1.01167	727.09	2912	0.1	40
A13-7 2.5	698685	1.02031	712.87	3075	0.1	43
A14-7 2.5	754238	1.01358	764.48	3008	0.1	39
A15-7 2.5	713505	1.01641	725.21	2690	0.1	37
A16-7 2.5	686585	0.99871	685.70	2591	0.1	38
A17-7 2.5	658857	1.00909	664.85	2483	0.1	37
A18-7 2.5	666174	1.01088	673.42	2475	0.1	37
A19-7 2.5	699173	1.01687	710.97	2755	0.1	39
A20-7 2.5	742458	1.00376	745.25	2971	0.1	40
A21-7 2.5	647617	1.01044	654.38	2954	0.1	45
A22-7 2.5	648775	1.00093	649.38	2830	0.1	44

blank				0		
Blank-spk (2500 ppb)				2354		
B1-7 2.5	1427932	1.00238	1431.33	6326	0.1	44
B2-7 2.5	1448251	0.98795	1430.80	6328	0.1	44
B3-7 2.5	1169929	1.01095	1182.74	3587	0.1	30
B4-7 2.5	1085163	1.02084	1107.78	3960	0.1	36
B5-7 2.5	1099567	1.00057	1100.19	2417	0.1	22
B6-7 2.5	1056847	0.99931	1056.12	2671	0.1	25
B7-7 2.5	1099673	0.99401	1093.09	2111	0.1	19
B8-7 2.5	1196311	1.00477	1202.02	2536	0.1	21
B9-7 2.5	1036598	0.99805	1034.58	1384	0.1	13
B10-7 2.5	1016903	1.02573	1043.07	2227	0.1	21
blank				0		
Blank-spk (2500 ppb)				2352		
B11-7 2.5	1299449	1.01728	1321.90	5375	0.1	41
B12-7 2.5	1139335	1.0181	1159.96	5003	0.1	43
B13-7 2.5	1176003	1.00774	1185.11	5406	0.1	46
B14-7 2.5	1392479	1.01652	1415.48	6792	0.1	48
B15-7 2.5	1137812	1.01348	1153.15	4300	0.1	37
B16-7 2.5	1108866	0.99608	1104.52	4434	0.1	40
B17-7 2.5	1078790	1.02249	1103.05	4111	0.1	37
B18-7 2.5	1124049	1.00674	1131.62	4277	0.1	38
B19-7 2.5	1230887	0.99828	1228.77	5094	0.1	41
B20-7 2.5	1200982	1.01676	1221.11	5025	0.1	41
B21-7 2.5	1151611	1.00743	1160.17	5458	0.1	47
B22-7 2.5	1064332	1.02639	1092.42	4964	0.1	45
C1-7 2.5	2330276	1.02206	2381.68	13481	0.1	57
C2-7 2.5	2365095	1.02737	2429.83	14012	0.1	58
C3-7 2.5	1584236	1.01688	1610.98	6765	0.1	42
C4-7 2.5	1912556	1.01095	1933.50	7981	0.1	41
blank				0.009		
Blank-spk (2500 ppb)				2580		
C5-7 2.5	1132165	1.02358	1158.86	3843	0.1	33
C6-7 2.5	1658073	0.99736	1653.70	5535	0.1	33
C7-7 2.5	1700748	1.03088	1753.27	5434	0.1	31
C8-7 2.5	1764689	1.03531	1827.00	5559	0.1	30
C9-7 2.5	1680722	1.0152	1706.27	4340	0.1	25
C10-7 2.5	1415041	0.99659	1410.22	4177	0.1	30
C11-7 2.5	1729932	1.0001	1730.11	9474	0.1	55
C12-7 2.5	1639902	1.01051	1657.14	9086	0.1	55
C13-7 2.5	2019028	1.02583	2071.18	13493	0.1	65
C14-7 2.5	2378515	1.01108	2404.87	14794	0.1	62
blank				0.017		
Blank-spk (2500 ppb)				2534		
C15-7 2.5	2028967	1.00999	2049.24	10774	0.1	53
C16-7 2.5	1919677	1.0151	1948.66	9284	0.1	48
C17-7 2.5	3080028	1.01551	3127.80	16896	0.1	54
C18-7 2.5	2729021	1.02369	2793.67	13497	0.1	48
C19-7 2.5	1998361	1.01164	2021.62	8391	0.1	42
C20-7 2.5	1889105	1.0007	1890.43	9194	0.1	49
C21-7 2.5	2301750	1.01168	2328.63	13693	0.1	59
C22-7 2.5	2009449	1.01702	2043.65	12310	0.1	60
C1-14 2.5	2169086	1.03359	2241.95	14950	0.1	67
C2-14 2.5	2194213	1.02164	2241.70	14100	0.1	63
BLANK				0.053		
Blank-spk (2500 ppb)				2495		
C3-14 2.5	1742609	0.98953	1724.36	9049	0.1	52
C4-14 2.5	1652061	1.02045	1685.85	8949	0.1	53
C5-14 2.5	1590131	0.99142	1576.49	6643	0.1	42
C6-14 2.5	1420552	1.02455	1455.43	6056	0.1	42
C7-14 2.5	1692734	1.01257	1714.01	6750	0.1	39
C8-14 2.5	1681235	1.00931	1696.89	6820	0.1	40
C9-14 2.5	1665741	1.02183	1702.10	4778	0.1	28
C10-14 2.5	1591136	1.00022	1591.49	4812	0.1	30

