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LEACHATE CHEMISTRY DATA FOR SOLID MINE WASTE COMPOSITE SAMPLES FROM SILVERTON AND LEADVILLE, COLORADO

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Abstract

The leachate chemistry data for solid mine waste composite samples are presented for comparison. Four mine waste composite samples were samples collected from Silverton (YUK and MAY) and Leadville (SUN and VEN), Colorado and underwent laboratory leach procedures. The laboratory leach procedures utilized for this study are EPA Method 1311 Toxicity Characteristic Leaching Procedure (TCLP), a modification of the TCLP utilizing deionized water (TCLP-DI), EPA Method 1312 Synthetic Precipitation Leaching Procedure (SPLP), and a modification of EPA Method 1312 (MM1). Data from a field leach test and from collected rainfall runoff are presented. For the laboratory study, pH data by sample indicates that pH increased by method: SPLP≤TCLP-DI<MM1<<TCLP. Within a particular method, the sample pH values ranked VEN<SUN<YUK<MAY. Specific conductivity values for each sample increased by method: MM1<TCLP-DI≤SPLP<<TCLP. Specific conductivity values for samples within a particular method ranked: MAY<YUK<SUN<VEN. For metal concentrations, no consistent pattern emerges for a particular method with the exception of lead, where the TCLP method extracted more lead than the other methods for all four samples. The field leach test was performed on a grab sample from the YUK site. Data indicates that the pH was lower, specific conductivity and metal concentrations were higher than was observed in the mine waste composite laboratory leach test data. Rainfall runoff data collected from the MAY site had a slightly lower pH, high specific conductivity value and metal concentrations than the MAY composite sample laboratory leach test data. The exception was lead, where the TCLP lead concentration was higher.

Introduction

Metal Contamination from Mining Waste

Accurately assessing metal mobility from abandoned mine waste piles is an area of concern for land management agencies. Drainage and runoff from mine waste piles can present water quality concerns similar to acid mine drainage. Mine waste piles that contain potential metal and sulfide reservoirs can become sources of acidic drainage when exposed to the surface conditions of oxygen and water. Work that has begun on abandoned mine lands projects have demonstrated a need for a method to aid land management agencies in characterizing and prioritizing mine waste piles for remediation. Current leach methods suggested by the U.S. Environmental Protection Agency, Toxicity Characteristic Leaching Procedure (TCLP) and Synthetic Precipitation Leaching Procedure (SPLP), were developed to determine toxicity for disposal purposes and not intended to accurately predict surface runoff chemistry from mine waste piles. The effects of particle size reduction, end-over-end rotary agitation, and extended extraction time (18 hours) are believed to remove most realistic approximations of simulating runoff from mine waste. Alternative leach methods that more closely approximate field conditions as well as quick, simple field leach methods are needed to help determine more realistic runoff chemistry values as well as to aid agencies in characterizing and prioritizing mine waste piles for remediation.

Purpose of Investigation

The purpose of the original leach study was to conduct a comparison of solid mine waste leachate chemistry utilizing several different extraction, also known as leach, methods. The leachate chemistry results for different methods were to be compared with each other for a particular sampling location and compared with actual rainfall runoff chemistry when available. The results of this comparative study were to be utilized in the development of a simpler, more realistic leach procedure. This leach procedure would be a modification of EPA Method 1312 and, while developed for laboratory use, could be quickly modified for field use in the preliminary characterization of solid mine waste. This paper presents the data from the work completed on the comparative phase of the overall leach study.

General Methods of Study

The main goal of this study was to compare the resulting leachate chemistry from solid mine wastes that were subjected to different extraction methods. Four solid mine waste sample composites were prepared for use in leach studies. Each split of a mine waste composite sample had a different extraction method performed on it. The four extraction methods utilized for this portion of the comparative study were EPA Methods 1311 (TCLP) and 1312 (SPLP), and two modifications of those methods (TCLP-DI and MM1). The resulting leachate from the experiments was filtered as designated by the method and aliquots of the filtrate were taken for metals and anion analysis. Measurements were made for pH, specific conductivity, and temperature on both unfiltered and filtered aliquots of the leachate. For one extraction method (MM1), an aliquot of the unfiltered leachate was collected for metals analysis.

Methods

Sampling

Sampling Locations

Four samples were collected from two mining districts in Colorado. Two samples, Mayday (MAY) and Yukon (YUK), were collected from the Silverton district in southwestern Colorado in July, 1997. The sampling sites are located along Cement Creek north of Silverton in San Juan County (37°15'00" 107°40'00"). Two samples, Sunday No. 2 (SUN) and Venir (VEN), were collected from the eastern side of the Leadville mining district in Lake County (39°15'00" 106°17'30"), near the middle of the northeast-trending Colorado mineral belt during August, 1997.

Collection of Mine Waste Composite Samples

At each location, the Mine Waste Characterization Project members delineated a grid of approximately 30 cells for sampling on the mine waste pile. Thirty subsamples were taken randomly from the pile surface (upper 6 inches/15 cm) within each individual grid cell. The cell composite subsamples were collected with a steel trowel, placed in a plastic bucket, and then mixed together in a plastic dishpan to produce the grid cell composite. A subsample of the grid cell composite was stored in a paper soil sampling bag to aid in drying of the sample. All of the grid cell composite samples were then composited into one large mine waste pile sample composite representing all of the grid cells.

Upon return to the laboratory, the mine waste pile composite samples were spread out on plastic sheets and air dried. Samples were turned once daily with plastic shovels until it was visually determined that the samples were completely dry. The dried composite samples were then mixed in a V-blender to break up solidified clods. Each composite was then sieved with a 2 mm screen, with the < 2 mm fraction being re-homogenized in the V-blender for use in these experiments. The mine waste pile sample composites were the samples used for the comparison study experiments conducted in the laboratory (P. Hageman, unpublished notes).

Collection of Cell Sample for Rainfall Leach Experiment

During the sampling at the Silverton District, an opportunity to perform an "in-situ" rainfall leach experiment presented itself. A grab sample from Yukon mine waste pile, sample grid cell B1, was collected with a steel trowel and a plastic bucket. The sample material consisted of a gray, sulfide-rich material, with visible specks of pyrite present throughout. The material was wet from the persistent rainfall. The sample was then immediately set up for the rainfall leach experimental procedure which is described in the laboratory testing section.

Collection of Mine Waste Pile Rainfall Runoff Samples

Samples of rainfall runoff from the Mayday waste pile in the Silverton mining district were collected by USGS Water Resources Division (WRD) personnel on September 6, 1997. A precipitation event occurred and WRD water sample bottles were used to collect storm runoff from the lower pile at the Mayday site. Five bottles of runoff sample were collected from small rivulets on the surface of the pile. No water samples were filtered. Three bottles were acidified with HNO_3 acid for preservation of metals (Samples MAY WRD1 FA, MAY WRD2 FA, MAY WRD3 FA), while the remaining two bottles remained unacidified (MAY WRD4 FU, MAY WRD 5 FU) (USGS WRD personnel, unpublished field notes).

Laboratory Testing

Extraction procedures utilized in the laboratory and field are outlined in Table 1. The important parameters of the various methods are presented. Specifics for each particular extraction method are presented below.

TCLP

The Toxicity Characteristic Leaching Procedure (TCLP) (U.S. EPA Method 1311; U.S. Environmental Protection Agency, 1986) is a leaching test utilized by the Environmental Protection Agency to characterize the toxicity of waste. The TCLP utilizes an acetic acid extraction fluid designed to simulate a co-disposal scenario of municipal waste with industrial waste in a sanitary landfill. The use of an acetic acid extraction fluid is intended to model an acidic leachate presumed to be most dominant in a municipal landfill environment. While this is not necessarily the most appropriate leach method to be utilized for determining the potential impact of mine wastes on the local environment, it is still a regulatory point of reference and needs to be performed to determine the toxicity of the solid mine waste composite samples.

The TCLP extraction method for 100% solids and no volatiles was utilized. A sample that is 100% solids involves determining the appropriate TCLP extraction fluid to use, reduction of particle size to <1 cm (if necessary), and then extracting the solid at a 20:1

Table 1. Leach Methods Used in Comparative Study

Method Name	Test Type	Liquid to Solid Ratio	Extractant Fluid Chemistry	pH of Extractant Fluid	Particle Size Reduction	Minimum Amount of Sample	Length of Extraction Time	Method of Agitation	Filtration	Filter Type and Pore Size
EPA - 1311 TCLP	Batch	20 to 1	buffered acetic acid (0.1 M)	based on alkalinity: 4.93 or 2.88	< 1 cm	100 g	18 hours	end-over-end rotary	yes positive pressure	0.7 um borosilicate glass
TCLP - Deionized Water	Batch	20 to 1	deionized water	approx. 5.7	< 1 cm	100 g	18 hours	end-over-end rotary	yes positive pressure	0.7 um borosilicate glass
EPA - 1312 SPLP	Batch	20 to 1	60/40 H_2SO_4/HNO_3	4.2 wastes & East soils 5.0 West soils	< 1 cm	100 g	18 hours	end-over-end rotary	yes positive pressure	0.7 um borosilicate glass
Montour Method 1	Batch	20 to 1	60/40 H_2SO_4/HNO_3	4.2 wastes & East soils 5.0 West soils	no	1000 g	2 hours	inversion at intervals	yes positive pressure	0.45 um nitrocellulose
Field - rainfall	column?	0.4 to 1	natural rainfall	pH of rainfall	no	na	21 hours	natural percolation	yes syringe	0.45 um nitrocellulose

liquid to solid ratio on an end-over-end rotary agitator for 18 hours. The solid/liquid slurry is then filtered through a 0.7 µm borosilicate glass fiber filter utilizing a pressure filtration unit. The TCLP method utilizes the alkalinity of the sample to determine the appropriate extraction fluid. All four of the mine waste composite samples underwent preliminarytesting to determine the appropriate TCLP extraction fluid and it was determined that all samples would utilize TCLP extraction fluid 1, a buffered, acetic acid leaching fluid of pH 4.93 ± 0.05. Since the mine waste composites samples were sieved to utilize the <2 mm fraction, there was no need for particle size reduction.

Clean extraction vessels (Nalgene® high density polyethylene 2-liter bottles) were rinsed twice with 10 mL of extracting fluid and the rinses discarded. One hundred grams of each sample were weighed out and placed in an extractor vessel. Two liters of the appropriate extraction fluid were slowly added to the vessel. The extractor vessels had Teflon® tape wrapped around the bottle threads to create a tight seal and minimize leaks when the caps were closed. The extractor vessels were secured in an Analytical Testing Rotary Agitator (Model DC-20B) and rotated for 18 hours at 28 r.p.m.

After 18 hours of extraction, the samples were filtered through a new 0.7 µm borosilicate glass fiber filter (Gelman Sciences Inc. P/N 66257, TCLP glass fiber filter, 0.7 µm pore size, 142 mm diameter). The filtration unit was a Gelman Sciences Hazardous Waste pressure filtration unit (Gelman Sciences Product No. 15046). The filters were acid-washed with one liter of 1 N HNO_3 followed by three one liter deionized water rinses prior to filtration of the samples. A small aliquot of the unfiltered leachate was taken for pH and specific conductivity measurements. After filtration, the pH, temperature, and specific conductivity of the filtrates were measured and recorded.

Aliquots of the filtrate (TCLPA) were taken for different analyses. An aliquot designated for cations and metals measurement by inductively coupled plasma-atomic emission spectrometry (ICP-AES) and inductively coupled plasma-mass spectrometry (ICP-MS) was preserved by acidification to pH $\leq$ 1.5 with Ultrex® II Ultrapure nitric acid. An unacidified aliquot designated for ion chromatography analysis to determine selected anion concentrations was preserved by refrigeration.

TCLP-DI

The method of replacing the TCLP acetic acid extraction fluid with deionized water is informally known as the TCLP-DI. This procedure is designed to parallel the TCLP method, but does not require preliminary evaluation steps to determine the appropriate TCLP extraction fluid since deionized water is used for all samples. All other procedure steps of the TCLP-DI method remain the same as the TCLP method.

The method for a sample that is 100% solids and no volatiles requires reduction of particle size to <1 cm (if necessary), and then extracting the solid at a 20:1 liquid to solid ratio on an end-over-end rotary agitator for 18 hours. The solid/liquid slurry is then filtered through a 0.7 µm borosilicate glass fiber filter utilizing a pressure filtration unit. Since the mine waste composites samples were sieved to utilize the <2 mm fraction, there was no need for particle size reduction.

Following the TCLP method, clean extraction vessels (Nalgene® high density polyethylene 2-liter bottles) were rinsed twice with 10 mL of deionized water and the rinses discarded. One hundred grams of each sample were weighed out and placed in an extractor vessel.

Two liters deionized water were slowly added to the vessel. The extractor vessels had Teflon® tape wrapped around the bottle threads to create a tight seal and minimize leaks when the caps were closed. The extractor vessels were secured in an Analytical Testing Rotary Agitator (Model DC-20B) and rotated for 18 hours at 28 r.p.m.

After 18 hours of extraction, the samples were filtered through a new 0.7 µm borosilicate glass fiber filter (Gelman Sciences Inc. P/N 66257, TCLP glass fiber filter, 0.7 µm pore size, 142 mm diameter). The filtration unit was a Gelman Sciences Hazardous Waste pressure filtration unit (Gelman Sciences Product No. 15046). The filters were acid-washed with one liter of 1 N HNO_3 followed by three one liter deionized water rinses prior to filtration of the samples. A small aliquot of the unfiltered leachate was taken for pH and specific conductivity measurements. After filtration, the pH, specific conductivity, and the temperature of the filtrates were measured and recorded.

Aliquots of the filtrate (EPADIA) were taken for different analyses. An aliquot designated for cations and metals measurement by ICP-AES and ICP-MS was preserved by acidification to pH $\leq$ 1.5 with Ultrex® II Ultrapure nitric acid. An unacidified aliquot designated for ion chromatography analysis to determine selected anion concentrations was preserved by refrigeration.

SPLP

The Synthetic Precipitation Leaching Procedure (SPLP) (U.S. EPA Method 1312; U.S. Environmental Protection Agency, 1986; 1994 update) is a method designed by the Environmental Protection Agency to evaluate the impact of contaminated soils on groundwater. Although the SPLP method closely parallels the TCLP, the extraction fluid consists of slightly acidified deionized water that is designed to simulate precipitation. A mixture of 60/40 H_2SO_4/HNO_3 (by weight) is used to achieve the appropriate pH for the extraction fluid. The pH of the deionized water is adjusted with the 60/40 H_2SO_4/HNO_3 mixture, depending on which side of the Mississippi River the soils originate from, to either pH 4.2 $\pm$ 0.05 (east of the Mississippi) or pH 5.0 $\pm$ 0.05 (west of the Mississippi). The SPLP mandates that for wastes, the more acidic pH 4.2 extraction fluid be used. For this study, the pH 4.2 extraction fluid was used for all samples because they were all mine wastes.

This procedure is designed to parallel the TCLP method, but does not require preliminary experimental steps to determine the appropriate SPLP extraction fluid since determination of the appropriate extraction fluid is dependent on sample type and origin. All other procedure steps of the SPLP method remain the same as the TCLP method.

The SPLP extraction method for 100% solids and no volatiles was utilized for this study. A sample that is 100% solids requires reduction of particle size to <1 cm (if necessary), and then extracting the solid at a 20:1 liquid to solid ratio on an end-over-end rotary agitator for 18 hours. The solid/liquid slurry is then filtered through a 0.7 µm borosilicate glass fiber filter utilizing a pressure filtration unit. Since the mine waste composites samples were sieved to utilize the <2 mm fraction, there was no need for particle size reduction.

Clean extraction vessels (Nalgene® high density polyethylene 2-liter bottles) were rinsed twice with 10 mL of pH 4.2 extraction solution and the rinses discarded. One hundred grams of each sample were weighed out and placed in an extractor vessel. Two liters pH 4.2 extraction solution were slowly added to the vessel. The extractor vessels had Teflon® tape wrapped around the bottle threads to create a tight seal and minimize leaks when the caps were closed. The extractor vessels were secured in an Analytical Testing Rotary Agitator (Model DC-20B) and rotated for 18 hours at 28 r.p.m.

After 18 hours of extraction, the samples were filtered through a new 0.7 μm borosilicate glass fiber filter (Gelman Sciences Inc. P/N 66257, TCLP glass fiber filter, 0.7 μm pore size, 142 mm diameter). The filtration unit was a Gelman Sciences Hazardous Waste pressure filtration unit (Gelman Sciences Product No. 15046). The filters were acid-washed with one liter of 1 N HNO_3 followed by three one liter deionized water rinses prior to filtration of the samples. A small aliquot of the unfiltered leachate was taken for pH and specific conductivity measurements. After filtration, the pH, specific conductivity, and the temperature of the filtrates were measured and recorded.

Aliquots of the filtrate (SPLPA) were taken for different analyses. An aliquot designated for cations and metals measurement by ICP-AES and ICP-MS was preserved by acidification to pH $\leq$ 1.5 with Ultrex® II Ultrapure nitric acid. An unacidified aliquot designated for ion chromatography analysis to determine selected anion concentrations was preserved by refrigeration.

Montour Method 1

This method, a modification of the SPLP method, was designed by M. Montour as a short term method to assess the mobility of metals in surface runoff from mine waste piles. The method utilizes the pH 4.2 extraction fluid from the SPLP method and the liquid to solid ratio of 20:1, but agitates the sample gently by periodic inversion, as opposed to the end-over-end rotary agitation performed in the EPA methods. This method attempted to create a more realistic approximation to runoff conditions by eliminating the vigorous agitation of the EPA methods and by eliminating particle size reduction of the sample.

The method is intended for use on a 100% solids sample. The particle size of the solid phase is not reduced. The solid sample is extracted at a 20:1 liquid to solid ratio, with the extraction fluid utilized dependent on the same conditions as the EPA SPLP method. The sample is leached for two hours and the solution is mixed by inverting the sample gently at periodic time intervals over a two hour time period. After two hours, the sample is filtered through a 0.45 μm nitrocellulose filter utilizing a pressure filtration unit. For the purposes of this study, the pH 4.2 extraction fluid was used for all samples because the samples were mine wastes. The 0.45 μm filter pore size was utilized because it is the generally accepted pre size to determine concentrations of dissolved constituents.

Clean extraction vessels (Nalgene® high density polyethylene 2-liter bottles) were rinsed twice with 10 mL of pH 4.2 extraction solution and the rinses discarded. One hundred grams of each sample were weighed out and placed in an extractor vessel. Two liters pH 4.2 extraction solution were slowly added to the vessel. The extractor vessels had Teflon® tape wrapped around the bottle threads to create a tight seal and minimize leaks when the caps were closed. The extractor vessels were inverted gently by hand and then returned to an upright position and placed on the laboratory bench countertop. The inversion of the samples was repeated at 5 minutes, 30 minutes, 1 hour, 1 hour 30 minutes, and at 2 hours. The samples are allowed to settle for a 5 minute period.

Prior to filtration, an aliquot of decanted leachate is collected for pH, temperature, and specific conductivity measurements. Another aliquot of unfiltered, decanted leachate is collected and preserved with Ultrex® II Ultrapure nitric acid to pH $\leq$ 1.5 for subsequent metals analysis by ICP-AES and ICP-MS (MM1 RA). The remainder of the decanted leachate was filtered through a new 0.45 μm cellulose nitrate filter (Geotech No.

GN045142, 0.45 µm pore size, 142 mm diameter). The filtration unit was a Gelman Sciences Hazardous Waste pressure filtration unit (Gelman Sciences Product No. 15046). The filters were rinsed with 300 mL of sample leachate, with the rinse discarded appropriately. The remainder of the leachate was processed through the filtration system. After filtration, the pH, specific conductivity, and the temperature of the filtrates were measured and recorded.

Aliquots of the filtrate were taken for different analyses. An aliquot (MM1 FA) designated for cations and metals measurement by ICP-AES and ICP-MS was preserved by acidification to pH $\leq$ 1.5 with Ultrex® II Ultrapure nitric acid. An unacidified aliquot (MM1 FU) designated for ion chromatography analysis to determine selected anion concentrations was preserved by refrigeration. The detailed procedure of this method is listed in Appendix A.