C11-14 2.5	1768201	1.0097	1785.35	10792	0.1	60
C12-14 2.5	2039655	1.01039	2060.85	12027	0.1	58
C13-14 2.5	1997255	1.02416	2045.51	13755	0.1	67
C14-14 2.5	1701493	1.00033	1702.05	10719	0.1	63
C15-14 2.5	1621237	0.99398	1611.48	9200	0.1	57
C16-14 2.5	1921166	1.02127	1962.03	10804	0.1	55
blank				0.228		
Blank-spk (2500 ppb)				2497		
C17-14 2.5	1746869	1.01703	1776.62	9796	0.1	55
C18-14 2.5	1562146	1.01095	1579.25	9169	0.1	58
C19-14 2.5	1728690	1.01426	1753.34	8138	0.1	46
C20-14 2.5	1790238	1.03026	1844.41	8292	0.1	45
C21-14 2.5	1579062	1.0102	1595.17	9742	0.1	61
C22-14 2.5	1635866	1.00137	1638.11	9682	0.1	59
B1-14 2.5	1436138	1.00467	1442.84	7172	0.1	50
B2-14 2.5	1439339	1.02777	1479.31	7447	0.1	50
B3-14 2.5	1138105	1.0161	1156.43	4645	0.1	40
B4-14 2.5	1188256	1.01896	1210.79	4806	0.1	40
blank				0.168		
Blank-spk (2500 ppb)				2608		
B5-15 2.5	1044157	1.01325	1057.99	3139	0.1	30
B6-14 2.5	1062344	1.01056	1073.56	3103	0.1	29
B7-14 2.5	1099800	0.9929	1091.99	2635	0.1	24
B8-14 2.5	1115837	0.98996	1104.63	2495	0.1	23
B9-14 2.5	942462	0.99431	937.10	1266	0.1	14
B10-14 2.5	970125	0.99165	962.02	965	0.1	10
B11-14 2.5	1165078	1.01285	1180.05	5920	0.1	50
B12-14 2.5	1122074	1.01935	1143.79	5457	0.1	48
B13-14 2.5	1130880	0.99962	1130.45	6089	0.1	54
B14-14 2.5	1158275	1.01461	1175.20	6361	0.1	54
BLANK				0.053	0.1	
Blank-spk (2500 ppb)				2620	0.1	
B15-14 2.5	1119399	1.00465	1124.60	5335	0.1	47
B16-14 2.5	1118696	0.99995	1118.64	5125	0.1	46
B17-14 2.5	1132633	0.99897	1131.47	5386	0.1	48
B18-14 2.5	1078621	1.01854	1098.62	5145	0.1	47
B19-14 2.5	1173586	1.00389	1178.15	5274	0.1	45
B20-14 2.5	1171676	1.01117	1184.76	5377	0.1	45
B21-14-2.5	1126662	1.00605	1133.48	5569	0.1	49
B22-14 2.5	1135944	1.02318	1162.27	5423	0.1	47
BLANK				0.118		
Blank-spk (2500 ppb)				2628		
A1-14 2.5	827083	1.01622	840.50	3609	0.1	43
A2-14 2.5	828561	1.03159	854.73	3494	0.1	41
A3-14 2.5	672190	1.01873	684.78	2562	0.1	37
A4-14 2.5	662275	0.98984	655.55	2589	0.1	39
A5-14 2.5	660231	1.00899	666.17	1696	0.1	25
A6-14 2.5	612198	0.99912	611.66	1634	0.1	27
A7-14 2.5	699693	1.01343	709.09	1594	0.1	22
A8-14 2.5	669668	1.00573	673.51	1855	0.1	28
A9-14 2.5	624309	1.04499	652.40	884	0.1	14
A10-14 2.5	682428	1.00801	687.89	1058	0.1	15
A11-14 2.5	749581	1.00485	753.22	3168	0.1	42
A12-14 2.5	720232	1.01772	732.99	3215	0.1	44
A13-14 2.5	722377	0.99729	720.42	3304	0.1	46
A14-14 2.5	706748	1.014	716.64	3279	0.1	46
A15-14 2.5	688054	1.01009	695.00	2771	0.1	40
A16-14 2.5	674617	1.00055	674.99	2801	0.1	41
A17-14 2.5	688336	1.00242	690.00	2963	0.1	43
A18-14 2.5	661108	1.01796	672.98	2865	0.1	43
A19-14 2.5	699407	1.01805	712.03	2901	0.1	41
A20-14 2.5	754132	1.00641	758.97	2972	0.1	39
A21-14 2.5	643645	1.01327	652.19	2937	0.1	45
A22-14 2.5	718730	1.01352	728.45	3017.371	0.1	41

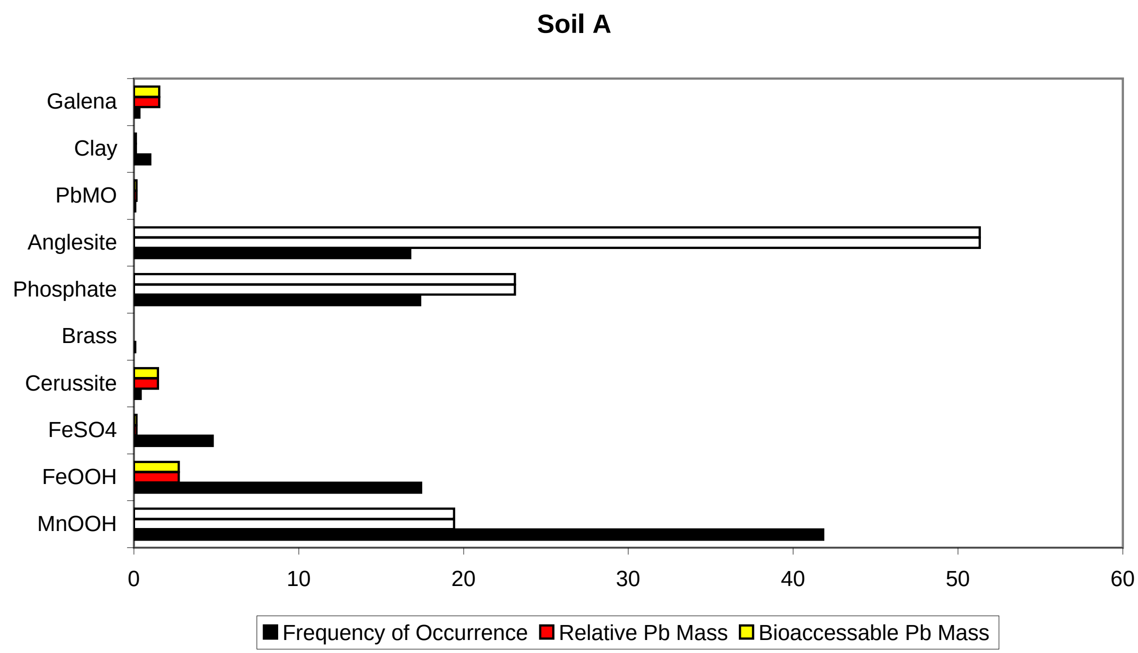
BLANK	-0.015
Blank-spk (2500 ppb)	2250.793