Field Testing

Rainfall Leach Field Experiment

During the field sampling at the Silverton district, a sustained period of rainfall occurred and it was decided to set up a field test to see how mine waste behaves under actual rainfall conditions. After a grab sample was collected from one of the Yukon waste sampling grids, the solid sample (wet from rainfall) was placed on a plastic pool skimmer that sat across the top of a 2-gallon bucket. The solid sample (YUKB1LCH) was smoothed out with the steel trowel to try to get an even as layer of sample as possible over the top of the bucket. The sample was also arranged so that all sample was in a pattern on the pool skimmer that covered the opening of the bucket, with no sample lying outside of the area. A rain gauge was set up next to the two gallon bucket to estimate the amount of rainfall. The experiment was set up in the afternoon of 7/30/97. The weather was drizzly and rainy for most of the day. It took approximately two hours for the material to have rainwater leach through (approximately 0.25 inches or 0.6 cm of rain accumulated in gauge). The experiment was left out overnight and checked the following morning. The sample was in the experimental setup for 21 hours total.

At 21 hours, the rain gauge level was noted at 0.4 inches (approximately 1 cm) of rainfall. A minor amount of fine material washed through the sieve into the bucket during the rainfall extraction period, but the majority of the material stayed on top of the pool skimmer. The solid material was collected from the mesh material of the pool skimmer and placed in a plastic one liter container to measure the weight of the wet material later. 414 mL of leachate was collected from the bucket underlying the sample and placed in a one liter bottle for processing. Measurements of pH, specific conductivity, and temperature were made on an aliquot of the unfiltered leachate. The leachate was filtered with a 0.45 µm, cellulose nitrate, syringe filter (MSI P/N DDE04025SD).

Aliquots were collected for metals and anions analyses. The aliquot designated for cations and metals measurement by ICP-AES and ICP-MS was preserved by acidification to pH $\leq$ 1.5 with Ultrex® II Ultrapure nitric acid. The unacidified aliquot designated for ion chromatography analysis to determine selected anion concentrations was preserved by refrigeration.

Upon return to the laboratory, the wet solid sample was weighed. Utilizing the rain gauge measurement of rainfall and the measured diameter of the two-gallon bucket, the volume of rainfall added to the solids during the 21 hour period was calculated to be 568 mL.

Analytical Methods

Methods employed to analyze the various parameters are discussed below. Table 2 lists the methods, sample preservation techniques, and recommended holding times for the analytes. Analyses for this study were performed by U.S. Geological Survey personnel in the Central Region Mineral Resources Program, Denver, CO.

Table 2. List of parameters and components measured

Parameter/ Component	Sample Treatment	Recommended Holding Time	Type of Analysis
pH	None	Immediate Analysis	pH meter
Conductivity	None	Immediate Analysis	Conductivity meter
Temperature	None	Immediate Analysis	Temp. probe on Cond. meter
Metals	Filter, Acidify with HNO3	180 days	ICP-MS, ICP-AES
Anions	Filter, 4°C	28 days (SO4)	Ion Chromatography

Project Laboratory

pH

pH was measured using an Orion Model 230A pH meter and Orion Combination pH electrode (Orion electrode no. 915600). At the beginning of each set of measurements the instrument was calibrated with commercial buffer solutions that bracketed the expected range of the samples to be measured (either pH 4 and 7 or pH 1.68 and 4). A pH buffer check on a third buffer (either pH 6 or 3 depending on calibration range) was performed to check the calibration of the instrument prior to beginning measurements and prior to measurements for each sample.

Specific Conductance

Specific Conductance was measured with Orion Conductivity Meter Model 126 and an Orion conductivity cell (Orion No. 012210). The calibration of the instrument was checked with commercial conductivity standards prior to each set of measurements.

Temperature

Temperature was measured in degrees Centigrade (°C) by the Orion Conductivity Meter Model 126 and an Orion conductivity cell (Orion No. 012210). Temperature was measured in conjunction with the specific conductivity measurements.

Metals

Concentrations of cations and metals in the leachates were determined by inductively coupled plasma - mass spectroscopy (ICP-MS) (Meier, et al., 1994) and/or inductively coupled plasma - atomic emission spectroscopy (ICP-AES) (Briggs and Fey, 1996). The analyses were performed using U.S. Geological Survey analytical equipment by USGS personnel. Results are expressed as µg/L (ppb) or mg/L (ppm).

Anions

Concentrations (ppm) of selected anions were determined by ion chromatography (IC) (d'Angelo and Ficklin, 1996). Anions measured were fluoride, chloride, nitrate, and sulfate. The analyses were performed using U.S. Geological Survey analytical equipment by USGS personnel.

Quality Control

Table 3 shows the frequency and control limits of laboratory quality control checks used for leachate samples obtained from the leach methods in this study. A brief description and definition of each type of quality control check during the project follows. Results of quality control checks are presented in Appendix B.

Table 3. Laboratory Quality Control Checks

Quality Control Check	Frequency*	Control Limits
Preparation Blank	one per experimental batch	<IDL or unprocessed extraction fluid chemistry
Matrix Spikes	one per experimental batch**	75 - 125%
Analytical Batch Duplicates	one per experimental batch	± 20% RPD
Acid Blanks	one per experimental batch	<IDL or acid chemical analysis
Reference Standards	one set per analytical group submittal	

*U.S. EPA, 1990, Document ILMO1.0 Statement of Work for Inorganic Analysis

**Utilized for TCLP, TCLP-DI, and SPLP only.

Preparation Blank

A preparation blank is a sample of the appropriate volume of extraction fluid that is carried through the entire experimental process including analysis. The preparation blank is used to determine whether any added reagents, equipment, or procedures introduce any contaminants to the samples. One preparation blank was run with each analytical batch for the laboratory study.

Matrix Spikes

Matrix spikes are filtrate samples that are spiked with selected aqueous metal standards prior to preservation to provide information about any matrix effects during the analytical methods. Matrix spikes for lead (5 ppm Pb) and cadmium (1 ppm Cd) were prepared for the TCLP analytical batch. Matrix spikes for lead (5 ppm Pb) were prepared for the TCLP-DI analytical batch and for the SPLP analytical batch.

Analytical Batch Duplicates

Analytical batch duplicates are duplicate samples that are carried through the entire experimental process including analysis to determine the precision of the analytical results. One duplicate was run with each analytical batch for the laboratory study.

Acid Blanks

Acid blanks are deionized water samples preserved with the same amount of Ultrex® II Ultrapure nitric acid as a sample to determine if any contaminants are introduced by the preservation step. One acid blank was prepared for each laboratory leach experiment.

Reference Standards

USGS Water Resources Division (WRD) water standards were submitted with each group of samples as a check on the analytical method. Standards for major cations and for trace metals were submitted with sample groups undergoing ICP-MS and ICP-AES analysis.

Data

Laboratory Method Data listed by Sample

Selected leachate chemistry data for the different extractions are listed by sample in Table 4. The complete data set for all elements analyzed is listed in Appendix C. The data in Appendix C lists all elements run on either ICP-AES, ICP-MS, or IC. Several ICP-AES elements (Ag, As, Be, Li, P, Ti, V) that were below detection limits for the majority of the samples and had ICP-MS data available were omitted from Appendix C. ICP-AES concentrations were used for major cations and selected metals (Al, Ca, Fe, K, Mg, Na) when available. ICP-MS concentrations for lead (Pb) were utilized for this study. WRD rainfall runoff data was analyzed only by ICP-MS and is included for qualitative comparisons only.

pH

The samples remained near the starting pH of 4.94 for the TCLP method due to the buffered nature of the extraction fluid. For the other methods, SPLP and MM1 (starting pH near 4.2) and TCLP-DI (starting pH at 5.8), the samples dropped in pH, ranging from 2.7 (VEN) to 4.2 (MAY). For each sample, pH increased by method: SPLP ≤ TCLP-DI < MM1 << TCLP. Overall, the sample pH values within a particular method ranked VEN < SUN < YUK < MAY.

Specific Conductivity

The samples had specific conductivity values for the TCLP leachates greater than 4000 µS, which remained near the extraction fluid blank value of approximately 4000 µS. For the other methods, the samples ranged in conductivity from approximately 200 µS to 1100 µS. For each sample, specific conductivity values increased by method: MM1 < TCLP-DI ≤ SPLP <<TCLP. Overall, the sample specific conductivity values within a particular method ranked opposite of pH: MAY < YUK < SUN < VEN.

Metals

Aluminum (Al)

Leachate concentrations for aluminum ranged from 0.15 mg/L (MAY) to 17 mg/L (VEN). Generally, the TCLP method had lower concentrations than the other methods for samples SUN and VEN, with the other filtered leachate methods at similar concentrations. MM1 RA aluminum values for SUN and VEN were the highest between the different leachate methods. For YUK, TCLP values and MM1 FA values were near similar levels, with the other leachate aluminum concentrations at higher values, with no large differences in

Table 4. Selected Comparative Study Leachate Data Listed By Sample

Sample	Date	Leach Method	Extraction Fluid pH	Sample Weight (g)	Temperature degrees C	pH pre-filter	pH post-filter	Specific Conductance pre-filter (uS)	Specific Conductance post-filter (uS)	F ppm	Cl ppm	SO4 ppm	NO3 ppm	Al mg/L	As ug/L	Ba ug/L	Be ug/L	Ca mg/L	Cd ug/L	Ce ug/L	Co ug/L	Cr ug/L	Cu ug/L	Fe mg/L	K mg/L	La ug/L
Sunday No. 2																										
SUNTCLPA	2/12/98	TCLP	4.94	100.00	20.4	4.85	4.85	4270	4260	<0.1	<0.1	330	1.0	**0.25**	*< 0.2*	**110**	*0.2*	**4.5**	**20**	*0.86*	**<10**	**<10**	**67**	**0.93**	**2.1**	*< 0.01*
SUNEPADIA	2/19/98	TCLP-DI	5.81	100.00	20.6	2.79	2.81	778	781	2.1	0.6	340	0.4	**7.1**	*2.2*	**61**	*0.9*	**6.2**	**27**	*4.8*	**15**	**10**	**260**	**17**	**0.94**	*< 0.01*
SUNSPLPA	3/4/98	SPLP	4.23	100.00	23.2	2.77	2.78	803	801	1.3	0.6	330	1.6	**6.6**	*2.5*	**53**	*1.3*	**6.6**	**24**	*4.4*	**14**	**<10**	**220**	**13**	**0.89**	*< 0.01*
SUNMM1 RA	3/11/98	Montour 1	4.19	100.00	20.1	2.92	nd	651	nd	nd	nd	nd	nd	**11**	*14*	**210**	*0.9*	**5.7**	**23**	*5.5*	**14**	**11**	**310**	**26**	**1.8**	*< 0.01*
SUNMM1 FA	3/11/98	Montour 1	4.19	100.00	20.1	2.92	2.89	651	653	1.0	0.6	380	1.4	**8.9**	*5.7*	**38**	*0.9*	**5.8**	**23**	*4.7*	**13**	**10**	**220**	**17**	**<0.5**	*< 0.01*
Venir																										
VENTCLPA	2/12/98	TCLP	4.94	100.00	20.2	4.84	4.83	4390	4360	<0.1	<0.1	560	2.0	**1.9**	*< 0.2*	**97**	*0.4*	**5.2**	**13**	*5.3*	**15**	**<10**	**2400**	**1.7**	**2.2**	*< 0.01*
VENEPADIA	2/19/98	TCLP-DI	5.81	100.00	20.7	2.69	2.70	1067	1069	1.1	0.7	720	1.2	**14**	*0.5*	**61**	*1.6*	**5.9**	**13**	*17*	**19**	**27**	**4600**	**36**	**1.3**	*6.7*
VENSPLPA	3/4/98	SPLP	4.23	100.00	23.3	2.67	2.68	1077	1080	0.9	0.9	740	2.6	**14**	*0.6*	**52**	*1.4*	**6.2**	**12**	*17*	**21**	**24**	**3900**	**27**	**1.1**	*6.7*
VENMM1 RA	3/11/98	Montour 1	4.19	100.00	19.9	2.85	nd	867	nd	nd	nd	nd	nd	**17**	*4.1*	**75**	*1*	**5.7**	**12**	*16*	**22**	**33**	**4100**	**45**	**1.7**	*5.0*
VENMM1 FA	3/11/98	Montour 1	4.19	100.00	19.9	2.85	2.87	867	869	0.8	0.9	730	1.5	**15**	*2.0*	**34**	*1.3*	**5.7**	**11**	*15*	**22**	**30**	**4100**	**38**	**<0.5**	*5.0*
Yukon																										
YUKTCLPA	2/12/98	TCLP	4.94	100.00	20.4	4.87	4.87	4430	4430	<0.1	<0.1	360	1.0	**3.9**	*< 0.2*	**59**	*0.3*	**36**	**<10**	*7.5*	**21**	**<10**	**220**	**0.67**	**2.3**	*< 0.01*
YUKEPADIA	2/19/98	TCLP-DI	5.81	100.00	20.5	3.12	3.13	644	651	18	0.7	530	1.8	**11**	*< 0.2*	**42**	*0.8*	**42**	**<10**	*5.2*	**25**	**<10**	**530**	**20**	**1.2**	*< 0.01*
YUKSPLPA	3/4/98	SPLP	4.23	100.00	22.8	3.09	3.10	657	658	20	0.7	530	1.7	**13**	*0.6*	**29**	*0.9*	**47**	**<10**	*5.0*	**32**	**<10**	**620**	**17**	**1.3**	*< 0.01*
YUKMM1 RA	3/11/98	Montour 1	4.19	100.00	20.1	3.26	nd	345	nd	nd	nd	nd	nd	**11**	*4.3*	**94**	*0.3*	**17**	**<10**	*5.4*	**14**	**<10**	**250**	**23**	**4.5**	*< 0.01*
YUKMM1 FA	3/11/98	Montour 1	4.19	100.00	20.1	3.26	3.25	345	348	3.7	0.4	220	1.3	**3.7**	*< 0.2*	**<10**	*0.2*	**17**	**<10**	*3.9*	**12**	**<10**	**210**	**4.9**	**<0.5**	*< 0.01*
Mayday																										
MAYTCLPA	2/12/98	TCLP	4.94	100.00	20.2	4.89	4.89	4190	4180	<0.1	<0.1	91	0.7	**0.39**	*< 0.2*	**130**	*0.09*	**2.8**	**<10**	*1.8*	**<10**	**<10**	**63**	**0.42**	**2.4**	*< 0.01*
MAYEPADIA	2/19/98	TCLP-DI	5.81	100.00	20.3	3.42	3.42	193.5	194.4	0.3	0.2	110	0.5	**0.47**	*< 0.2*	**94**	*0.2*	**2.4**	**<10**	*0.3*	**<10**	**<10**	**130**	**0.46**	**1.5**	*< 0.01*
MAYSPLPA	3/4/98	SPLP	4.23	100.00	23.5	3.37	3.38	202	203	0.4	0.2	110	1.4	**0.43**	*< 0.2*	**73**	*0.2*	**2.3**	**<10**	*0.2*	**<10**	**<10**	**110**	**0.47**	**1.5**	*< 0.01*
MAYMM1 RA	3/11/98	Montour 1	4.19	100.00	20.2	3.49	nd	134.2	nd	nd	nd	nd	nd	**5.8**	*2.6*	**90**	*0.1*	**1.3**	**<10**	*0.92*	**<10**	**<10**	**150**	**11**	**2.4**	*< 0.01*
MAYMM1 FA	3/11/98	Montour 1	4.19	100.00	20.2	3.49	3.46	134.2	136.4	0.2	0.2	96	1.2	**0.15**	*< 0.2*	**13**	*0.09*	**1.2**	**<10**	*0.02*	**<10**	**<10**	**59**	**0.34**	**<0.5**	*< 0.01*
YUKB1LCHFA	7/31/97	Rainfall		1367	20.3	2.17	2.21	5030	5020	10	6.1	2600	<0.1	**34**	*50*	**23**	*1.5*	**130**	**<10**	*140*	**240**	**20**	**5200**	**550**	**15**	*97*
MAY WRD1 FA	9/6/97	na			13.0	2.84	nd	531	nd	nd	nd	nd	nd	*150*	*11*	*21*	*1.4*	*21*	*19*	*440*	*60*	*87*	*1500*	nd	nd	*120*
MAY WRD2 FA	9/6/97	na			13.0	2.84	nd	531	nd	nd	nd	nd	nd	*100*	*17*	*230*	*0.7*	*9*	*7.3*	*50*	*32*	*31*	*520*	nd	nd	*23*
MAY WRD3 FA	9/6/97	na			13.0	2.84	nd	531	nd	nd	nd	nd	nd	*94*	*21*	*230*	*0.9*	*18*	*8.3*	*140*	*55*	*55*	*730*	nd	nd	*64*
MAY WRD4 FU	9/6/97	na			13.0	2.84	nd	531	nd	nd	nd	nd	nd	*2.8*	*< 0.2*	*2*	*0.2*	*5.4*	*6.1*	*2.5*	*9*	*0.7*	*180*	nd	nd	*0.99*
MAY WRD5 FU	9/6/97	na			13.0	2.84	nd	531	nd	nd	nd	nd	nd	*3*	*< 0.2*	*4*	*0.2*	*4.2*	*5.7*	*3.9*	*11*	*0.9*	*190*	nd	nd	*1.6*

Anions measured by IC. Concentrations in bold measured by ICP-AES. Concentrations in italics measured by ICP-MS. nd=not determined.

Table 4. Selected Comparative Study Leachate Data Listed By Sample (continued)

Sample	Li ug/L	Mg mg/L	Mn ug/L	Na mg/L	Ni ug/L	Pb ug/L	Si mg/L	Sr ug/L	Th ug/L	Ti ug/L	U ug/L	V ug/L	Zn ug/L
Sunday No. 2													
SUNTCLPA	*1.5*	**0.31**	**560**		**11**	*11000*	**1.6**	**44**	*< 0.005*	*1.2*	*1.5*	*< 0.1*	**2400**
SUNEPADIA	*3.0*	**0.47**	**800**	**<0.1**	**18**	*1300*	**1.2**	**50**	*0.13*	*0.8*	*1.5*	*< 0.1*	**3800**
SUNSPLPA	*3.3*	**0.42**	**700**	**<0.1**	**17**	*1100*	**1.4**	**50**	*0.09*	*1.2*	*1.6*	*< 0.1*	**3800**
SUNMM1 RA	*2.8*	**0.47**	**650**	**<0.1**	**16**	*780*	**4.7**	**19**	*0.74*	*1.1*	*1.5*	*0.2*	**3700**
SUNMM1 FA	*2.4*	**0.39**	**670**	**<0.1**	**16**	*220*	**0.16**	**14**	*0.57*	*1.0*	*1.4*	*0.3*	**3700**
Venir													
VENTCLPA	*5.5*	**7.0**	**810**		**34**	*2800*	**1.2**	**41**	*0.08*	*2.2*	*8.7*	*< 0.1*	**740**
VENEPADIA	*7.4*	**8.2**	**1100**	**<0.1**	**48**	*960*	**1.3**	**42**	*5.4*	*2.3*	*8.1*	*0.4*	**990**
VENSPLPA	*7.5*	**7.2**	**990**	**<0.1**	**38**	*820*	**1.3**	**39**	*5.5*	*2.1*	*8.4*	*0.5*	**970**
VENMM1 RA	*6.8*	**7.5**	**810**	**<0.1**	**45**	*640*	**4.1**	**24**	*7.7*	*3.7*	*7.5*	*0.5*	**960**
VENMM1 FA	*6.8*	**7.4**	**790**	**<0.1**	**42**	*580*	**0.11**	**18**	*7.8*	*2.9*	*7.6*	*0.2*	**980**
Yukon													
YUKTCLPA	*9.0*	**4.2**	**1500**		**18**	*680*	**1.6**	**52**	*0.12*	*2.2*	*0.57*	*< 0.1*	**1100**
YUKEPADIA	*12*	**4.5**	**1500**	**0.13**	**19**	*120*	**1.6**	**48**	*1.6*	*2.9*	*0.66*	*< 0.1*	**1200**
YUKSPLPA	*14*	**4.6**	**1500**	**0.10**	**22**	*86*	**2.0**	**50**	*1.7*	*4.2*	*0.73*	*0.1*	**1400**
YUKMM1 RA	*6.4*	**2.4**	**600**	**0.13**	**<10**	*620*	**13**	**37**	*0.88*	*10*	*0.30*	*2*	**590**
YUKMM1 FA	*5.5*	**1.9**	**590**	**<0.1**	**10**	*38*	**0.12**	**14**	*0.52*	*1.5*	*0.28*	*< 0.1*	**590**
Mayday													
MAYTCLPA	*3.7*	**0.94**	**230**		**<10**	*5500*	**1.7**	**34**	*0.006*	*0.4*	*0.35*	*< 0.1*	**990**
MAYEPADIA	*4.3*	**0.82**	**210**	**0.25**	**<10**	*2400*	**1.6**	**26**	*0.01*	*< 0.1*	*0.12*	*< 0.1*	**860**
MAYSPLPA	*4.8*	**0.79**	**190**	**0.21**	**<10**	*2200*	**1.9**	**26**	*< 0.005*	*0.2*	*0.12*	*< 0.1*	**980**
MAYMM1 RA	*3.6*	**0.73**	**110**	**0.27**	**<10**	*1000*	**9.4**	**29**	*0.04*	*1.2*	*0.10*	*0.9*	**540**
MAYMM1 FA	*3.8*	**0.39**	**88**	**<0.1**	**<10**	*490*	**0.40**	**<10**	*< 0.005*	*< 0.1*	*0.06*	*< 0.1*	**500**
YUKB1LCHFA	*26*	**8.0**	**2400**	**0.70**	**210**	*1500*	**6.1**	**560**	*7.1*	*12*	*2.1*	*54*	**3800**
MAY WRD1 FA	*170*	*51*	*11000*	nd	*24*	*37*	nd	nd	*6.1*	*8.6*	*5.2*	*65*	3400
MAY WRD2 FA	*130*	*69*	*11000*	nd	*29*	*7.9*	nd	nd	*3.3*	*8.4*	*1.3*	*130*	1600
MAY WRD3 FA	*190*	*73*	*13000*	nd	*43*	*21*	nd	nd	*6.0*	*9.4*	*2.1*	*46*	1900
MAY WRD4 FU	*26*	*3.4*	*350*	nd	*3.6*	*0.29*	nd	nd	*0.03*	*3.5*	*0.25*	*< 0.1*	1500
MAY WRD5 FU	*15*	*2.9*	*750*	nd	*2.7*	*0.48*	nd	nd	*0.01*	*3.8*	*0.42*	*< 0.1*	1600

Anions measured by IC. Concentrations in bold measured by ICP-AES. Concentrations in italics measured by ICP-MS. nd=not determined.

concentration. MAY behaved similarly, with the main difference a high concentration for MM1 RA compared to the other methods.