Form	Association	Size (microns)
Mn	Cemented	17
Mn	Liberated	4
Fe	Cemented	11
Mn	Cemented	8
Mn	Cemented	7
Mn	Cemented	3
Mn	Cemented	3
Mn	Cemented	3
Mn	Cemented	3
Mn	Cemented	3
Mn	Cemented	7
Sulf	Liberated	15
Fe	Liberated	4
Fe	Cemented	7
Cer	Liberated	6
Fe	Cemented	13
brass	Liberated	1
Fe	Cemented	9
Fe	Rimming	5
Sulf	Liberated	8
Phos	Cemented	3
Fe	Cemented	6
Mn	Cemented	18
Mn	Rimming	14
Mn	Cemented	11
Mn	Cemented	14
Mn	Cemented	27
Mn	Cemented	26
Mn	Cemented	44

Form	Particle Count Number	Size Mean	Std-Dev	Range low	Range high
total	103	14.65	30.12	1	250
MnOOH	39	16.18	16.19	3	85
FeOOH	25	10.52	10.36	1	50
FeSO4	10	7.2	8.28	3	28
Cerussite	1	6	ND	6	6
Brass	1	1	ND	1	1
Phosphate	20	13.1	33.94	1	150
Anglesite	2	126.5	174.66	3	250
PbMO	1	1	ND	1	1
Clay	3	5	4.36	2	10
Galena	1	5	ND	5	5

Form	(linear) freq	Bio freq	Rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
MnOOH	41.82	41.82	19.43	19.43	9.53
FeOOH	17.43	17.43	2.72	2.72	7.33
FeSO4	4.77	4.77	0.15	0.15	4.12
Cerussite	0.4	0.4	1.45	1.45	1.22
Brass	0.07	0.07	0	0	0.5
Phosphate	17.36	17.36	23.11	23.11	7.32
Anglesite	16.77	16.77	51.32	51.32	7.21
PbMO	0.07	0.07	0.16	0.16	0.5
Clay	0.99	0.99	0.12	0.12	1.92
Galena	0.33	0.33	1.53	1.53	1.11

Sulf	Rimming	28
Mn	Cemented	13
Fe	Liberated	50
Mn	Cemented	3
Mn	Cemented	28
Ang	Liberated	3
Mn	Liberated	16
Mn	Liberated	8
Fe	Cemented	4
Fe	Cemented	10
Mn	Liberated	22
Phos	Liberated	9
Fe	Cemented	9
Fe	Cemented	27
Mn	Rimming	8
Fe	Liberated	8
Mn	Cemented	16
Mn	Cemented	12
Phos	Cemented	40
Fe	Cemented	9
Fe	Liberated	10
Fe	Liberated	8
Phos	Cemented	3
Phos	Cemented	4
Mn	Cemented	8
Mn	Rimming	13
Mn	Rimming	7
Mn	Rimming	3
PbMO	Cemented	1
Ang	Cemented	250
Phos	Cemented	150
Mn	Rimming	50
Fe	Rimming	4
Fe	Liberated	3
Fe	Cemented	1
Fe	Cemented	1
Fe	Liberated	4
Phos	Cemented	8
Mn	Cemented	13
Mn	Cemented	42
Fe	Liberated	21
Sulf	Liberated	3
Sulf	Liberated	3
Sulf	Liberated	3