Arsenic (As)

Arsenic concentrations in the leachates were below instrument detection limits for the TCLP method. Arsenic concentrations for the other methods were below concentrations of 5 µg/L for most samples, with the exception of SUN, which had an arsenic concentration of 14 µg/L for leachate sample MM1 RA.

Cadmium (Cd)

Cadmium concentrations ranged from below detection (YUK and MAY) to 27 µg/L (SUN). Generally, the concentrations of cadmium for a particular sample were similar for the various leach methods.

Cobalt (Co)

Cobalt concentrations ranged from below instrument detection limits (MAY) to 32 µg/L (YUK). For SUN and VEN, the concentrations for all methods were similar for a particular sample. VEN had slightly lower values for the MM1 method than the other methods.

Chromium (Cr)

Chromium concentrations ranged from below detection (MAY and YUK) to 27 µg/L (VEN). SUN had chromium concentrations that were similar for the various leach methods. VEN had a lower TCLP concentration (<10 µg/L) where the other methods ranged from 24 – 33 µg/L.

Copper (Cu)

The samples had copper concentrations ranging from 0.06 mg/L (SUN) to 4.6 mg/L (VEN). TCLP values for copper were lower than the other methods for SUN and VEN, and similar to other methods for YUK and MAY. Method MM1 produced lower concentrations of copper than the SPLP and TCLP-DI for YUK and MAY, but similar copper concentrations for SUN and VEN.

Iron (Fe)

Total iron concentrations ranged from 0.4 mg/L (MAY) to 45 mg/L (VEN). With the exception of MAY, TCLP iron concentrations were noticeably lower than for the other leach methods. The MM1 RA (unfiltered) leachate iron concentration was typically higher than the other leachate concentrations. The TCLP-DI and MM1 FA were typically similar in concentration level, with the SPLP leachate iron concentrations slightly higher in value.

Manganese (Mn)

The concentration range for Mn was 0.1 mg/L (MAY) to 1.5 mg/L (YUK). All samples had similar concentrations for the various leach methods.

Nickel (Ni)

Nickel concentrations ranged from below detection (YUK) to 48 µg/L for VEN. Concentrations were similar for the various leach methods.

Lead (Pb)

Lead concentrations ranged from 38 µg/L (YUK) to 11000 µg/L (SUN). TCLP leachate lead concentrations were typically higher than other methods, ranging from 680 µg/L

(YUK) to 11000 µg/L (SUN), probably due to the complexation of lead with the acetate in the extraction fluid. SPLP and TCLP-DI value ranges were similar for each sample. MM1 RA values were typically lower with MM1 FA having the lowest concentration for each sample.

Zinc (Zn)

Concentrations for zinc ranged from 0.5 mg/L (MAY) to 3.8 mg/L (SUN). Within the leachate values for samples SUN and VEN, TCLP zinc concentrations were lower than other leach method zinc concentrations. The other leach methods (TCLP-DI, SPLP, and MM1) produced similar zinc concentrations with SUN values near 3.7 mg/L and VEN values near 0.97 mg/L. YUK and MAY had similar zinc concentrations for both leach methods and concentration levels. For both samples, the MM1 method produced lower concentrations than for the other three methods. The zinc concentrations of the SPLP, TCLP, and TCLP-DI were similar in value for both samples.

Sulfate (SO_4)

Sulfate concentrations ranged from 91 mg/L (MAY) to 740 mg/L (VEN). MM1 FA and TCLP leachate concentrations were typically lower than TCLP-DI and SPLP, which were similar in concentration levels.

Field Test Data

Selected results from the field test data are also presented in Table 4, with the complete data set listed in Appendix C. The results for sample YUKB1LCH, although from the Yukon mine waste pile, cannot be directly compared with laboratory leachate results for sample YUK. Sample YUKB1LCH was a grab sample collected from sampling cell B1, whereas sample YUK is a composite sample of the surface of the entire pile.

Sample YUKB1LCH had a pH of 2.21 and a specific conductivity value of 5030 µS. The sulfate concentration was 2600 mg/L. Selected metal concentrations are as follows: aluminum 34 mg/L; arsenic 50 µg/L; Co 240 µg/L; Cu 5200 µg/L; Fe 550 mg/L; Mn 2400 µg/L; Ni 210 µg/L; and Zn 3800 µg/L.

WRD Rainfall Data

Selected results from the rainfall runoff data from the Mayday sampling site are also presented in Table 4, with the complete data set listed in Appendix C. The samples had a pH of 2.84, slightly lower than the MAY laboratory leach method results. The specific conductivity value of 531 µS was higher for the laboratory leach methods with the exception of the MAY TCLP leachate (4190 µS). Generally, metal values were higher for the rainfall runoff data than all of the MAY laboratory leach results, with some metals (Al, Cu, Mn, and Zn) an order of magnitude higher. The exception was lead, with a rainfall runoff concentration range (7.9 to 37 µg/L) lower than the MAY TCLP leachate lead value of 5500 µg/L.

Discussion and Conclusion

Comparison of Laboratory Leach Techniques

Selected data for samples MAY and VEN are plotted in Figures 1a-h. For both samples, pH and specific conductance values have TCLP values different than the other methods. TCLP pH values remain near the starting pH of 4.93 due to the buffered nature of the TCLP extraction fluid. Since the starting specific conductance value of the TCLP extraction fluid was near 4000 µS, the specific conductance values are high in comparison with the other methods, where the starting specific conductance value of the other extraction fluids was approximately 25 µS or less. The MM1 values (RA and FA) tend to be slightly higher in pH and lower in specific conductance than the TCLP-DI and SPLP methods. It was not determined whether this is a result of the utilization of a different agitation method (period inversion vs. rotary agitation) or the shortened extraction period (two hours vs. eighteen hours) or a combination of both factors. However, the pH and specific conductance results of the MM1 method are similar to the SPLP and TCLP-DI methods. SPLP and TCLP-DI methods have very similar pH and specific conductance values.

There is no consistent pattern for the leachate metal concentrations. With the exception of lead (Pb), TCLP values were less than or nearly equivalent to the other leach methods. For lead, TCLP concentrations were noticeably higher than the other methods, probably due to the complexation of lead by the acetate in the TCLP extraction fluid. Typically, for the laboratory methods, the metal concentrations were fairly similar. In some cases (Fe and Al), the MM1 RA (unfiltered) concentrations were higher than the filtered leachate concentrations.

Comparison of MAY Runoff Concentrations to Leach Tests

The runoff sample had lower pH and higher specific conductivity than the laboratory methods with the exception of TCLP. For metal concentrations available, the runoff sample had higher metal concentrations than all of the laboratory methods with the exception of lead where the runoff sample had the lowest lead concentration. Iron (Fe) and aluminum (Al) values were not available for the runoff sample, but would have been expected to be higher than the laboratory methods, considering the orange colored waters of the sample and the behavior of the MM1 RA sample.

Generally, with the exception of the TCLP method, the laboratory methods produce similar pH, specific conductance, and metal concentrations in the leachates. However, it appears that the laboratory methods may possibly underpredict the metals in actual rainfall runoff for the MAY sample. Further comparisons with rainfall runoff are needed to determine which, if any, of the methods may be used as a preliminary characterization tool for mine waste piles.

Figure 1a. Sample VEN pH vs. Specific Conductance

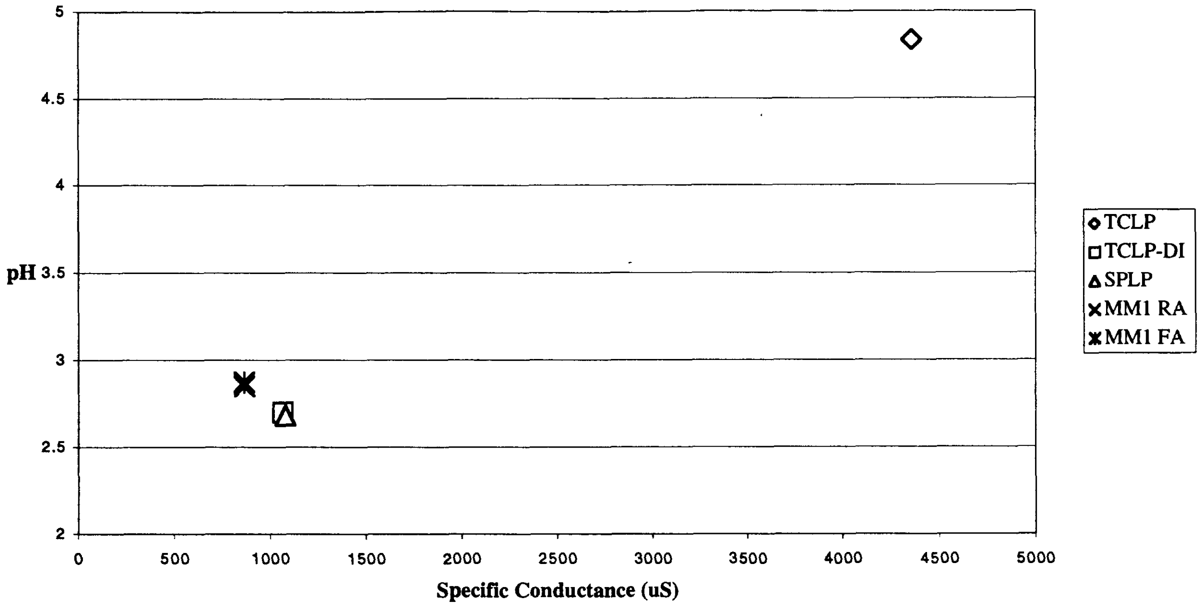
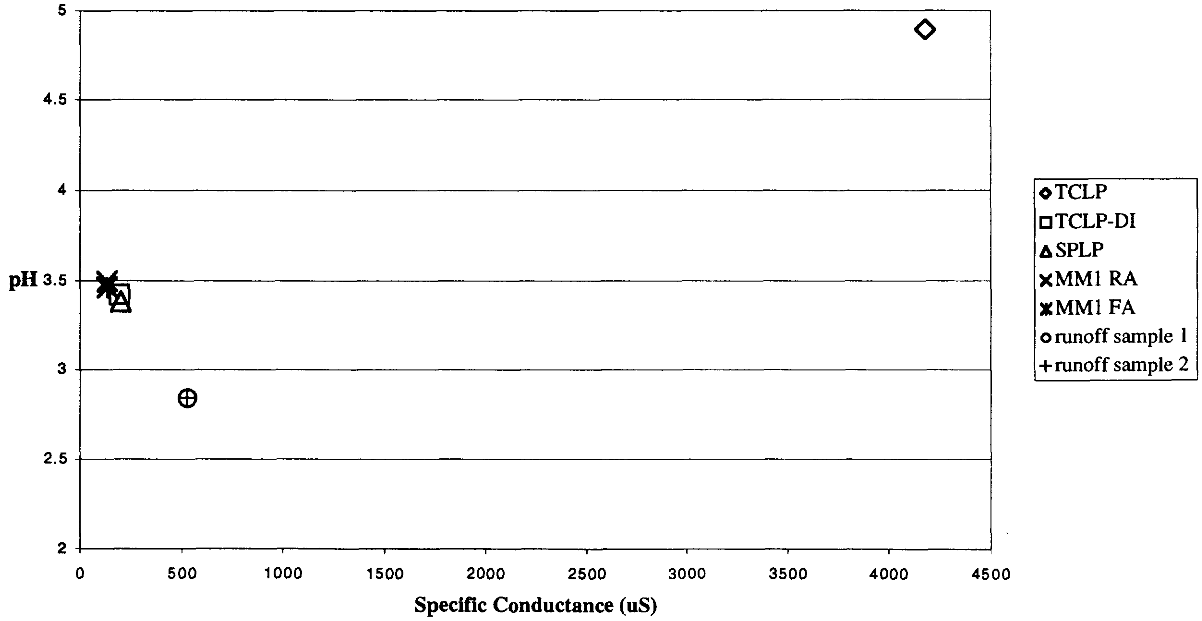


Figure 1b. Sample MAY pH vs. Specific Conductance



Figures 1a and b. Samples VEN and MAY pH values plotted against specific conductance values for the different leach methods.

Figure 1c. Sample VEN Selected Metal Concentrations by Method

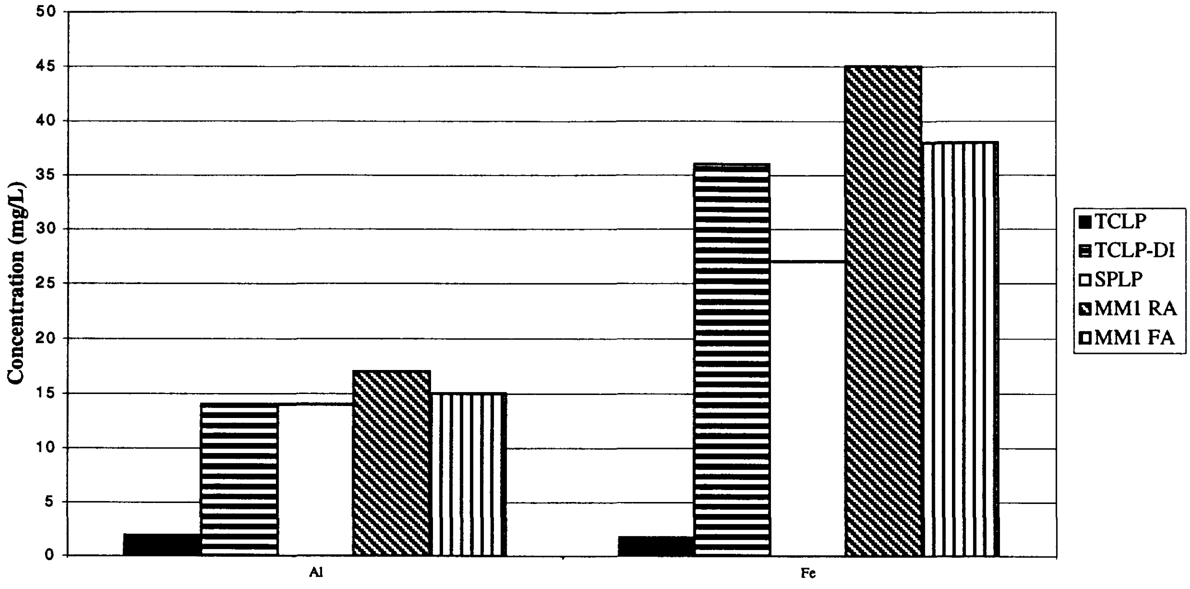
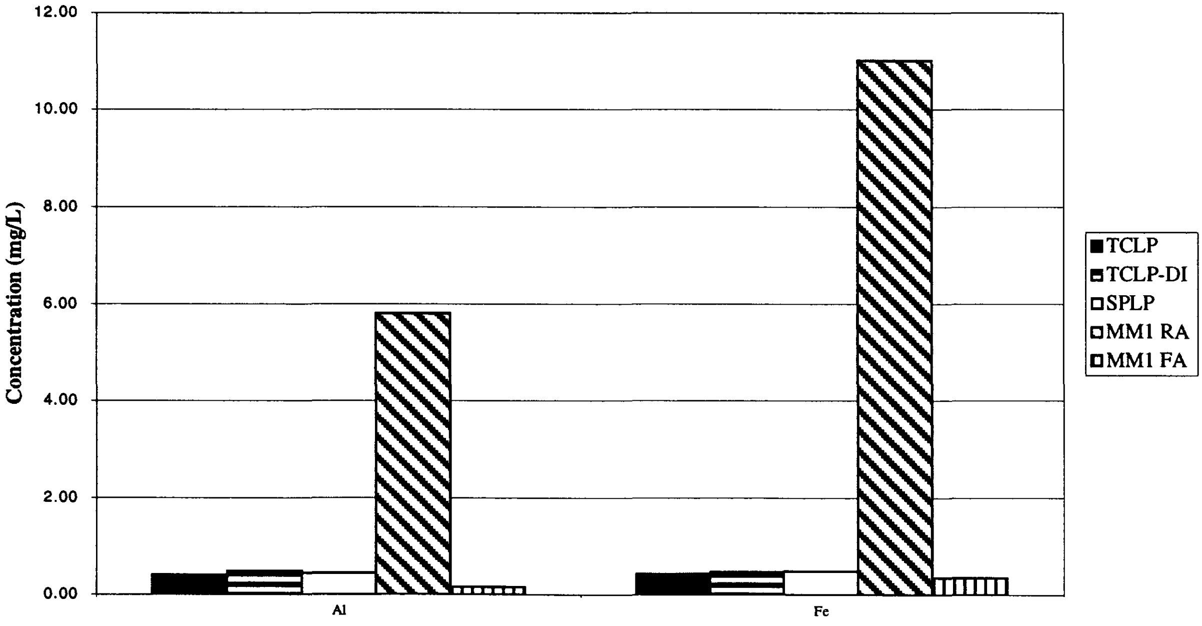


Figure 1d. Sample MAY Selected Metal Concentrations by Method



Figures 1c and d. Samples VEN and MAY iron and aluminum concentrations for the different leach methods.