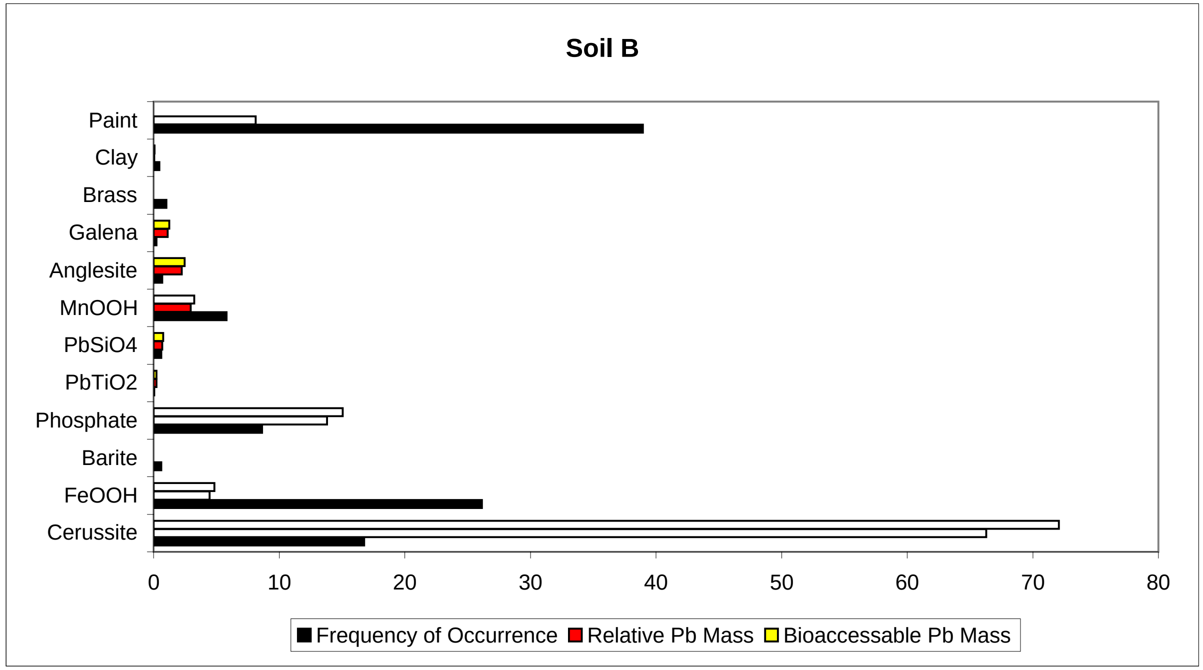
Sulf	Liberated	3
Sulf	Liberated	3
Sulf	Liberated	3
Sulf	Liberated	3
Mn	Cemented	85
AlSi	Liberated	2
AlSi	Liberated	10
AlSi	Liberated	3
Fe	Liberated	9
Phos	Liberated	2
Mn	Cemented	16
Mn	Cemented	10
Fe	Cemented	22
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Phos	Cemented	1
Mn	Cemented	10
Ga	Liberated	5
Phos	Liberated	32
Fe	Liberated	8
Mn	Liberated	8
Mn	Cemented	28

Form	Association	Size (microns)
Cer	Liberated	1
Fe	Liberated	11
Cer	Cemented	1
bar	Cemented	3
Cer	Cemented	1
Phos	Liberated	3
Cer	Liberated	2
Cer	Cemented	1
Fe	Cemented	32
Fe	Cemented	6
Cer	Liberated	1
Fe	Cemented	13
Fe	Rimming	10
Fe	Cemented	14
Cer	Liberated	1
pbtio2	Liberated	1
Cer	Cemented	1
PbSiO4	Liberated	1
Cer	Liberated	1
Cer	Liberated	4
Cer	Liberated	3
Cer	Liberated	1
Mn	Liberated	6
Phos	Liberated	3
Fe	Rimming	5
Mn	Cemented	30
Fe	Cemented	65
Cer	Cemented	3
Cer	Liberated	1
Cer	Liberated	1
Cer	Liberated	1
Fe	Liberated	4

Form	Particle Count Number	Size Mean	Std-Dev	Range low	Range high
total	135	13.12	62.09	1	690
Cerussite	63	4.71	25.03	1	200
FeOOH	24	19.29	19.53	4	75
Barite	2	5.5	3.54	3	8
Phosphate	21	7.29	9.2	1	43
PbTiO2	1	1	ND	1	1
PbSiO4	9	1.22	0.44	1	2
MnOOH	7	14.71	11.48	1	30
Anglesite	3	4	4.36	1	9
Galena	2	2	1.41	1	3
Brass	1	18	ND	18	18
Clay	1	8	ND	8	8
Paint	1	690	ND	690	690

Form	(linear) freq	Bio freq	Rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
Cerussite	16.77	27.41	66.29	72.08	6.3
FeOOH	26.14	42.87	4.45	4.85	7.41
Barite	0.62	1.02	0	0	1.33
Phosphate	8.64	14.17	13.8	15.06	4.74
PbTiO2	0.06	0.09	0.22	0.24	0.4
PbSiO4	0.62	1.02	0.7	0.77	1.33
MnOOH	5.82	9.54	2.96	3.23	3.95
Anglesite	0.68	1.11	2.25	2.46	1.38
Galena	0.23	0.37	1.13	1.24	0.8
Brass	1.02	1.67	0.01	0.01	1.69
Clay	0.45	0.74	0.06	0.07	1.13
Paint	38.96	0	8.12	0	8.23

Cer	Cemented	1
Cer	Liberated	3
Cer	Liberated	1
Cer	Liberated	1
PbSiO4	Liberated	1
Cer	Cemented	1
Phos	Cemented	5
Phos	Liberated	2
Mn	Cemented	18
Cer	Liberated	1
Phos	Cemented	11
Cer	Rimming	1
Phos	Cemented	4
Phos	Cemented	7
Phos	Liberated	43
Fe	Cemented	16
Phos	Cemented	2
Ang	Rimming	1
Phos	Liberated	19
Cer	Liberated	1
Cer	Liberated	1
Cer	Liberated	1
bar	Rimming	8
Phos	Liberated	6
PbSiO4	Liberated	1
PbSiO4	Liberated	1
Mn	Cemented	1
Fe	Cemented	12
Cer	Inclusion	1
Fe	Cemented	16
Phos	Liberated	1
Phos	Liberated	6
Ga	Liberated	3
Cer	Liberated	3
Phos	Liberated	5
Cer	Cemented	2
Cer	Cemented	1
Fe	Rimming	16
Ang	Liberated	2
Cer	Liberated	1
Fe	Cemented	7
Fe	Liberated	5
Fe	Liberated	4
Cer	Liberated	1
Cer	Rimming	1



Phos	Liberated	4
Cer	Liberated	9
Cer	Liberated	5
Cer	Liberated	2
Mn	Liberated	29
Cer	Liberated	1
Cer	Liberated	2
brass	Liberated	18
AlSi	Cemented	8
Cer	Liberated	1
PbSiO4	Rimming	1
PbSiO4	Liberated	1
Fe	Liberated	23
Cer	Liberated	1
Cer	Cemented	200
Cer	Liberated	1
Cer	Liberated	4
Cer	Liberated	1
Mn	Cemented	13
Cer	Liberated	2
Phos	Liberated	5
PbSiO4	Liberated	1
Cer	Liberated	2
Fe	Liberated	75
Mn	Cemented	6
Phos	Cemented	13
Phos	Liberated	5
Ga	Liberated	1
Cer	Liberated	3
Fe	Liberated	35
Cer	Liberated	1
Cer	Liberated	2
Cer	Cemented	1
Fe	Cemented	4
Fe	Cemented	4
Phos	Liberated	4
Phos	Liberated	3
Cer	Liberated	1
Cer	Liberated	1
PbSiO4	Liberated	2
Fe	Cemented	42
Cer	Liberated	1
Cer	Liberated	1
Cer	Liberated	1
Cer	Liberated	1