Figure 1e. Sample VEN Selected Metal Concentrations by Method

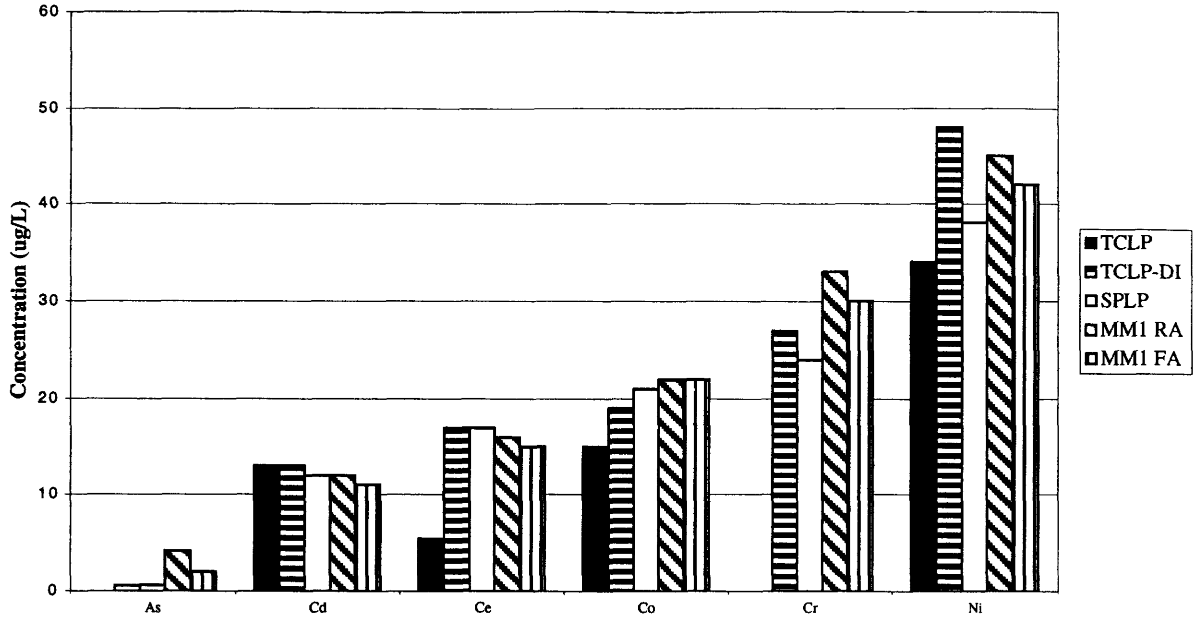
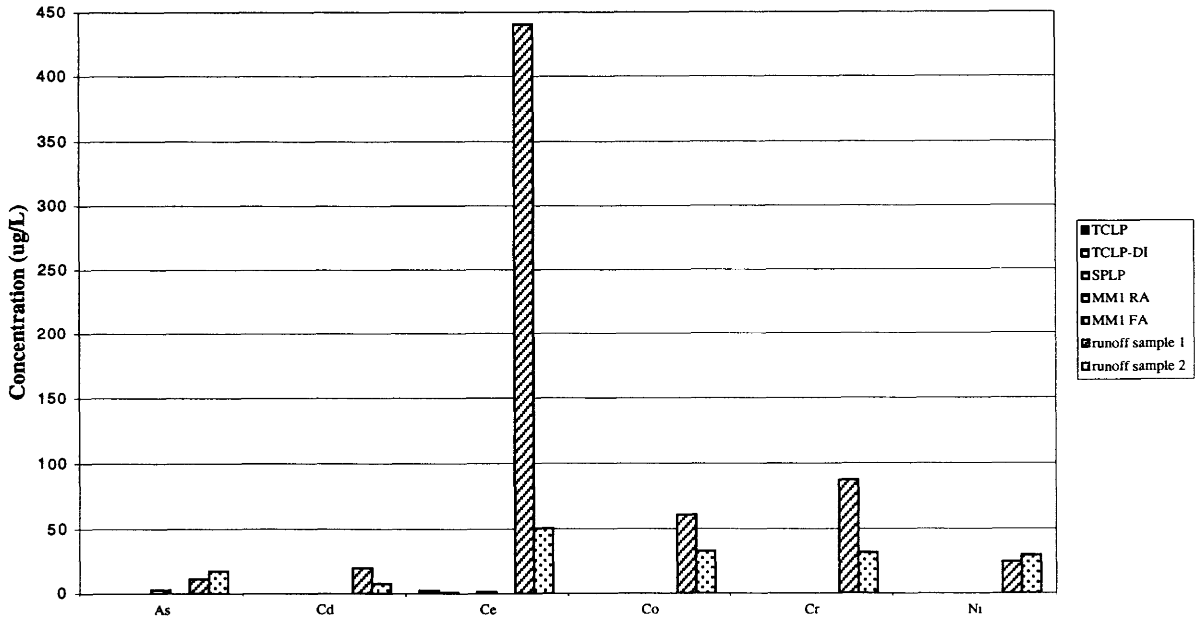


Figure 1f. Sample MAY Selected Metal Concentrations by Method



Figures 1e and f. Samples VEN and MAY selected metal concentrations for the different leach methods.

Figure 1g. Sample VEN Selected Metal Concentrations by Method

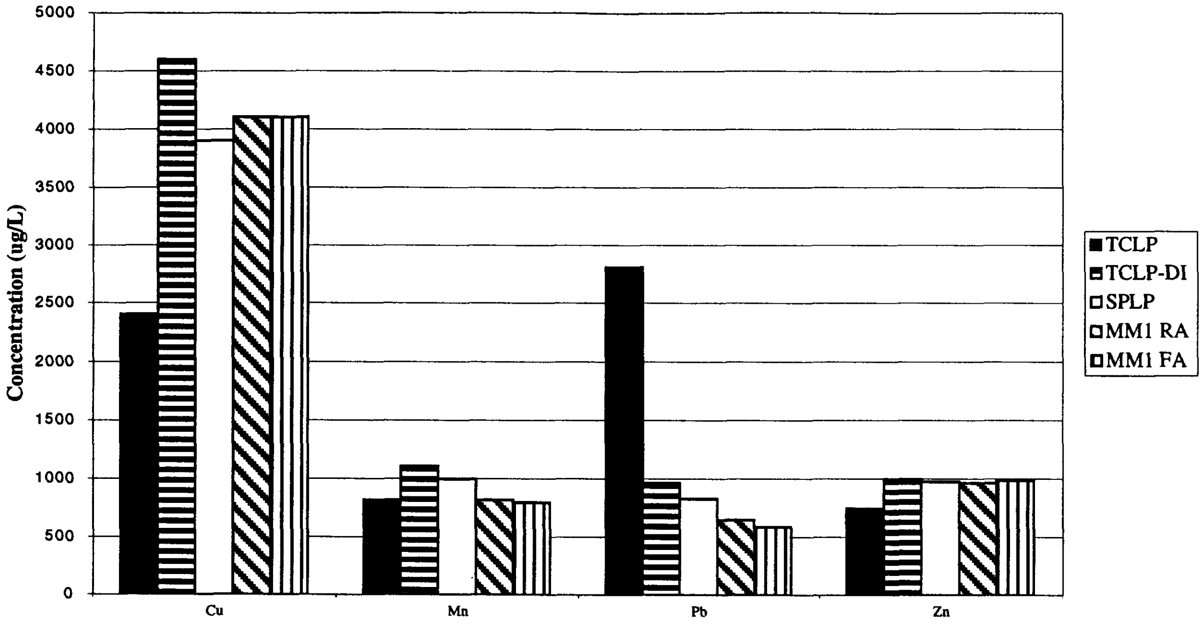
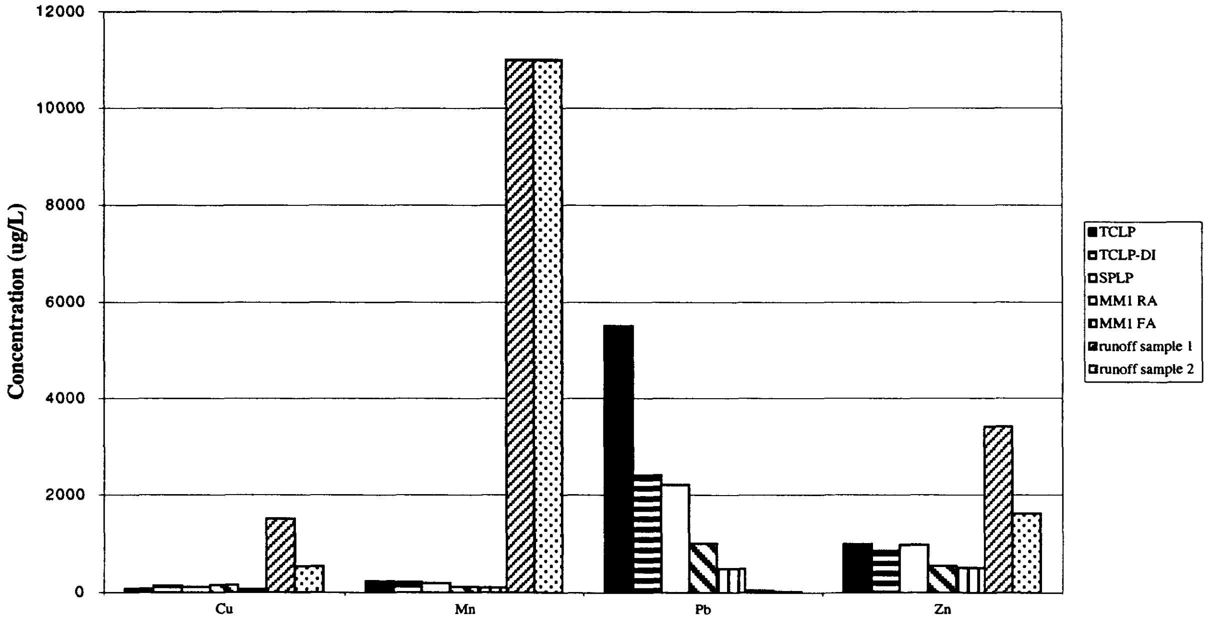


Figure 1h. Sample MAY Selected Metal Concentrations by Method



Figures 1g and h. Samples VEN and MAY selected metal concentrations for the different leach methods.

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Appendices

Appendix A. Montour Leach Method 1

Appendix B. Quality Control Checks

Appendix C. Data for Comparative Leach Study

Appendix A. Montour Leach Method 1 (MM1)

(Modified EPA Method 1312 Leach Procedure)

The leach procedure presented below was designed as a reconnaissance method for determining metal mobility from mine waste dumps during runoff. The technique must be 1) relatively easily accomplished; 2) replicate as closely as possible actual conditions (i.e., minimize breakage). EPA Method 1312 is designed to determine the mobility of both organic and inorganic analytes present in samples of soils and wastes. For this study, the assumption is made that the samples will be 100% solids. Stream sediments and any other damp samples will be air or oven dried and will be considered as 100% solid for purposes of these experiments.

Summary of Method

The particle size of the solid phase is not reduced. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the region of the country where the sample site is located if the sample is a soil. If the sample is a waste, the extraction fluid employed is a pH 4.2 solution. The sample is leached for 2 hours and the solution is mixed by inverting the sample gently at time intervals of 5 minutes, 30 minutes, one hour, one and a half hours, and two hours. After two hours, the sample is filtered and preserved.

Apparatus and Materials:

1) Extraction Vessel: a bottle with sufficient capacity to hold the sample and extraction fluid is needed. Headspace is allowed in vessel. It is recommended that the vessel be constructed of HDPE or similar material for inorganic analytes (metals).

2) Filters: disposable 0.45 µm cellulose nitrate filters

4) Filtration Unit: pressure filtration unit such as for EPA Method 1312

5) pH meters: the meter should be accurate to ± 0.05 units at 25°C.

6) Laboratory Balance: balance should be accurate to within ± 0.01 grams.

7) Disposable plastic beakers

Chemical Reagents:

1) Reagent grade chemicals shall be used in all tests.

2) Reagent water. For inorganic analytes, water which would achieve the performance standards for ASTM Type II water (i.e., deionized water purified by ion exchange, etc.).

3) Sulfuric acid/nitric acid (60/40 weight percent mixture) H_2SO_4/HNO_3. Cautiously mix 60 g of concentrated sulfuric acid with 40 g of concentrated nitric acid. If preferred, a

more dilute H_2SO_4/HNO_3 acid mixture may be prepared and used making it easier to adjust the pH of the extraction fluids.

4) Extraction fluids.

Extraction fluid #1: Add the 60/40 weight percent mixture of sulfuric and nitric acids to reagent water until the pH is 4.20 ± 0.05. This fluid is used the determine the leachability of soil from a site that is east of the Mississippi River, and the leachability of wastes.

Extraction fluid #2. Add the 60/40 weight percent mixture of sulfuric and nitric acids to reagent water until the pH is 5.00 ± 0.05. The fluid is used to determine the leachability of soil from a site that is west of the Mississippi River.

Both extraction fluids are best made by adding drops of the acid mixture to a large volume of deionized water until the desired pH is attained.

Procedure:

1) Preliminary Evaluations

Determination of appropriate extraction fluid

1) Wastes, extraction fluid #1 is used.
2) Soils east of the Mississippi River, extraction fluid #1 is used.
3) Soils west of the Mississippi River, extraction fluid #2 is used.

2) Leach Procedure

Weigh out a minimum sample amount of 100 grams.

Transfer solid to an extraction vessel.

Determine amount of extraction fluid to add to the extractor vessel as follows:

Weight of extraction fluid = 20 x weight of waste

for example, 100 grams of solid requires 2000 g of extraction fluid.

Slowly add this amount of appropriate extraction fluid to the extractor vessel. Close extractor bottle tightly, with Teflon tape recommended to ensure a tight seal.

At beginning of experiment, invert sample gently and return to upright orientation. Repeat inversion of sample at 5 minutes, 30 minutes, 1 hour, 1 hour 30 minutes, and at 2 hours.

At end of 2 hour extraction period, allow sample to settle briefly.

Decant a small aliquot of leachate into disposable beaker. Measure specific conductivity, temperature, and pH and record.

Aliquot and preserve for analysis.

1) Unfiltered acidified (RA) aliquot. A 125 mL acid-washed HDPE bottle is used for collection of aliquot for determination of total concentration of metals and major cations. Allow extraction bottle to sit and sample to briefly settle. Decant approximately 10 mL of leachate off of sample from the extraction bottle into 125 mL HDPE bottle. Rinse bottle three times with approximately 10 mL of decanted leachate and discard. Collect sample by decanting leachate into rinsed bottle. Mark sample name, date, and RA on bottle. Acidify with 10 drops of concentrated HNO_3 (use 20 drops if pH is above 4.5).

2) Filtration of sample. Use a 0.45 µm nitrocellulose filter. If using a pressure filtration unit, use approximately 300 mL of leachate to rinse filter. Collect this filtrate and discard. Filter sample and collect filtrate for analysis.

3) Filtered acidified (FA) aliquot. A 125 mL acid-washed HDPE bottle is used for collection of aliquot for determination of dissolved concentration of metals and major cations. Rinse bottle three times with approximately 10 mL of filtered sample and discard. Collect sample. Mark sample name, date, and FA on bottle. Acidify with 10 drops of concentrated HNO_3 (use 20 drops if pH is above 4.5).

4) Filtered unacidified (FU) aliquot. A 30 mL new, unwashed HDPE wide mouth bottle is used for collection of anion aliquot. Rinse bottle three times with approximately 10 mL of filtered sample and discard. Collect sample. Mark sample name, date, and FU on bottle. Preserve sample by refrigeration at 4°C.

Quality Control Checks:

1) A minimum of one blank is run for each type of extraction fluid used in an analytical batch.

2) A minimum of one blank for every 20 extractions that have been conducted in an extraction vessel.

3) One duplicate per analytical batch with a minimum of one for every 20 samples.

4) All quality control measures described in the appropriate analytical methods shall be followed.

5) Samples must undergo extraction within the following time periods:

From field collection to extraction:	Hg (28 days);	Metals (180 days)
From extraction to analysis:	Hg (28 days);	Metals (180 days)
Total elapsed time	Hg (56 days);	Metals (360 days)

Appendix B. Quality Control Checks

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- List of Tables
- Quality Control Checks

Appendix B List of Tables

Quality Control Checks

The data generated from the laboratory was subjected to quality control checks to provide information on the quality and usability of the data. The majority of quality control procedures used were based upon procedures listed in the U.S. Environmental Protection Agency Document ILMO1.0 (1990) Statement of Work for Inorganic Analysis and upon quality control measures specified in the leach procedures.

Performance Blanks

Performance Blank Analytical Results are presented in Table B-1. Leachate samples filtered with a borosilicate glass fiber filter had elevated barium (Ba) concentrations. Extraction fluid 1 (EF1) for the SPLP has pre-filtration barium concentrations below the 0.02 µg/L instrument detection limit, but has a post-filtration concentration of 21 µg/L. Similar behavior is observed for the TCLP-DI leachate (M. Montour, unpublished leach parameter study data). Molybdenum (Mo) shows small increases for all blanks except the TCLP-DI. Nickel (Ni) has an elevated concentration for the MM1FA filtrate, while the unfiltered sample is below detection limits (MM1RA). In general, all other elements are below or near instrument detection limits consistently for all blanks.

Matrix Spike Recovery

Matrix spike recovery results for the TCLP, TCLP-DI, and SPLP methods are summarized in Table B-2. Matrix spikes were performed only for lead (Pb) and cadmium (Cd) (TCLP only) because preliminary analyses indicated that these two metals from the EPA TCLP regulatory list would be of most interest to the study. If the matrix spike lies outside of the range of 75 to 125 percent spike recovery, the samples need to be flagged (U.S. EPA, 1990). All matrix spikes had recoveries within the acceptable limits.

Analytical Batch Duplicates

Analytical batch duplicate results are presented in Table B-3. Many duplicate samples were below the instrument detection limit of the elements. The samples were generally within the relative percent difference (RPD) control limits of 20 percent. Elements with concentrations near detection limits sometimes exceeded the control limit. The control limit was exceeded for samples and elements (F, Al, Fe, K Na, Pb, Si) with concentrations above the control limit. It cannot be determined whether the discrepancy between the sample and duplicate is a result of heterogeneity between laboratory subsamples or analytical uncertainty.

Acid Blanks

Analytical results on the acid blanks are summarized in Table B-4. Most elements came out below instrument detection limits. Some elements are detectable, but are at concentrations close to the instrument detection limit and may be a function of analytical uncertainty. Four elements (Li, Mo, Na, Sb) were detectable at slightly elevated concentrations relative to detection limits for different blank samples. There was not a consistent pattern of elevated concentrations between blanks to indicate a particular acid blank was contaminated. In general, mine waste leachate element concentrations were high enough to be greater than 10 times the blank concentration for the particular batches and within control limits.

Table B-1. Performance Blank Analytical Results

Performance Blank	EF1TCLPA	DIEPADIA	EF1SPLPA	EF1MM1 RA	EF1MM1A FA
Analytical Batch	CB1	CB2	CB3	CB4	CB4
Date	2/12/98	2/19/98	3/4/98	3/11/98	3/11/98
Leach Method	TCLP	TCLP-DI	SPLP	Montour 1	Montour 1
Extraction Fluid	acetic acid	deionized water	60/40 H2SO4/HNO3	60/40 H2SO4/HNO3	60/40 H2SO4/HNO3
Extraction Fluid pH	4.94	5.81	4.23	4.19	4.19
Temperature, C	20.4	20.7	23.3	19.9	19.9
pH (pre-filter)	4.94	5.71	4.25	4.23	4.23
pH (post-filter)	4.94	4.51	4.23		4.22
Specific Conductance (µS, pre-filter)	4280	1.67	24.0	23.7	23.7
Specific Conductance (µS, post-filter)	4280	13.5	25.0	nd	24.2
F (ppm)	<0.1	<0.1	<0.1	nd	<0.1
Cl (ppm)	<0.1	<0.1	<0.1	nd	<0.1
SO4 (ppm)	<2.0	<2	23	nd	22
NO3 (ppm)	0.3	2.9	1.3	nd	1.0
Ag (ug/L)	*0.1*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Al (mg/L)	**0.017**	**<0.01**	**<0.01**	**<0.01**	**<0.01**
As (ug/L)	*< 0.2*	*< 0.2*	*< 0.2*	*< 0.2*	*< 0.2*
Au (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
B (mg/L)	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**
Ba (ug/L)	**19**	**29**	**21**	**<10**	**<10**
Be (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*
Bi (ug/L)	*0.06*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Ca (mg/L)	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Cd (ug/L)	**<10**	**<10**	**<10**	**<10**	**<10**
Ce (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Co (ug/L)	**<10**	**<10**	**<10**	**<10**	**<10**
Cr (ug/L)	**<10**	**<10**	**<10**	**<10**	**<10**
Cs (ug/L)	*0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Cu (ug/L)	**15**	**<10**	**<10**	**<10**	**<10**
Dy (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Er (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Eu (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Fe (mg/L)	**1.1**	**<0.05**	**<0.05**	**<0.05**	**<0.05**
Ga (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Gd (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Ge (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Hf (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*
Ho (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
In (ug/L	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
K (mg/L)	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<0.5**

Concentrations in bold measured by ICP-AES and italics by ICP-MS, nd=not determined.