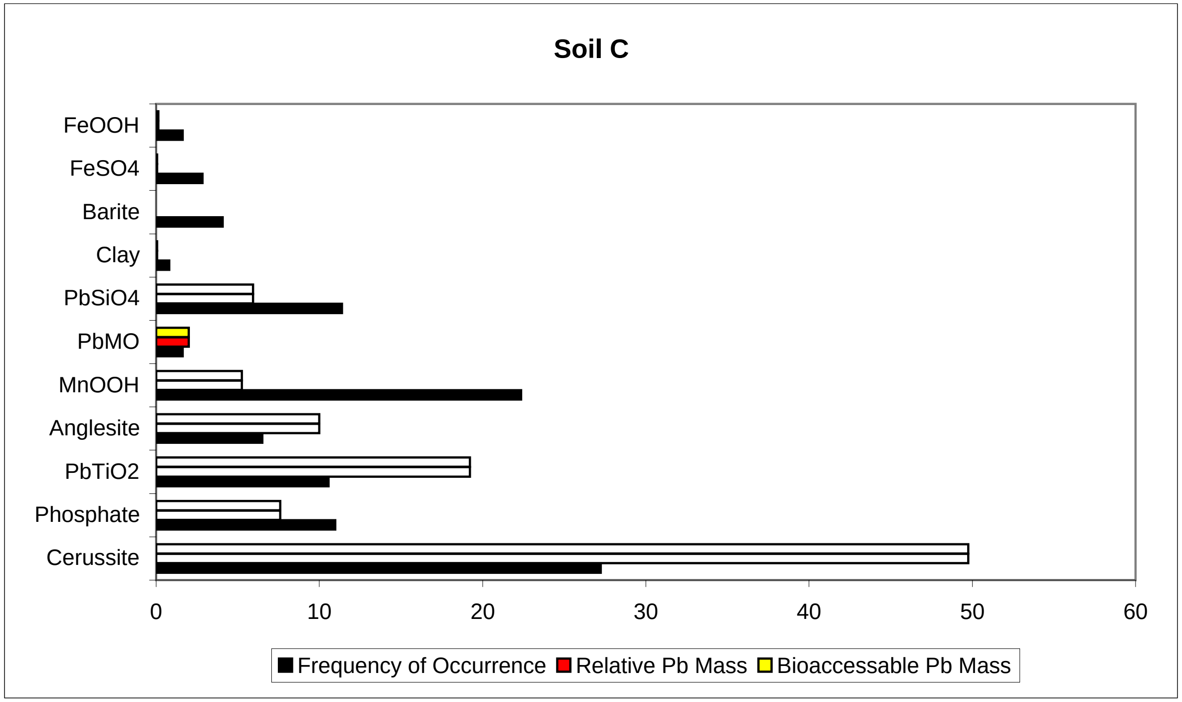
Cer	Liberated	1
Cer	Liberated	1
Cer	Liberated	1
Cer	Liberated	1
Cer	Liberated	1
Cer	Liberated	1
Fe	Liberated	40
Phos	Liberated	2
Ang	Rimming	9
Fe	Liberated	4
PbSiO4	Liberated	2
Cer	Liberated	1
Paint	Liberated	690

Form	Association	Size (microns)
Cer	Liberated	1
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
Phos	Cemented	2
pbtio2	Liberated	2
Ang	Liberated	8
Ang	Liberated	8
Mn	Liberated	19
Mn	Rimming	20
PbMO	Liberated	4
Cer	Liberated	5
Cer	Cemented	1
Cer	Cemented	1
pbtio2	Liberated	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	3
PbSiO4	Liberated	2
PbSiO4	Liberated	2
PbSiO4	Liberated	1
Cer	Cemented	1
PbSiO4	Liberated	2

Form	Particle Count Number	Size Mean	Std-Dev	Range low	Range high
total	110	2.24	3.22	1	20
Cerussite	38	1.76	1.63	1	8
Phosphate	12	2.25	0.87	2	5
PbTiO2	25	1.04	0.2	1	2
Anglesite	2	8	0	8	8
MnOOH	3	18.33	2.08	16	20
PbMO	1	4	ND	4	4
PbSiO4	25	1.12	0.33	1	2
Clay	1	2	ND	2	2
Barite	1	10	ND	10	10
FeSO4	1	7	ND	7	7
FeOOH	1	4	ND	4	4

Form	(linear) freq	Bio freq	Rm Pb	Biorm Pb	Error-95%
%	%	%	%	%	
Cerussite	27.24	27.24	49.76	49.76	8.32
Phosphate	10.98	10.98	7.6	7.6	5.84
PbTiO2	10.57	10.57	19.23	19.23	5.75
Anglesite	6.5	6.5	10	10	4.61
MnOOH	22.36	22.36	5.26	5.26	7.79
PbMO	1.63	1.63	1.99	1.99	2.36
PbSiO4	11.38	11.38	5.94	5.94	5.94
Clay	0.81	0.81	0.05	0.05	1.68
Barite	4.07	4.07	0	0	3.69
FeSO4	2.85	2.85	0.05	0.05	3.11
FeOOH	1.63	1.63	0.13	0.13	2.36

Cer	Liberated	5
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Liberated	4
Cer	Liberated	2
AlSi	Liberated	2
bar	Cemented	10
Sulf	Liberated	7
Phos	Cemented	5
Mn	Cemented	16
Fe	Cemented	4
Cer	Cemented	2
Cer	Liberated	5
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
Cer	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1



pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
pbtio2	Cemented	1
Cer	Cemented	8
Cer	Cemented	4
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1
PbSiO4	Cemented	1