Table B-1 (continued)

Performance Blank Analytical Batch Date Leach Method Extraction Fluid	EF1TCLPA CB1 2/12/98 TCLP acetic acid	DIEPADIA CB2 2/19/98 TCLP-DI deionized water	EF1SPLPA CB3 3/4/98 SPLP 60/40 H2SO4/HNO3	EF1MM1 RA CB4 3/11/98 Montour 1 60/40 H2SO4/HNO3	EF1MM1A FA CB4 3/11/98 Montour 1 60/40 H2SO4/HNO3
La (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Li (ug/L)	*0.8*	*1.1*	*< 0.1*	*0.2*	*< 0.1*
Mg (mg/L)	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Mn (ug/L)	**10**	**<10**	**<10**	**<10**	**<10**
Mo (ug/L)	*0.66*	*< 0.02*	*1.8*	*1.3*	*1.8*
Na (mg/L)	nd	**0.13**	**<0.1**	**<0.1**	**<0.1**
Nb (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Nd (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Ni (ug/L)	**<10**	**<10**	**<10**	**<10**	**53**
P (ug/L)	*< 1*	*10*	*< 1*	*< 1*	*8*
Pb (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*
Pr (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Rb (ug/L)	*0.08*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Re (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Sb (ug/L)	*< 0.02*	*< 0.02*	*0.1*	*< 0.02*	*0.04*
Sc (ug/L)	*< 0.1*	*< 0.1*	*< 0.1*	*< 0.1*	*0.1*
Se (ug/L)	*< 0.2*	*< 0.2*	*< 0.2*	*< 0.2*	*< 0.2*
Si (mg/L)	**<0.1**	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Sm (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Sn (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*
Sr (ug/L)	**<10**	**<10**	**<10**	**<10**	**<10**
Ta (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Tb (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Te (ug/L)	*< 0.1*	*< 0.1*	*< 0.1*	*< 0.1*	*< 0.1*
Th (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Ti (ug/L)	*< 0.1*	*< 0.1*	*< 0.1*	*< 0.1*	*< 0.1*
Tl (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*
Tm (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
U (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
V (ug/L)	*< 0.1*	*< 0.1*	*< 0.1*	*< 0.1*	*< 0.1*
W (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Y (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Yb (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Zn (ug/L)	**27**	**<10**	**11**	**<10**	**<10**
Zr (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*

Concentrations in bold measured by ICP-AES and italics by ICP-MS, nd=not determined.

Table B-2. Matrix Spike Recovery Results

Sample	Analytical Batch	Date	Leach Method	Pb ug/L	% Recovery Pb	Cd ug/L	% Recovery Cd
EF1TCLPA	CB1	2/12/98	TCLP	0.05		10	
EF1TCLP-MS	CB1	2/12/98	TCLP	4400	88.0	1000	99.0
YUKTCLPA	CB1	2/12/98	TCLP	680		0	
YUKTCLP-MS	CB1	2/12/98	TCLP	4800	82.4	1000	99.0
DIEPADIA	CB2	2/19/98	TCLP-DI	0.05			
DIEPADIMPB	CB2	2/19/98	TCLP-DI	4800	96.0		
MAYEPADIA	CB2	2/19/98	TCLP-DI	2400			
MAYEPADIMPB	CB2	2/19/98	TCLP-DI	7100	94.0		
SUNEPADIA	CB2	2/19/98	TCLP-DI	1300			
SUNEPADIMPB	CB2	2/19/98	TCLP-DI	6100	96.0		
VENEPADIA	CB2	2/19/98	TCLP-DI	960			
VENEPADIMPB	CB2	2/19/98	TCLP-DI	5500	90.8		
YUKEPADIA	CB2	2/19/98	TCLP-DI	120			
YUKEPADIMPB	CB2	2/19/98	TCLP-DI	4700	91.6		
EF1SPLPA	CB3	3/4/98	SPLP	0.05			
EF1SPLPMPB	CB3	3/4/98	SPLP	4800	96.0		
MAYSPLPA	CB3	3/4/98	SPLP	2200			
MAYSPLPMPB	CB3	3/4/98	SPLP	7200	100.0		
SUNSPLPA	CB3	3/4/98	SPLP	1100			
SUNSPLPMPB	CB3	3/4/98	SPLP	5700	92.0		
VENSPLPA	CB3	3/4/98	SPLP	820			
VENSPLPMPB	CB3	3/4/98	SPLP	5200	87.6		
YUKSPLPA	CB3	3/4/98	SPLP	86			
YUKSPLPMPB	CB3	3/4/98	SPLP	4800	94.3		

Table B-3. Analytical Batch Duplicates - Relative Percent Difference (RPD)

		Batch CB1			Batch CB2			Batch CB3			Batch CB4			Batch CB4	
	VENTCLPA	VENTCLPD	RPD	VENEPADIA	VENEPADID	RPD	MAYSPLPA	MAYSPLPD	RPD	SUNMM1 RA	SUNMM1D RA	RPD	SUNMM1 FA	SUNMM1D FA	RPD
Date	2/12/98	2/12/98		2/19/98	2/19/98		3/4/98	3/4/98		3/11/98	3/11/98		3/11/98	3/11/98	
Leach Method	TCLP	TCLP		TCLP-DI	TCLP-DI		SPLP	SPLP		Montour 1	Montour 1		Montour 1	Montour 1	
Temperature, C	20.2	20.4	1.0	20.7	20.8	0.5	23.5	23.1	1.7	20.1	20.0	0.5	20.1	20.0	0.5
pH pre-filter	4.84	4.84	0.0	2.69	2.72	1.1	3.37	3.34	0.9	2.92	2.89	1.0	2.92	2.89	1.0
pH post-filter	4.83	4.84	0.2	2.70	2.71	0.4	3.38	3.37	0.3	na	na		2.89	2.88	0.3
Specific Conductance pre-filter (uS)	4390	4390	0.0	1067	1065	0.2	202	205	1.5	651	660	1.4	651	660	1.4
Specific Conductance post-filter (uS)	4360	4390	0.7	1069	1064	0.5	203	205	1.0	na	na		653	658	0.8
F (ppm)	<0.1	<0.1	ND	1.1	0.9	20.0	0.4	0.3	28.6				1.0	0.5	66.7
Cl (ppm)	<0.1	<0.1	ND	0.7	0.9	25.0	0.2	0.3	40.0				0.6	0.7	15.4
SO4 (ppm)	560	570	1.8	720	710	1.4	110	98	11.5				380	410	7.6
NO3 (ppm)	2.0	< 0.4	ND	1.2	0.9	28.6	1.4	1.3	7.4				1.4	1.5	6.9
Ag (ug/L)	< 0.01	< 0.01	ND	0.01	0.03	100.0	0.02	0.04	66.7	1.4	1.9	30.3	0.2	< 0.01	ND
Al (mg/L)	1.9	1.8	5.4	14	14	0.0	0.43	0.45	4.5	11	14	24.0	8.9	9.0	1.1
As (ug/L)	< 0.2	< 0.2	ND	0.5	0.4	22.2	<.0.2	< 0.2	ND	14	16	13.3	5.7	5.6	1.8
Au (ug/L)	0.03	0.04	28.6	< 0.01	< 0.01	ND	< 0.01	< 0.01	ND	0.01	< 0.01	ND	< 0.01	< 0.01	ND
B (mg/L)	<0.01	<0.01	ND	<0.01	<0.01	ND	<0.01	<0.01	ND	<0.01	<0.01	ND	<0.01	<0.01	ND
Ba (ug/L)	97	70	32.3	61	63	3.2	73	72	1.4	210	280	28.6	38	39	2.6
Be (ug/L)	0.4	0.3	28.6	1.6	1.1	37.0	0.2	0.2	0.0	0.9	0.8	11.8	0.9	1.2	28.6
Bi (ug/L)	0.08	0.07	13.3	0.04	0.02	66.7	0.04	0.05	22.2	0.11	0.09	20.0	< 0.01	0.02	ND
Ca (mg/L)	5.2	4.8	8.0	5.9	5.7	3.4	2.3	2.4	4.3	5.7	6.3	10.0	5.8	5.8	0.0
Cd (ug/L)	13	13	0.0	13	13	0.0	<10	<10	ND	23	25	8.3	23	22	4.4
Ce (ug/L)	5.3	5.3	0.0	17	17	0.0	0.2	0.3	40.0	5.5	5.5	0.0	4.7	4.9	4.2
Co (ug/L)	15	12	22.2	19	20	5.1	<10	<10	ND	14	15	6.9	13	12	8.0
Cr (ug/L)	<10	<10	ND	27	27	0.0	<10	<10	ND	11	12	8.7	10	<10	ND
Cs (ug/L)	0.2	0.2	0.0	0.2	0.2	0.0	0.46	0.46	0.0	0.94	1.2	24.3	0.39	0.43	9.8
Cu (ug/L)	2400	2400	0.0	4600	4500	2.2	110	110	0.0	310	390	22.9	220	230	4.4
Dy (ug/L)	0.71	0.70	1.4	2.5	2.5	0.0	0.04	0.04	0.0	2.2	2.3	4.4	2.1	2.1	0.0
Er (ug/L)	0.31	0.34	9.2	1.3	1.4	7.4	0.02	0.01	66.7	1.4	1.4	0.0	1.3	1.4	7.4
Eu (ug/L)	0.22	0.23	4.4	0.65	0.62	4.7	0.01	0.01	0.0	0.55	0.60	8.7	0.50	0.52	3.9
Fe (mg/L)	1.7	1.7	0.0	36	35	2.8	0.47	0.51	8.2	26	34	26.7	17	17	0.0
Ga (ug/L)	0.05	0.06	18.2	0.3	0.3	0.0	< 0.02	< 0.02	ND	0.1	0.1	0.0	0.1	0.07	35.3
Gd (ug/L)	0.92	0.94	2.2	2.6	2.7	3.8	0.03	0.04	28.6	1.9	1.8	5.4	1.7	1.6	6.1
Ge (ug/L)	< 0.02	0.02	ND	0.06	0.05	18.2	< 0.02	< 0.02	ND	< 0.02	0.02	ND	0.02	< 0.02	ND
Hf (ug/L)	< 0.05	< 0.05	ND	< 0.05	< 0.05	ND	< 0.05	< 0.05	ND	< 0.05	< 0.05	ND	< 0.05	< 0.05	ND
Ho (ug/L)	0.13	0.12	8.0	0.48	0.50	4.1	0.006	0.006	0.0	0.50	0.49	2.0	0.47	0.46	2.2
In (ug/L)	0.08	0.07	13.3	0.30	0.32	6.5	0.02	0.01	66.7	0.38	0.40	5.1	0.26	0.27	3.8
K (mg/L)	2.2	2.2	0.0	1.3	1.2	8.0	1.5	1.4	6.9	1.8	3.1	53.1	<0.5	<0.5	ND
La (ug/L)	< 0.01	< 0.01	ND	6.7	7.0	4.4	< 0.01	< 0.01	ND	< 0.01	< 0.01	ND	< 0.01	< 0.01	ND
Li (ug/L)	5.5	5.0	9.5	7.4	6.8	8.5	4.8	4.1	15.7	2.8	2.5	11.3	2.4	2.8	15.4
Mg (mg/L)	7.0	6.6	5.9	8.2	8.0	2.5	0.79	0.79	0.0	0.47	0.60	24.3	0.39	0.40	2.5
Mn (ug/L)	810	780	3.8	1100	1100	0.0	190	190	0.0	650	740	12.9	670	660	1.5
Mo (ug/L)	0.61	0.5	19.8	0.90	0.4	76.9	0.4	2.9	151.5	2.7	2.8	3.6	7.4	3.7	66.7
Na (mg/L)				<0.1	<0.1	ND	0.21	0.21	0.0	<0.1	<0.1	ND	<0.1	0.17	ND
Nb (ug/L)	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND

Table B-3. Analytical Batch Duplicates - Relative Percent Difference (RPD) (continued)

	Batch CB1			Batch CB2			Batch CB3			Batch CB4			Batch CB4		
	VENTCLPA	VENTCLPD	RPD	VENEPADIA	VENEPADID	RPD	MAYSPLPA	MAYSPLPD	RPD	SUNMM1 RA	SUNMM1D RA	RPD	SUNMM1 FA	SUNMM1D FA	RPD
Nd (ug/L)	2.8	2.7	3.6	8.8	8.8	0.0	0.1	0.1	0.0	3.6	3.7	2.7	3.3	3.3	0.0
Ni (ug/L)	34	32	6.1	48	46	4.3	<10	<10	ND	16	24	40.0	16	18	11.8
P (ug/L)	6	8	28.6	11	9	20.0	3	3	0.0	140	150	6.9	61	60	1.7
Pb (ug/L)	2800	2600	7.4	960	870	9.8	2200	2700	20.4	780	900	14.3	220	230	4.4
Pr (ug/L)	0.67	0.68	1.5	2.1	2.2	4.7	0.03	0.03	0.0	0.74	0.80	7.8	0.66	0.75	12.8
Rb (ug/L)	3.5	3.5	0.0	4.1	4.0	2.5	2.2	2.3	4.4	2.9	3.3	12.9	1.0	1.0	0.0
Re (ug/L)	0.02	0.02	0.0	< 0.02	0.02	ND	0.03	0.04	28.6	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND
Sb (ug/L)	0.1	0.1	0.0	0.1	0.1	0.0	1.9	2.1	10.0	5.1	6.3	21.1	2.2	2.2	0.0
Sc (ug/L)	2	2	0.0	2	2	0.0	0.2	0.3	40.0	0.4	0.3	28.6	0.6	0.4	40.0
Se (ug/L)	1	2	66.7	2	2	0.0	0.8	1	22.2	0.8	0.7	13.3	1	0.7	35.3
Si (mg/L)	1.2	1.2	0.0	1.3	1.3	0.0	1.9	1.8	5.4	4.7	8.1	53.1	0.16	0.16	0.0
Sm (ug/L)	0.83	0.84	1.2	2.5	2.4	4.1	0.04	0.04	0.0	1.3	1.3	0.0	1.2	1.0	18.2
Sn (ug/L)	< 0.05	< 0.05	ND	< 0.05	< 0.05	ND	< 0.05	< 0.05	ND	< 0.05	< 0.05	ND	< 0.05	< 0.05	ND
Sr (ug/L)	41	41	0.0	42	40	4.9	26	25	3.9	19	23	19.0	14	14	0.0
Ta (ug/L)	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	0.02	ND
Tb (ug/L)	0.14	0.14	0.0	0.45	0.48	6.5	0.007	0.007	0.0	0.36	0.35	2.8	0.33	0.34	3.0
Te (ug/L)	< 0.1	< 0.1	ND	< 0.1	< 0.1	ND	< 0.1	< 0.1	ND	< 0.1	< 0.1	ND	< 0.1	< 0.1	ND
Th (ug/L)	0.08	0.08	0.0	5.4	5.4	0.0	< 0.005	< 0.005	ND	0.74	0.75	1.3	0.57	0.55	3.6
Ti (ug/L)	2.2	2.2	0.0	2.3	2.0	14.0	0.2	0.1	66.7	1.1	1.1	0.0	1.0	2.0	66.7
Tl (ug/L)	< 0.05	< 0.05	ND	0.05	0.06	18.2	< 0.05	0.2	ND	0.2	0.3	40.0	0.54	< 0.05	ND
Tm (ug/L)	0.04	0.03	28.6	0.18	0.17	5.7	< 0.005	< 0.005	ND	0.18	0.18	0.0	0.16	0.18	11.8
U (ug/L)	8.7	8.9	2.3	8.1	8.0	1.2	0.12	0.12	0.0	1.5	1.5	0.0	1.4	1.5	6.9
V (ug/L)	< 0.1	< 0.1	ND	0.4	0.4	0.0	< 0.1	< 0.1	ND	0.2	0.3	40.0	0.3	2	147.8
W (ug/L)	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	< 0.02	ND	< 0.02	0.2	ND
Y (ug/L)	4.3	4.1	4.8	11	12	8.7	0.2	0.1	66.7	13	13	0.0	13	13	0.0
Yb (ug/L)	0.20	0.2	0.0	0.97	0.96	1.0	< 0.01	< 0.01	ND	1.1	1.1	0.0	1.0	1.1	9.5
Zn (ug/L)	740	730	1.4	990	970	2.0	980	1000	2.0	3700	4200	12.7	3700	3700	0.0
Zr (ug/L)	< 0.05	< 0.05	ND	0.2	0.05	120.0	< 0.05	< 0.05	ND	< 0.05	0.06	ND	< 0.05	0.2	ND

Table B-4. Acid Blank Analytical Results

Blank	CB1AB	CB2AB	CB3AB	CB4AB
Analytical Batch	CB1	CB2	CB3	CB4
Date	2/12/98	2/19/98	3/4/98	3/11/98
Ag (ug/L)	*0.03*	*0.01*	*0.02*	*< 0.01*
Al (mg/L)	**<0.01**	**<0.01**	**<0.01**	**<0.01**
As (ug/L)	*< 0.2*	*< 0.2*	*< 0.2*	*< 0.2*
Au (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
B (mg/L)	**<0.01**	**<0.01**	**<0.01**	**<0.01**
Ba (ug/L)	**<10**	**<10**	**<10**	**<10**
Be (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*
Bi (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Ca (mg/L)	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Cd (ug/L)	**<10**	**<10**	**<10**	**<10**
Ce (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Co (ug/L)	**<10**	**<10**	**<10**	**<10**
Cr (ug/L)	**<10**	**<10**	**<10**	**<10**
Cs (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Cu (ug/L)	**<10**	**<10**	**<10**	**<10**
Dy (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Er (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Eu (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Fe (mg/L)	**<0.05**	**<0.05**	**<0.05**	**<0.05**
Ga (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Gd (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
Ge (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Hf (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*
Ho (ug/L)	*< 0.005*	*< 0.005*	*< 0.005*	*< 0.005*
In (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
K (mg/L)	**<0.5**	**<0.5**	**<0.5**	**<0.5**
La (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Li (ug/L)	*1.0*	*1.0*	*0.4*	*0.2*
Mg (mg/L)	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Mn (ug/L)	**<10**	**<10**	**<10**	**<10**
Mo (ug/L)	*< 0.02*	*< 0.02*	*1.6*	*1.5*
Na (mg/L)	**0.18**	**<0.1**	**<0.1**	**<0.1**
Nb (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*
Nd (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Ni (ug/L)	**<10**	**<10**	**<10**	**<10**
P (ug/L)	*<1*	*<1*	*<1*	*<1*
Pb (ug/L)	*< 0.05*	*< 0.05*	*< 0.05*	*< 0.05*
Pr (ug/L)	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Rb (ug/L)	*< 0.01*	*< 0.01*	*0.02*	*< 0.01*
Re (ug/L)	*< 0.02*	*< 0.02*	*< 0.02*	*< 0.02*

Concentrations in bold measured by ICP-AES and italics by ICP-MS

Table B-4 (continued)

Blank Analytical Batch Date	CB1AB CB1 2/12/98	CB2AB CB2 2/19/98	CB3AB CB3 3/4/98	CB4AB CB4 3/11/98
Sb (ug/L)	< *0.02*	< *0.02*	*0.07*	*0.05*
Sc (ug/L)	< *0.1*	< *0.1*	< *0.1*	< *0.1*
Se (ug/L)	< *0.2*	< *0.2*	< *0.2*	< *0.2*
Si (mg/L)	**<0.1**	**<0.1**	**<0.1**	**<0.1**
Sm (ug/L)	< *0.01*	< *0.01*	< *0.01*	< *0.01*
Sn (ug/L)	< *0.05*	< *0.05*	< *0.05*	< *0.05*
Sr (ug/L)	**<10**	**<10**	**<10**	**<10**
Ta (ug/L)	< *0.02*	< *0.02*	< *0.02*	< *0.02*
Tb (ug/L)	< *0.005*	< *0.005*	< *0.005*	< *0.005*
Te (ug/L)	< *0.1*	< *0.1*	< *0.1*	< *0.1*
Th (ug/L)	< *0.005*	< *0.005*	< *0.005*	< *0.005*
Ti (ug/L)	< *0.1*	< *0.1*	< *0.1*	< *0.1*
Tl (ug/L)	< *0.05*	< *0.05*	*0.06*	< *0.05*
Tm (ug/L)	< *0.005*	< *0.005*	< *0.005*	< *0.005*
U (ug/L)	< *0.005*	< *0.005*	< *0.005*	< *0.005*
V (ug/L)	< *0.1*	< *0.1*	< *0.1*	< *0.1*
W (ug/L)	< *0.02*	< *0.02*	< *0.02*	< *0.02*
Y (ug/L)	< *0.01*	< *0.01*	< *0.01*	< *0.01*
Yb (ug/L)	< *0.01*	< *0.01*	< *0.01*	< *0.01*
Zn (ug/L)	**<10**	**<10**	**<10**	**<10**
Zr (ug/L)	< *0.05*	< *0.05*	< *0.05*	< *0.05*

Concentrations in bold measured by ICP-AES and italics by ICP-MS

Reference Standards

Reference standard analyses are presented in Tables B-5 and B-6. Table B-5 summarizes results for two runs of USGS WRD water reference standard M142, a reference standard for major cations. Assuming a control limit of twenty-five percent relative difference, most elements came within control limits, with the exception of vanadium (V), which was consistently a magnitude lower than the most probable concentration for the standard.

Table B-6 summarizes results for two runs of USGS WRD water reference standard T147, a reference standard for trace metals. Several elements exceeded the assumed control limit of twenty-five percent relative difference, but in general, the concentrations were not that different from the standards' most probable concentration and some were still within the F-pseudosigma range.

Table B-5. WRD Reference Standard M142 - relative percent difference

	Reference Standard M142 MPV	F pseudosigma	N	Batch CB2 RFSM142	Batch CB2 RPD	Batch CB4 RFSM142	Batch CB4 RPD
B (mg/L)	0.121	10	45	0.13	7.2	0.11	9.5
Ca (mg/L)	67.6	3.4	112	71	4.9	66	2.4
K (mg/L)	5.7	0.39	99	6.3	9.7	5.5	3.9
Mg (mg/L)	25.3	1.3	111	27	6.5	25	1.2
Na (mg/L)	153	7	106	160	4.5	150	2.0
P (ug/L)	20	10	56	23	14.0	18	10.5
Sr (ug/L)	646	32	42	690	6.6	640	0.9
V (ug/L)	22.7	3.7	45	2	167.6	2	167.6

*MPV – most probable value, N - number of samples

Table B-6. WRD Reference Standard T147 - relative percent difference

	Reference Standard T147 MPV	F pseudosigma	N	Batch CB2		Batch CB4	
				RFST147	RPD	RFST147	RPD
Ag (ug/L)	7.60	7.60	65	5.3	35.7	5.1	39.4
Al (mg/L)	0.014	0.0075	48	0.010	33.3	0.011	24.0
As (ug/L)	2.39	0.67	58	2	17.8	2	17.8
B (mg/L)	0.05	0.0058	41	0.055	9.5	0.046	8.3
Ba (ug/L)	73	3.2	75	78	6.6	67	8.6
Be (ug/L)	16	1.1	71	14	13.3	15	6.5
Ca (mg/L)	41	1.7	99	41	0.0	39	5.0
Cd (ug/L)	15.9	1.2	94	17	6.7	14	12.7
Co	Insufficient	Data					
Cr (ug/L)	12.8	1.2	83	12	6.5	10	24.6
Cu (ug/L)	11.4	1.3	89	12	5.1	10	13.1
Fe (mg/L)	0.0084	0.0064	49	<0.05	ND	<0.05	ND
K (mg/L)	3.52	0.19	88	3.8	7.7	3.2	9.5
Li (ug/L)	18	1.3	35	13	32.3	15	18.2
Mg (mg/L)	8.2	0.30	100	8.7	5.9	7.7	6.3
Mn (ug/L)	17.2	1.4	91	18	4.5	16	7.2
Mo (ug/L)	11.8	1.3	49	13	9.7	18	41.6
Na (mg/L)	52.6	2.2	95	58	9.8	51	3.1
Ni (ug/L)	13.6	1.5	70	13	4.5	12	12.5
Pb (ug/L)	13.8	1.1	83	9.5	36.9	8.2	50.9
Sb (ug/L)	10.5	0.9	49	8.7	18.8	9.0	15.4
Se (ug/L)	10.1	1.8	66	12	17.2	11	8.5
Sr (ug/L)	313	13	49	340	8.3	290	7.6
Tl (ug/L)	20.0	2.1	49	33	49.1	31	43.1
U (ug/L)	3.21	0.59	9	2.7	17.3	2.4	28.9
V (ug/L)	15.2	1.4	53	12	23.5	13	15.6
Zn (ug/L)	14.0	2.2	72	10	33.3	17	19.4

*MPV – most probable value, N - number of samples

Appendix C. Data from Comparative Leach Study

Appendix C. Comparative Study Leachate and Water Data

Sample	Analytical Batch	Date	Leach Method	Liquid to Solid Ratio	Extraction Fluid Chemistry	Method Extraction Fluid	Particle Size Reduction	Length of Extraction Time (hours)	Method of Agitation	Filtration	Filter Type	Filter Pore Size (um)	Filter Membrane Preparation	Amount of Extraction Fluid (mL)	Extraction Fluid pH
CB1AB	CB1	2/12/98	Acid Blank												
CB1EF1TCLPA	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1EF1TCLPMCD	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1EF1TCLPMPB	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1MAYTCLPA	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1SUNTCLPA	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1VENTCLPA	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1VENTCLPD	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1YUKTCLPA	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1YUKTCLPMCD	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB1YUKTCLPMPB	CB1	2/12/98	TCLP	20:1	acetic acid	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.94
CB2AB	CB2	2/19/98	Acid Blank												
CB2DIEPADIA	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2DIEPADIMPB	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2MAYEPADIA	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2MAYEPADIMPB	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2SUNEPADIA	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2SUNEPADIMPB	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2VENEPADIA	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2VENEPADID	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2VENEPADIMPB	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2YUKEPADIA	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2YUKEPADIMPB	CB2	2/19/98	TCLP-DI	20:1	deionized water	na	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	5.81
CB2RFSM142	CB2	2/19/98	Ref. Std.												
CB2RFST147	CB2	2/19/98	Ref. Std.												
CB3AB	CB3	3/4/98	Acid Blank												
CB3EF1SPLPA	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3EF1SPLPMPB	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3MAYSPLPA	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3MAYSPLPD	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3MAYSPLPMPB	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3SUNSPLPA	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3SUNSPLPMPB	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3VENSPLPA	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3VENSPLPMPB	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3YUKSPLPA	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23
CB3YUKSPLPMPB	CB3	3/4/98	SPLP	20:1	60/40 H2SO4/HNO3	1	no	18	rotary agitator	positive pressure	borosilicate glass	0.7	acid wash	2000	4.23

Anions by IC. Concentrations in bold by ICP-AES. Concentrations in italics by ICP-MS. nd=not determined.

Appendix C. Comparative Study Leachate and Water Data (continued)

Sample	Analytical Batch	Date	Leach Method	Liquid to Solid Ratio	Extraction Fluid Chemistry	Method Extraction Fluid	Particle Size Reduction	Length of Extraction Time (hours)	Method of Agitation	Filtration	Filter Type	Filter Pore Size (um)	Filter Membrane Preparation	Amount of Extraction Fluid (mL)	Extraction Fluid pH
CB4AB	CB4	3/11/98	Acid Blank												
CB4EF1MM1A	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4EF1MM1ANN	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4MAYMM1A	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4MAYMM1ANN	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4SUNMM1A	CB4	3/11/98	Montour 1.	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4SUNMM1ANN	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4SUNMM1D	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4SUNMM1DNN	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4VENMM1A	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4VENMM1ANN	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4YUKMM1A	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4YUKMM1ANN	CB4	3/11/98	Montour 1	20:1	60/40 H2SO4/HNO3	1	no	2	periodic inversion	positive pressure	nitrocellulose	0.45	leachate rinsed	2000	4.19
CB4RFSM142	CB4	3/11/98	Ref. Std.												
CB4RFST147	CB4	3/11/98	Ref. Std.												
YUKB1LCHFA	FB1	7/31/97	Rainfall	0.4:1	Rainwater	na	no	21	natural percolation	syringe	nitrocelluose	0.45	leachate rinsed	568	
MAY WRD1 FA	water	9/6/97	na		rainfall runoff										
MAY WRD2 FA	water	9/6/97	na		rainfall runoff										
MAY WRD3 FA	water	9/6/97	na		rainfall runoff										
MAY WRD4 FU	water	9/6/97	na		rainfall runoff										
MAY WRD5 FU	water	9/6/97	na		rainfall runoff										

Anions by IC. Concentrations in bold by ICP-AES. Concentrations in italics by ICP-MS. nd=not determined.

Appendix C. Comparative Study Leachate and Water Data (continued)

Sample	Sample Weight (g)	Temperature degrees C	pH pre-filter	pH post-filter	Specific Conductance pre-filter (uS)	Specific Conductance post-filter (uS)	F ppm	Cl ppm	SO4 ppm	NO3 ppm	Ag ug/L	Al mg/L	As ug/L	Au ug/L	B mg/L	Ba ug/L	Be ug/L	Bi ug/L	Ca mg/L	Cd ug/L	Ce ug/L	Co ug/L	Cr ug/L	Cs ug/L	Cu ug/L
CB1AB							nd	nd	nd	nd	*0.03*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**<10**	*< 0.05*	*< 0.01*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB1EFITCLPA	0	20.4	4.94	4.94	4280	4280	<0.1	<0.1	<2.0	0.3	*0.1*	**0.017**	*< 0.2*	*< 0.01*	**<0.01**	**19**	*< 0.05*	*0.06*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*0.01*	**15**
CB1EFITCLPMCD	0	20.4	4.94	4.94	4280	4280	nd	nd	nd	nd	*< 0.01*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**19**	*< 0.05*	*0.02*	**<0.1**	**1000**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB1EFITCLPMPB	0	20.4	4.94	4.94	4280	4280	nd	nd	nd	nd	*< 0.01*	**0.013**	*< 0.2*	*< 0.01*	**<0.01**	**20**	*< 0.05*	*0.09*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB1MAYTCLPA	100.00	20.2	4.89	4.89	4190	4180	<0.1	<0.1	91	0.7	*0.02*	**0.39**	*< 0.2*	*< 0.01*	**<0.01**	**130**	*0.09*	*0.09*	**2.8**	**<10**	*1.8*	**<10**	**<10**	*0.95*	**63**
CB1SUNTCLPA	100.00	20.4	4.85	4.85	4270	4260	<0.1	<0.1	330	1.0	*< 0.01*	**0.25**	*< 0.2*	*0.04*	**<0.01**	**110**	*0.2*	*0.06*	**4.5**	**20**	*0.86*	**<10**	**<10**	*0.71*	**67**
CB1VENTCLPA	100.00	20.2	4.84	4.83	4390	4360	<0.1	<0.1	560	2.0	*< 0.01*	**1.9**	*< 0.2*	*0.03*	**<0.01**	**97**	*0.4*	*0.08*	**5.2**	**13**	*5.3*	**15**	**<10**	*0.2*	**2400**
CB1VENTCLPD	100.00	20.4	4.84	4.84	4390	4390	<0.1	<0.1	570	<0.4	*< 0.01*	**1.8**	*< 0.2*	*0.04*	**<0.01**	**70**	*0.3*	*0.07*	**4.8**	**13**	*5.3*	**12**	**<10**	*0.2*	**2400**
CB1YUKTCLPA	100.00	20.4	4.87	4.87	4430	4430	<0.1	<0.1	360	1.0	*< 0.01*	**3.9**	*< 0.2*	*0.01*	**<0.01**	**59**	*0.3*	*0.12*	**36**	**<10**	*7.5*	**21**	**<10**	*0.60*	**220**
CB1YUKTCLPMCD	100.00	20.4	4.87	4.87	4430	4430	nd	nd	nd	nd	*< 0.01*	**4.1**	*< 0.2*	*< 0.01*	**0.010**	**62**	*0.5*	*0.18*	**36**	**1000**	*7.8*	**22**	**<10**	*0.62*	**220**
CB1YUKTCLPMPB	100.00	20.4	4.87	4.87	4430	4430	nd	nd	nd	nd	*< 0.01*	**4.0**	*< 0.2*	*< 0.01*	**<0.01**	**61**	*0.5*	*0.26*	**36**	**<10**	*7.5*	**21**	**<10**	*0.64*	**230**
CB2AB							nd	nd	nd	nd	*0.01*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**<10**	*< 0.05*	*< 0.01*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB2DIEPADIA	0	20.7	5.71	4.51	1.67	13.5	<0.1	<0.1	<2	2.9	*< 0.01*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**29**	*< 0.05*	*< 0.01*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB2DIEPADIMPB	0	20.7	5.71	4.51	1.67	13.5	nd	nd	nd	nd	*< 0.01*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**30**	*< 0.05*	*0.06*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB2MAYEPADIA	100.00	20.3	3.42	3.42	193.5	194.4	0.3	0.2	110	0.5	*< 0.01*	**0.47**	*< 0.2*	*< 0.01*	**<0.01**	**94**	*0.2*	*0.04*	**2.4**	**<10**	*0.3*	**<10**	**<10**	*0.42*	**130**
CB2MAYEPADIMPB	100.00	20.3	3.42	3.42	193.5	194.4	nd	nd	nd	nd	*0.02*	**0.50**	*< 0.2*	*< 0.01*	**<0.01**	**97**	*0.2*	*0.05*	**2.5**	**<10**	*0.2*	**<10**	**<10**	*0.38*	**130**
CB2SUNEPADIA	100.00	20.6	2.79	2.81	778	781	2.1	0.6	340	0.4	*0.02*	**7.1**	*2.2*	*< 0.01*	**<0.01**	**61**	*0.9*	*0.04*	**6.2**	**27**	*4.8*	**15**	**10**	*0.49*	**260**
CB2SUNEPADIMPB	100.00	20.6	2.79	2.81	778	781	nd	nd	nd	nd	*0.02*	**7.1**	*2.3*	*< 0.01*	**<0.01**	**61**	*0.9*	*0.06*	**6.3**	**28**	*4.6*	**12**	**11**	*0.47*	**260**
CB2VENEPADIA	100.00	20.7	2.69	2.70	1067	1069	1.1	0.7	720	1.2	*0.01*	**14**	*0.5*	*< 0.01*	**<0.01**	**61**	*1.6*	*0.04*	**5.9**	**13**	*17*	**19**	**27**	*0.2*	**4600**
CB2VENEPADID	100.00	20.8	2.72	2.71	1065	1064	0.9	0.9	710	0.9	*0.03*	**14**	*0.4*	*< 0.01*	**<0.01**	**63**	*1.1*	*0.02*	**5.7**	**13**	*17*	**20**	**27**	*0.2*	**4500**
CB2VENEPADIMPB	100.00	20.7	2.69	2.70	1067	1069	nd	nd	nd	nd	*0.02*	**14**	*0.3*	*< 0.01*	**<0.01**	**61**	*1.2*	*0.05*	**5.9**	**13**	*17*	**20**	**28**	*0.2*	**4600**
CB2YUKEPADIA	100.00	20.5	3.12	3.13	644	651	18	0.7	530	1.8	*0.02*	**11**	*< 0.2*	*< 0.01*	**<0.01**	**42**	*0.8*	*< 0.01*	**42**	**<10**	*5.2*	**25**	**<10**	*0.3*	**530**
CB2YUKEPADIMPB	100.00	20.5	3.12	3.13	644	651	nd	nd	nd	nd	*0.03*	**11**	*< 0.2*	*< 0.01*	**<0.01**	**40**	*0.8*	*0.07*	**41**	**<10**	*5.2*	**22**	**<10**	*0.2*	**530**
CB2RFSM142							nd	nd	nd	nd	*0.04*	**<0.01**	*< 0.2*	*< 0.01*	**0.13**	**59**	*< 0.05*	*< 0.01*	**71**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB2RFST147							nd	nd	nd	nd	*5.3*	**0.010**	*2*	*< 0.01*	**0.055**	**78**	*14*	*< 0.01*	**41**	**17**	*< 0.01*	**<10**	**12**	*0.01*	**12**
CB3AB							nd	nd	nd	nd	*0.02*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**<10**	*< 0.05*	*< 0.01*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB3EFISPLPA	0	23.3	4.25	4.23	24.0	25.0	<0.1	<0.1	23	1.3	*< 0.01*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**21**	*< 0.05*	*< 0.01*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB3EFISPLPMPB	0	23.3	4.25	4.23	24.0	25.0	nd	nd	nd	nd	*0.03*	**0.012**	*< 0.2*	*< 0.01*	**<0.01**	**21**	*< 0.05*	*0.13*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB3MAYSPLPA	100.00	23.5	3.37	3.38	202	203	0.4	0.2	110	1.4	*0.02*	**0.43**	*< 0.2*	*< 0.01*	**<0.01**	**73**	*0.2*	*0.04*	**2.3**	**<10**	*0.2*	**<10**	**<10**	*0.46*	**110**
CB3MAYSPLPD	100.00	23.1	3.34	3.37	205	205	0.3	0.3	98	1.3	*0.04*	**0.45**	*< 0.2*	*< 0.01*	**<0.01**	**72**	*0.2*	*0.05*	**2.4**	**<10**	*0.3*	**<10**	**<10**	*0.46*	**110**
CB3MAYSPLPMPB	100.00	23.5	3.37	3.38	202	203	nd	nd	nd	nd	*< 0.01*	**0.43**	*< 0.2*	*< 0.01*	**<0.01**	**71**	*0.2*	*0.08*	**2.3**	**<10**	*0.2*	**<10**	**<10**	*0.47*	**110**
CB3SUNSPLPA	100.00	23.2	2.77	2.78	803	801	1.3	0.6	330	1.6	*0.02*	**6.6**	*2.5*	*< 0.01*	**<0.01**	**53**	*1.3*	*0.05*	**6.6**	**24**	*4.4*	**14**	**<10**	*0.50*	**220**
CB3SUNSPLPMPB	100.00	23.2	2.77	2.78	803	801	nd	nd	nd	nd	*0.06*	**6.5**	*3.0*	*< 0.01*	**<0.01**	**52**	*1.2*	*0.05*	**6.6**	**26**	*4.5*	**12**	**<10**	*0.48*	**230**
CB3VENSPLPA	100.00	23.3	2.67	2.68	1077	1080	0.9	0.9	740	2.6	*0.1*	**14**	*0.6*	*< 0.01*	**<0.01**	**52**	*1.4*	*0.03*	**6.2**	**12**	*17*	**21**	**24**	*0.2*	**3900**
CB3VENSPLPMPB	100.00	23.3	2.67	2.68	1077	1080	nd	nd	nd	nd	*0.2*	**15**	*0.8*	*< 0.01*	**<0.01**	**55**	*1.5*	*0.11*	**6.5**	**12**	*16*	**22**	**25**	*0.2*	**4200**
CB3YUKSPLPA	100.00	22.8	3.09	3.10	657	658	20	0.7	530	1.7	*< 0.01*	**13**	*0.6*	*< 0.01*	**<0.01**	**29**	*0.9*	*< 0.01*	**47**	**<10**	*5.0*	**32**	**<10**	*0.30*	**620**
CB3YUKSPLPMPB	100.00	22.8	3.09	3.10	657	658	nd	nd	nd	nd	*0.04*	**12**	*0.4*	*< 0.01*	**<0.01**	**28**	*0.7*	*0.06*	**44**	**<10**	*5.1*	**28**	**<10**	*0.30*	**580**

Anions by IC. Concentrations in bold by ICP-AES. Concentrations in italics by ICP-MS. nd=not determined.

Appendix C. Comparative Study Leachate and Water Data (continued)

Sample	Sample Weight (g)	Temperature degrees C	pH pre-filter	pH post-filter	Specific Conductance pre-filter (uS)	Specific Conductance post-filter (uS)	F ppm	Cl ppm	SO4 ppm	NO3 ppm	Ag ug/L	Al mg/L	As ug/L	Au ug/L	B mg/L	Ba ug/L	Be ug/L	Bi ug/L	Ca mg/L	Cd ug/L	Ce ug/L	Co ug/L	Cr ug/L	Cs ug/L	Cu ug/L
CB4AB							nd	nd	nd	nd	*< 0.01*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**<10**	*< 0.05*	*< 0.01*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB4EF1MM1A	0	19.9	4.23	nd	23.7	nd	nd	nd	nd	nd	*< 0.01*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**<10**	*< 0.05*	*< 0.01*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB4EF1MM1ANN	0	19.9	4.23	4.22	23.7	24.2	<0.1	<0.1	22	1.0	*< 0.01*	**<0.01**	*< 0.2*	*< 0.01*	**<0.01**	**<10**	*< 0.05*	*< 0.01*	**<0.1**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<10**
CB4MAYMM1A	100.00	20.2	3.49	nd	134.2	nd	nd	nd	nd	nd	*1.4*	**5.8**	*2.6*	*< 0.01*	**<0.01**	**90**	*0.1*	*1.0*	**1.3**	**<10**	*0.92*	**<10**	**<10**	*0.91*	**150**
CB4MAYMM1ANN	100.00	20.2	3.49	3.46	134.2	136.4	0.2	0.2	96	1.2	*0.04*	**0.15**	*< 0.2*	*< 0.01*	**<0.01**	**13**	*0.09*	*< 0.01*	**1.2**	**<10**	*0.02*	**<10**	**<10**	*0.37*	**59**
CB4SUNMM1A	100.00	20.1	2.92	nd	651	nd	nd	nd	nd	nd	*1.4*	**11**	*14*	*0.01*	**<0.01**	**210**	*0.9*	*0.11*	**5.7**	**23**	*5.5*	**14**	**11**	*0.94*	**310**
CB4SUNMM1ANN	100.00	20.1	2.92	2.89	651	653	1.0	0.6	380	1.4	*0.2*	**8.9**	*5.7*	*< 0.01*	**<0.01**	**38**	*0.9*	*< 0.01*	**5.8**	**23**	*4.7*	**13**	**10**	*0.39*	**220**
CB4SUNMM1D	100.00	20.0	2.89	nd	660	nd	nd	nd	nd	nd	*1.9*	**14**	*16*	*< 0.01*	**<0.01**	**280**	*0.8*	*0.09*	**6.3**	**25**	*5.5*	**15**	**12**	*1.2*	**390**
CB4SUNMM1DNN	100.00	20.0	2.89	2.88	660	658	0.5	0.7	410	1.5	*< 0.01*	**9.0**	*5.6*	*< 0.01*	**<0.01**	**39**	*1.2*	*0.02*	**5.8**	**22**	*4.9*	**12**	**<10**	*0.43*	**230**
CB4VENMM1A	100.00	19.9	2.85	nd	867	nd	nd	nd	nd	nd	*0.80*	**17**	*4.1*	*< 0.01*	**<0.01**	**75**	*1*	*0.85*	**5.7**	**12**	*16*	**22**	**33**	*0.36*	**4100**
CB4VENMM1ANN	100.00	19.9	2.85	2.87	867	869	0.8	0.9	730	1.5	*0.06*	**15**	*2.0*	*< 0.01*	**<0.01**	**34**	*1.3*	*< 0.01*	**5.7**	**11**	*15*	**22**	**30**	*0.2*	**4100**
CB4YUKMM1A	100.00	20.1	3.26	nd	345	nd	nd	nd	nd	nd	*3.9*	**11**	*4.3*	*< 0.01*	**<0.01**	**94**	*0.3*	*7.6*	**17**	**<10**	*5.4*	**14**	**<10**	*1.6*	**250**
CB4YUKMM1ANN	100.00	20.1	3.26	3.25	345	348	3.7	0.4	220	1.3	*0.1*	**3.7**	*< 0.2*	*< 0.01*	**<0.01**	**<10**	*0.2*	*< 0.01*	**17**	**<10**	*3.9*	**12**	**<10**	*0.2*	**210**
CB4RFSM142							nd	nd	nd	nd	*0.04*	**<0.01**	*< 0.2*	*< 0.01*	**0.11**	**52**	*< 0.05*	*0.01*	**66**	**<10**	*< 0.01*	**<10**	**<10**	*< 0.01*	**<0.01**
CB4RFST147							nd	nd	nd	nd	*5.1*	**0.011**	*2*	*< 0.01*	**0.046**	**67**	*15*	*< 0.01*	**39**	**14**	*< 0.01*	**<10**	**10**	*0.01*	**10**
YUKB1LCHFA	1367	20.3	2.17	2.21	5030	5020	10	6.1	2600	<0.1	*1.2*	**34**	*50*	*< 0.01*	**<0.01**	**23**	*1.5*	2.2	**130**	**<10**	*140*	240	**20**	*32*	**5200**
MAY WRD1 FA		13.0	2.84		531		nd	nd	nd	nd	nd	*150*	*11*	*0.03*	nd	*21*	*1.4*	*0.01*	*21*	*19*	*440*	*60*	*87*	*9.6*	*1500*
MAY WRD2 FA		13.0	2.84		531		nd	nd	nd	nd	nd	*100*	*17*	*0.31*	nd	*230*	*0.7*	*0.05*	*8.7*	*7.3*	*50*	*32*	*31*	*6.9*	*520*
MAY WRD3 FA		13.0	2.84		531		nd	nd	nd	nd	nd	*94*	*21*	*0.33*	nd	*230*	*0.9*	*0.02*	*18*	*8.3*	*140*	*55*	*55*	*6.3*	*730*
MAY WRD4 FU		13.0	2.84		531		nd	nd	nd	nd	nd	*2.8*	*< 0.2*	*< 0.01*	nd	*2*	*0.2*	*< 0.01*	*5.4*	*6.1*	*2.5*	*9.0*	*0.7*	*1.4*	*180*
MAY WRD5 FU		13.0	2.84		531		nd	nd	nd	nd	nd	*3*	*< 0.2*	*< 0.01*	nd	*4*	*0.2*	*< 0.01*	*4.2*	*5.7*	*3.9*	*11*	*0.9*	*0.51*	*190*

Anions by IC. Concentrations in bold by ICP-AES. Concentrations in italics by ICP-MS. nd=not determined.

Appendix C. Comparative Study Leachate and Water Data (continued)

Sample	Dy ug/L	Er ug/L	Eu ug/L	Fe mg/L	Ga ug/L	Gd ug/L	Ge ug/L	Hf ug/L	Ho ug/L	In ug/L	K mg/L	La ug/L	Li ug/L	Mg mg/L	Mn ug/L	Mo ug/L	Na mg/L	Nb ug/L	Nd ug/L	Ni ug/L	P ug/L	Pb ug/L	Pr ug/L	Rb ug/L	Re ug/L
CB1AB	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*1.0*	**<0.1**	**<10**	*< 0.02*	**0.18**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*< 0.05*	*< 0.01*	*< 0.01*	*< 0.02*
CB1EF1TCLPA	*< 0.005*	*< 0.005*	*< 0.005*	**1.1**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*0.8*	**<0.1**	**10**	*0.66*	**nd**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*< 0.05*	*< 0.01*	*0.08*	*< 0.02*
CB1EF1TCLPMCD	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**0.64**	*< 0.01*	*< 0.1*	**<0.1**	**<10**	*0.04*	**nd**	*< 0.02*	*< 0.01*	**<10**	*9*	*< 0.05*	*< 0.01*	*0.2*	*< 0.02*
CB1EF1TCLPMPB	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**0.64**	*< 0.01*	*0.1*	**<0.1**	**<10**	*0.1*	**nd**	*< 0.02*	*< 0.01*	**<10**	*2*	*4400*	*< 0.01*	*0.2*	*< 0.02*
CB1MAYTCLPA	*0.21*	*0.078*	*0.11*	**0.42**	*< 0.02*	*0.38*	*< 0.02*	*< 0.05*	*0.04*	*0.2*	**2.4**	*< 0.01*	*3.7*	**0.94**	**230**	*0.83*	**nd**	*< 0.02*	*1.5*	**<10**	*8*	*5500*	*0.30*	*2.3*	*0.05*
CB1SUNTCLPA	*0.37*	*0.22*	*0.14*	**0.93**	*< 0.02*	*0.39*	*< 0.02*	*< 0.05*	*0.071*	*0.1*	**2.1**	*< 0.01*	*1.5*	**0.31**	**560**	*0.4*	**nd**	*< 0.02*	*0.73*	**11**	*10*	*11000*	*0.1*	*2.6*	*0.04*
CB1VENTCLPA	*0.71*	*0.31*	*0.22*	**1.7**	*0.05*	*0.92*	*< 0.02*	*< 0.05*	*0.13*	*0.08*	**2.2**	*< 0.01*	*5.5*	**7.0**	**810**	*0.61*	**nd**	*< 0.02*	*2.8*	**34**	*6*	*2800*	*0.67*	*3.5*	*< 0.02*
CB1VENTCLPD	*0.70*	*0.34*	*0.23*	**1.7**	*0.06*	*0.94*	*0.02*	*< 0.05*	*0.12*	*0.07*	**2.2**	*< 0.01*	*5.0*	**6.6**	**780**	*0.5*	**nd**	*< 0.02*	*2.7*	**32**	*8*	*2600*	*0.68*	*3.5*	*0.02*
CB1YUKTCLPA	*0.62*	*0.24*	*0.26*	**0.67**	*0.1*	*1.0*	*0.03*	*< 0.05*	*0.10*	*0.1*	**2.3**	*< 0.01*	*9.0*	**4.2**	**1500**	*0.71*	**nd**	*< 0.02*	*5.0*	**18**	*10*	*680*	*1.1*	*1.8*	*< 0.02*
CB1YUKTCLPMCD	*0.60*	*0.24*	*0.30*	**0.88**	*0.09*	*1.0*	*0.03*	*< 0.05*	*0.10*	*0.1*	**2.4**	*< 0.01*	*10*	**4.3**	**1500**	*2.3*	**nd**	*< 0.02*	*4.9*	**19**	*11*	*660*	*1.1*	*1.8*	*< 0.02*
CB1YUKTCLPMPB	*0.56*	*0.23*	*0.30*	**0.75**	*0.08*	*0.97*	*< 0.02*	*< 0.05*	*0.090*	*0.1*	**2.4**	*< 0.01*	*9.9*	**4.3**	**1500**	*1.6*	**nd**	*< 0.02*	*4.9*	**18**	*16*	*4800*	*1.1*	*1.8*	*< 0.02*
CB2AB	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*1.0*	**<0.1**	**<10**	*< 0.02*	**<0.1**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*< 0.05*	*< 0.01*	*< 0.01*	*< 0.02*
CB2DIEPADIA	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*1.1*	**<0.1**	**<10**	*< 0.02*	**0.13**	*< 0.02*	*< 0.01*	**<10**	*10*	*< 0.05*	*< 0.01*	*< 0.01*	*< 0.02*
CB2DIEPADIMPB	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*0.8*	**<0.1**	**<10**	*< 0.02*	**<0.1**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*4800*	*< 0.01*	*< 0.01*	*< 0.02*
CB2MAYEPADIA	*0.04*	*0.02*	*0.01*	**0.46**	*< 0.02*	*0.04*	*< 0.02*	*< 0.05*	*0.006*	*0.02*	**1.5**	*< 0.01*	*4.3*	**0.82**	**210**	*0.1*	**0.25**	*< 0.02*	*0.2*	**<10**	*< 1*	*2400*	*0.04*	*1.9*	*0.04*
CB2MAYEPADIMPB	*0.03*	*0.01*	*0.01*	**0.56**	*< 0.02*	*0.04*	*< 0.02*	*< 0.05*	*0.006*	*0.01*	**1.5**	*< 0.01*	*4.5*	**0.86**	**220**	*0.3*	**0.27**	*< 0.02*	*0.1*	**<10**	*3*	*7100*	*0.03*	*1.8*	*0.03*
CB2SUNEPADIA	*1.8*	*1.0*	*0.42*	**17**	*0.07*	*1.5*	*< 0.02*	*< 0.05*	*0.37*	*0.2*	**0.94**	*< 0.01*	*3.0*	**0.47**	**800**	*0.5*	**<0.1**	*< 0.02*	*2.7*	**18**	*24*	*1300*	*0.64*	*2.3*	*0.02*
CB2SUNEPADIMPB	*1.7*	*1.1*	*0.41*	**17**	*0.05*	*1.3*	*< 0.02*	*< 0.05*	*0.36*	*0.2*	**0.97**	*< 0.01*	*2.9*	**0.47**	**820**	*0.4*	**<0.1**	*< 0.02*	*2.7*	**19**	*23*	*6100*	*0.64*	*2.3*	*0.02*
CB2VENEPADIA	*2.5*	*1.3*	*0.65*	**36**	*0.3*	*2.6*	*0.06*	*< 0.05*	*0.48*	*0.30*	**1.3**	*6.7*	*7.4*	**8.2**	**1100**	*0.90*	**<0.1**	*< 0.02*	*8.8*	**48**	*11*	*960*	*2.1*	*4.1*	*< 0.02*
CB2VENEPADID	*2.5*	*1.4*	*0.62*	**35**	*0.3*	*2.7*	*0.05*	*< 0.05*	*0.50*	*0.32*	**1.2**	*7.0*	*6.8*	**8.0**	**1100**	*0.4*	**<0.1**	*< 0.02*	*8.8*	**46**	*9*	*870*	*2.2*	*4.0*	*0.02*
CB2VENEPADIMPB	*2.5*	*1.4*	*0.68*	**36**	*0.3*	*2.8*	*0.05*	*< 0.05*	*0.50*	*0.33*	**1.2**	*6.6*	*7.0*	**8.2**	**1100**	*0.65*	**<0.1**	*< 0.02*	*9.1*	**46**	*17*	*5500*	*2.2*	*4.1*	*< 0.02*
CB2YUKEPADIA	*0.47*	*0.19*	*0.18*	**20**	*0.06*	*0.59*	*< 0.02*	*< 0.05*	*0.087*	*0.1*	**1.2**	*< 0.01*	*12*	**4.5**	**1500**	*0.68*	**0.13**	*< 0.02*	*2.6*	**19**	*9*	*120*	*0.68*	*1.7*	*< 0.02*
CB2YUKEPADIMPB	*0.48*	*0.22*	*0.15*	**19**	*0.06*	*0.59*	*0.02*	*0.1*	*0.079*	*0.1*	**1.2**	*< 0.01*	*12*	**4.4**	**1400**	*0.83*	**0.17**	*< 0.02*	*2.7*	**21**	*24*	*4700*	*0.63*	*1.7*	*< 0.02*
CB2RFSM142	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**6.3**	*< 0.01*	*48*	**27**	**<10**	*30*	**160**	*< 0.02*	*< 0.01*	**<10**	*23*	*< 0.05*	*< 0.01*	*1.3*	*0.06*
CB2RFST147	*< 0.005*	*< 0.005*	*0.006*	**<0.05**	*< 0.02*	*0.01*	*0.07*	*< 0.05*	*< 0.005*	*< 0.01*	**3.8**	*< 0.01*	*13*	**8.7**	**18**	*13*	**58**	*< 0.02*	*< 0.01*	**13**	*5*	*9.5*	*< 0.01*	*1.8*	*0.06*
CB3AB	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*0.4*	**<0.1**	**<10**	*1.6*	**<0.1**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*< 0.05*	*< 0.01*	*0.02*	*< 0.02*
CB3EF1SPLPA	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*< 0.1*	**<0.1**	**<10**	*1.8*	**<0.1**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*< 0.05*	*< 0.01*	*< 0.01*	*< 0.02*
CB3EF1SPLPMPB	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*0.7*	**<0.1**	**<10**	*0.4*	**<0.1**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*4800*	*< 0.01*	*0.01*	*< 0.02*
CB3MAYSPLPA	*0.04*	*0.02*	*0.01*	**0.47**	*< 0.02*	*0.03*	*< 0.02*	*< 0.05*	*0.006*	*0.02*	**1.5**	*< 0.01*	*4.8*	**0.79**	**190**	*0.4*	**0.21**	*< 0.02*	*0.1*	**<10**	*3*	*2200*	*0.03*	*2.2*	*0.03*
CB3MAYSPLPD	*0.04*	*0.01*	*0.01*	**0.51**	*< 0.02*	*0.04*	*< 0.02*	*< 0.05*	*0.006*	*0.01*	**1.4**	*< 0.01*	*4.1*	**0.79**	**190**	*2.9*	**0.21**	*< 0.02*	*0.1*	**<10**	*3*	*2700*	*0.03*	*2.3*	*0.04*
CB3MAYSPLPMPB	*0.04*	*0.01*	*0.01*	**0.48**	*< 0.02*	*0.05*	*< 0.02*	*< 0.05*	*0.007*	*0.02*	**1.4**	*< 0.01*	*4.8*	**0.77**	**190**	*1.0*	**0.23**	*< 0.02*	*0.1*	**<10**	*8*	*7200*	*0.03*	*2.2*	*0.04*
CB3SUNSPLPA	*1.6*	*0.94*	*0.39*	**13**	*0.07*	*1.3*	*0.03*	*< 0.05*	*0.35*	*0.1*	**0.89**	*< 0.01*	*3.3*	**0.42**	**700**	*0.89*	**<0.1**	*< 0.02*	*2.6*	**17**	*20*	*1100*	*0.60*	*2.7*	*< 0.02*
CB3SUNSPLPMPB	*1.6*	*0.97*	*0.36*	**13**	*0.08*	*1.2*	*0.03*	*< 0.05*	*0.32*	*0.1*	**0.88**	*< 0.01*	*3.3*	**0.42**	**700**	*3.2*	**<0.1**	*< 0.02*	*2.5*	**19**	*24*	*5700*	*0.56*	*2.7*	*0.02*
CB3VENSPLPA	*2.4*	*1.3*	*0.64*	**27**	*0.3*	*2.6*	*0.07*	*< 0.05*	*0.48*	*0.31*	**1.1**	*6.7*	*7.5*	**7.2**	**990**	*2.0*	**<0.1**	*< 0.02*	*8.6*	**38**	*12*	*820*	*2.1*	*4.5*	*0.02*
CB3VENSPLPMPB	*2.4*	*1.3*	*0.61*	**28**	*0.4*	*2.4*	*0.08*	*< 0.05*	*0.44*	*0.30*	**1.3**	*6.6*	*7.5*	**7.6**	**1000**	*2.7*	**<0.1**	*< 0.02*	*8.2*	**43**	*19*	*5200*	*2.0*	*4.4*	*< 0.02*
CB3YUKSPLPA	*0.48*	*0.19*	*0.18*	**17**	*0.08*	*0.66*	*0.03*	*0.4*	*0.083*	*0.1*	**1.3**	*< 0.01*	*14*	**4.6**	**1500**	*1.8*	**0.10**	*< 0.02*	*2.6*	**22**	*24*	*86*	*0.65*	*2.1*	*< 0.02*
CB3YUKSPLPMPB	*0.45*	*0.19*	*0.18*	**17**	*0.07*	*0.59*	*0.03*	*0.2*	*0.082*	*0.1*	**1.2**	*< 0.01*	*13*	**4.3**	**1400**	*1.3*	**0.15**	*< 0.02*	*2.5*	**22**	*12*	*4800*	*0.65*	*1.9*	*< 0.02*

Anions by IC. Concentrations in bold by ICP-AES. Concentrations in italics by ICP-MS. nd=not determined.

Appendix C. Comparative Study Leachate and Water Data (continued)

Sample	Dy ug/L	Er ug/L	Eu ug/L	Fe mg/L	Ga ug/L	Gd ug/L	Ge ug/L	Hf ug/L	Ho ug/L	In ug/L	K mg/L	La ug/L	Li ug/L	Mg mg/L	Mn ug/L	Mo ug/L	Na mg/L	Nb ug/L	Nd ug/L	Ni ug/L	P ug/L	Pb ug/L	Pr ug/L	Rb ug/L	Re ug/L
CB4AB	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*0.2*	**<0.1**	**<10**	*1.5*	**<0.1**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*< 0.05*	*< 0.01*	*< 0.01*	*< 0.02*
CB4EF1MM1A	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*0.2*	**<0.1**	**<10**	*1.3*	**<0.1**	*< 0.02*	*< 0.01*	**<10**	*< 1*	*< 0.05*	*< 0.01*	*< 0.01*	*< 0.02*
CB4EF1MM1ANN	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*< 0.1*	**<0.1**	**<10**	*1.8*	**<0.1**	*< 0.02*	*< 0.01*	**53**	*8*	*< 0.05*	*< 0.01*	*< 0.01*	*< 0.02*
CB4MAYMM1A	*0.10*	*0.04*	*0.04*	**11**	*0.1*	*0.14*	*< 0.02*	*< 0.05*	*0.01*	*0.2*	**2.4**	*< 0.01*	*3.6*	**0.73**	**110**	*1.7*	**0.27**	*< 0.02*	*0.63*	**<10**	*78*	*1000*	*0.1*	*2.0*	*0.02*
CB4MAYMM1ANN	*0.009*	*< 0.005*	*< 0.005*	**0.34**	*< 0.02*	*0.01*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**<0.5**	*< 0.01*	*3.8*	**0.39**	**88**	*0.3*	**<0.1**	*< 0.02*	*0.02*	**<10**	*6*	*490*	*< 0.01*	*0.85*	*0.02*
CB4SUNMM1A	*2.2*	*1.4*	*0.55*	**26**	*0.1*	*1.9*	*< 0.02*	*< 0.05*	*0.50*	*0.38*	**1.8**	*< 0.01*	*2.8*	**0.47**	**650**	*2.7*	**<0.1**	*< 0.02*	*3.6*	**16**	*140*	*780*	*0.74*	*2.9*	*< 0.02*
CB4SUNMM1ANN	*2.1*	*1.3*	*0.50*	**17**	*0.1*	*1.7*	*0.02*	*< 0.05*	*0.47*	*0.26*	**<0.5**	*< 0.01*	*2.4*	**0.39**	**670**	*7.4*	**<0.1**	*< 0.02*	*3.3*	**16**	*61*	*220*	*0.66*	*1.0*	*< 0.02*
CB4SUNMM1D	*2.3*	*1.4*	*0.60*	**34**	*0.1*	*1.8*	*0.02*	*< 0.05*	*0.49*	*0.40*	**3.1**	*< 0.01*	*2.5*	**0.60**	**740**	*2.8*	**<0.1**	*< 0.02*	*3.7*	**24**	*150*	*900*	*0.80*	*3.3*	*< 0.02*
CB4SUNMM1DNN	*2.1*	*1.4*	*0.52*	**17**	*0.07*	*1.6*	*< 0.02*	*< 0.05*	*0.46*	*0.27*	**<0.5**	*< 0.01*	*2.8*	**0.40**	**660**	*3.7*	**0.17**	*< 0.02*	*3.3*	**18**	*60*	*230*	*0.75*	*1.0*	*< 0.02*
CB4VENMM1A	*2.6*	*1.4*	*0.69*	**45**	*0.50*	*2.7*	*0.04*	*< 0.05*	*0.52*	*0.36*	**1.7**	*5.0*	*6.8*	**7.5**	**810**	*1.4*	**<0.1**	*< 0.02*	*8.9*	**45**	*63*	*640*	*2.1*	*3.6*	*< 0.02*
CB4VENMM1ANN	*2.5*	*1.4*	*0.64*	**38**	*0.4*	*2.6*	*0.06*	*< 0.05*	*0.50*	*0.35*	**<0.5**	*5.0*	*6.8*	**7.4**	**790**	*4.3*	**<0.1**	*< 0.02*	*8.6*	**42**	*44*	*580*	*2.0*	*2.0*	*< 0.02*
CB4YUKMM1A	*0.33*	*0.13*	*0.14*	**23**	*0.3*	*0.48*	*0.02*	*0.1*	*0.055*	*0.21*	**4.5**	*< 0.01*	*6.4*	**2.4**	**600**	*12*	**0.13**	*< 0.02*	*2.3*	**<10**	*180*	*620*	*0.65*	*4.4*	*< 0.02*
CB4YUKMM1ANN	*0.34*	*0.14*	*0.11*	**4.9**	*0.04*	*0.41*	*< 0.02*	*< 0.05*	*0.050*	*0.1*	**<0.5**	*< 0.01*	*5.5*	**1.9**	**590**	*0.71*	**<0.1**	*< 0.02*	*2.0*	**10**	*8*	*38*	*0.48*	*0.3*	*< 0.02*
CB4RFSM142	*< 0.005*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*< 0.005*	*< 0.02*	*< 0.05*	*< 0.005*	*< 0.01*	**5.5**	*< 0.01*	*48*	**25**	**<10**	*76*	**150**	*< 0.02*	*< 0.01*	**<10**	*18*	*< 0.05*	*< 0.01*	*1.4*	*0.05*
CB4RFST147	*0.007*	*< 0.005*	*< 0.005*	**<0.05**	*< 0.02*	*0.005*	*0.08*	*0.1*	*< 0.005*	*< 0.01*	**3.2**	*< 0.01*	*15*	**7.7**	**16**	*18*	**51**	*< 0.02*	*0.02*	**12**	*6*	*8.2*	*< 0.01*	*1.7*	*0.06*
YUKB1LCHFA	*3.8*	*1.5*	*2.3*	**550**	*6.2*	*6.0*	*0.3*	*< 0.05*	*0.62*	*4.4*	**15**	*97*	*26*	**8.0**	**2400**	*260*	**0.70**	*0.04*	*59*	**210**	*1400*	*1500*	*17*	*130*	*0.1*
MAY WRD1 FA	*23*	*11*	*15*	nd	*35*	*52*	*0.6*	*0.07*	*3.3*	*21*	nd	*120*	*170*	*51*	*11000*	*< 0.02*	nd	*< 0.02*	*170*	*24*	*nd*	*37*	*19*	*0.29*	*nd*
MAY WRD2 FA	*5.4*	*1.5*	*2.3*	nd	*41*	*11*	*0.2*	*< 0.05*	*0.60*	*4.2*	nd	*23*	*130*	*69*	*11000*	*0.2*	nd	*< 0.02*	*33*	*29*	*nd*	*7.9*	*14*	*0.1*	*nd*
MAY WRD3 FA	*13*	*5.6*	*5.4*	nd	*38*	*19*	*0.4*	*< 0.05*	*1.7*	*6.1*	nd	*64*	*190*	*73*	*13000*	*0.1*	nd	*< 0.02*	*97*	*43*	*nd*	*21*	*7.9*	*0.2*	*nd*
MAY WRD4 FU	*0.27*	*0.11*	*0.13*	nd	*0.07*	*0.46*	*< 0.02*	*< 0.05*	*0.04*	*0.20*	nd	*0.99*	*26*	*3.4*	*350*	*< 0.02*	nd	*< 0.02*	*1.0*	*3.6*	*nd*	*0.29*	*3.0*	*0.06*	*nd*
MAY WRD5 FU	*0.46*	*0.21*	*0.16*	nd	*0.06*	*0.95*	*< 0.02*	*< 0.05*	*0.067*	*0.29*	nd	*1.6*	*15*	*2.9*	*750*	*< 0.02*	nd	*< 0.02*	*2.5*	*2.7*	*nd*	*0.48*	*1.3*	*0.06*	*nd*

Anions by IC. Concentrations in bold by ICP-AES. Concentrations in italics by ICP-MS. nd=not determined.

Appendix C. Comparative Study Leachate and Water Data (continued)

Sample	Sb ug/L	Sc ug/L	Se ug/L	Si mg/L	Sm ug/L	Sn ug/L	Sr ug/L	Ta ug/L	Tb ug/L	Te ug/L	Th ug/L	Ti ug/L	Tl ug/L	Tm ug/L	U ug/L	V ug/L	W ug/L	Y ug/L	Yb ug/L	Zn ug/L	Zr ug/L
CB1AB	*< 0.02*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**<10**	*< 0.05*
CB1EFITCLPA	*< 0.02*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**27**	*< 0.05*
CB1EFITCLPMCD	*< 0.02*	*2*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*0.01*	*< 0.01*	**22**	*< 0.05*
CB1EFITCLPMPB	*< 0.02*	*2*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**24**	*< 0.05*
CB1MAYTCLPA	*5.0*	*0.8*	*2*	**1.7**	*0.42*	*< 0.05*	**34**	*< 0.02*	*0.054*	*< 0.1*	*0.006*	*0.4*	*0.09*	*0.009*	*0.35*	*< 0.1*	*< 0.02*	*0.80*	*0.05*	**990**	*< 0.05*
CB1SUNTCLPA	*5.3*	*2*	*0.2*	**1.6**	*0.28*	*< 0.05*	**44**	*< 0.02*	*0.066*	*< 0.1*	*< 0.005*	*1.2*	*0.1*	*0.03*	*1.5*	*< 0.1*	*< 0.02*	*2.0*	*0.2*	**2400**	*< 0.05*
CB1VENTCLPA	*0.1*	*2*	*1*	**1.2**	*0.83*	*< 0.05*	**41**	*< 0.02*	*0.14*	*< 0.1*	*0.08*	*2.2*	*< 0.05*	*0.04*	*8.7*	*< 0.1*	*< 0.02*	*4.3*	*0.20*	**740**	*< 0.05*
CB1VENTCLPD	*0.1*	*2*	*2*	**1.2**	*0.84*	*< 0.05*	**41**	*< 0.02*	*0.14*	*< 0.1*	*0.08*	*2.2*	*< 0.05*	*0.03*	*8.9*	*< 0.1*	*< 0.02*	*4.1*	*0.2*	**730**	*< 0.05*
CB1YUKTCLPA	*1.9*	*2*	*2*	**1.6**	*1.1*	*< 0.05*	**52**	*< 0.02*	*0.15*	*< 0.1*	*0.12*	*2.2*	*< 0.05*	*0.03*	*0.57*	*< 0.1*	*< 0.02*	*2.6*	*0.1*	**1100**	*1.5*
CB1YUKTCLPMCD	*2.2*	*2*	*2*	**1.7**	*1.2*	*< 0.05*	**54**	*0.04*	*0.14*	*< 0.1*	*0.13*	*3.0*	*< 0.05*	*0.03*	*0.59*	*< 0.1*	*< 0.02*	*2.7*	*0.1*	**1100**	*3.7*
CB1YUKTCLPMPB	*2.0*	*2*	*2*	**1.6**	*1.3*	*< 0.05*	**54**	*0.03*	*0.13*	*< 0.1*	*0.13*	*2.5*	*< 0.05*	*0.03*	*0.59*	*< 0.1*	*< 0.02*	*2.6*	*0.1*	**1100**	*2.6*
CB2AB	*< 0.02*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**<10**	*< 0.05*
CB2DIEPADIA	*< 0.02*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**<10**	*< 0.05*
CB2DIEPADIMPB	*< 0.02*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**11**	*< 0.05*
CB2MAYEPADIA	*2.0*	*< 0.1*	*0.3*	**1.6**	*0.05*	*< 0.05*	**26**	*< 0.02*	*0.008*	*< 0.1*	*0.01*	*< 0.1*	*0.06*	*< 0.005*	*0.12*	*< 0.1*	*< 0.02*	*0.1*	*0.01*	**860**	*0.2*
CB2MAYEPADIMPB	*1.9*	*< 0.1*	*0.8*	**1.7**	*0.04*	*< 0.05*	**28**	*< 0.02*	*0.007*	*< 0.1*	*0.02*	*0.2*	*0.07*	*< 0.005*	*0.11*	*< 0.1*	*< 0.02*	*0.1*	*< 0.01*	**980**	*0.05*
CB2SUNEPADIA	*4.3*	*0.3*	*0.5*	**1.2**	*0.90*	*< 0.05*	**50**	*< 0.02*	*0.28*	*< 0.1*	*0.13*	*0.8*	*< 0.05*	*0.14*	*1.5*	*< 0.1*	*< 0.02*	*9.4*	*0.89*	**3800**	*< 0.05*
CB2SUNEPADIMPB	*4.3*	*0.3*	*0.4*	**1.3**	*0.94*	*< 0.05*	**50**	*< 0.02*	*0.26*	*< 0.1*	*0.12*	*0.8*	*0.06*	*0.14*	*1.6*	*< 0.1*	*< 0.02*	*9.3*	*0.81*	**3800**	*< 0.05*
CB2VENEPADIA	*0.1*	*2*	*2*	**1.3**	*2.5*	*< 0.05*	**42**	*< 0.02*	*0.45*	*< 0.1*	*5.4*	*2.3*	*0.05*	*0.18*	*8.1*	*0.4*	*< 0.02*	*11*	*0.97*	**990**	*0.2*
CB2VENEPADID	*0.1*	*2*	*2*	**1.3**	*2.4*	*< 0.05*	**40**	*< 0.02*	*0.48*	*< 0.1*	*5.4*	*2.0*	*0.06*	*0.17*	*8.0*	*0.4*	*< 0.02*	*12*	*0.96*	**970**	*0.05*
CB2VENEPADIMPB	*0.1*	*2*	*1*	**1.3**	*2.5*	*< 0.05*	**41**	*< 0.02*	*0.47*	*< 0.1*	*5.5*	*2.0*	*0.08*	*0.17*	*8.0*	*0.4*	*< 0.02*	*11*	*1.0*	**990**	*0.1*
CB2YUKEPADIA	*2.1*	*1*	*1*	**1.6**	*0.62*	*< 0.05*	**48**	*0.03*	*0.10*	*< 0.1*	*1.6*	*2.9*	*< 0.05*	*0.02*	*0.66*	*< 0.1*	*< 0.02*	*1.9*	*0.09*	**1200**	*7.1*
CB2YUKEPADIMPB	*1.9*	*1*	*0.9*	**1.6**	*0.62*	*< 0.05*	**47**	*0.04*	*0.097*	*< 0.1*	*1.8*	*2.9*	*< 0.05*	*0.02*	*0.74*	*< 0.1*	*< 0.02*	*1.8*	*0.1*	**1200**	*9.6*
CB2RFSM142	*0.86*	*0.2*	*2*	**3.9**	*< 0.01*	*0.08*	**690**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*1.1*	*< 0.05*	*< 0.005*	*3.3*	*2*	*0.86*	*0.07*	*< 0.01*	**<10**	*0.09*
CB2RFST147	*8.7*	*0.6*	*12*	**12**	*< 0.01*	*0.4*	**340**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*0.4*	*33*	*< 0.005*	*2.7*	*12*	*0.2*	*0.05*	*< 0.01*	**10**	*0.2*
CB3AB	*0.07*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*0.06*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**<10**	*< 0.05*
CB3EF1SPLPA	*0.1*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**11**	*< 0.05*
CB3EF1SPLPMPB	*< 0.02*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**14**	*< 0.05*
CB3MAYSPLPA	*1.9*	*0.2*	*0.8*	**1.9**	*0.04*	*< 0.05*	**26**	*< 0.02*	*0.007*	*< 0.1*	*< 0.005*	*0.2*	*< 0.05*	*< 0.005*	*0.12*	*< 0.1*	*< 0.02*	*0.2*	*< 0.01*	**980**	*< 0.05*
CB3MAYSPLPD	*2.1*	*0.3*	*1*	**1.8**	*0.04*	*< 0.05*	**25**	*< 0.02*	*0.007*	*< 0.1*	*< 0.005*	*0.1*	*0.2*	*< 0.005*	*0.12*	*< 0.1*	*< 0.02*	*0.1*	*< 0.01*	**1000**	*< 0.05*
CB3MAYSPLPMPB	*2.0*	*0.1*	*0.8*	**1.9**	*0.05*	*< 0.05*	**25**	*< 0.02*	*0.008*	*< 0.1*	*< 0.005*	*0.5*	*0.09*	*< 0.005*	*0.12*	*< 0.1*	*< 0.02*	*0.1*	*0.01*	**950**	*0.3*
CB3SUNSPLPA	*4.9*	*0.4*	*0.8*	**1.4**	*0.83*	*< 0.05*	**50**	*< 0.02*	*0.25*	*< 0.1*	*0.09*	*1.2*	*< 0.05*	*0.12*	*1.6*	*< 0.1*	*< 0.02*	*9.4*	*0.76*	**3800**	*< 0.05*
CB3SUNSPLPMPB	*5.0*	*0.4*	*2*	**1.3**	*0.80*	*< 0.05*	**48**	*< 0.02*	*0.24*	*< 0.1*	*0.12*	*1*	*0.1*	*0.12*	*1.6*	*< 0.1*	*< 0.02*	*9.4*	*0.76*	**3800**	*< 0.05*
CB3VENSPLPA	*0.3*	*2*	*2*	**1.3**	*2.4*	*< 0.05*	**39**	*< 0.02*	*0.42*	*< 0.1*	*5.5*	*2.1*	*0.08*	*0.17*	*8.4*	*0.5*	*< 0.02*	*12*	*0.98*	**970**	*< 0.05*
CB3VENSPLPMPB	*0.4*	*2*	*2*	**1.4**	*2.3*	*< 0.05*	**41**	*< 0.02*	*0.43*	*< 0.1*	*5.5*	*2.0*	*0.1*	*0.16*	*8.8*	*0.5*	*< 0.02*	*11*	*0.94*	**1000**	*0.05*
CB3YUKSPLPA	*2.5*	*2*	*2*	**2.0**	*0.68*	*< 0.05*	**50**	*0.04*	*0.11*	*< 0.1*	*1.7*	*4.2*	*< 0.05*	*0.02*	*0.73*	*0.1*	*0.08*	*2.2*	*0.1*	**1400**	*11*
CB3YUKSPLPMPB	*2.3*	*1*	*1*	**1.9**	*0.67*	*< 0.05*	**48**	*0.05*	*0.10*	*< 0.1*	*1.8*	*3.2*	*0.08*	*0.02*	*0.76*	*< 0.1*	*< 0.02*	*1.9*	*0.1*	**1300**	*15*

Anions by IC. Concentrations in bold by ICP-AES. Concentrations in italics by ICP-MS. nd=not determined.

Appendix C. Comparative Study Leachate and Water Data (continued)

Sample	Sb ug/L	Sc ug/L	Se ug/L	Si mg/L	Sm ug/L	Sn ug/L	Sr ug/L	Ta ug/L	Tb ug/L	Te ug/L	Th ug/L	Ti ug/L	Tl ug/L	Tm ug/L	U ug/L	V ug/L	W ug/L	Y ug/L	Yb ug/L	Zn ug/L	Zr ug/L
CB4AB	*0.05*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**<10**	*< 0.05*
CB4EFIMM1A	*< 0.02*	*< 0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**<10**	*< 0.05*
CB4EFIMM1ANN	*0.04*	*0.1*	*< 0.2*	**<0.1**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*< 0.005*	*< 0.1*	*< 0.02*	*< 0.01*	*< 0.01*	**<10**	*< 0.05*
CB4MAYMM1A	*8.9*	*0.2*	*0.8*	**9.4**	*0.2*	*< 0.05*	**29**	*< 0.02*	*0.02*	*< 0.1*	*0.04*	*1.2*	*0.1*	*< 0.005*	*0.10*	*0.9*	*< 0.02*	*0.2*	*0.02*	**540**	*< 0.05*
CB4MAYMM1ANN	*1.8*	*< 0.1*	*0.2*	**0.40**	*< 0.01*	*< 0.05*	**<10**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*< 0.1*	*< 0.05*	*< 0.005*	*0.06*	*< 0.1*	*< 0.02*	*0.03*	*< 0.01*	**500**	*< 0.05*
CB4SUNMM1A	*5.1*	*0.4*	*0.8*	**4.7**	*1.3*	*< 0.05*	**19**	*< 0.02*	*0.36*	*< 0.1*	*0.74*	*1.1*	*0.2*	*0.18*	*1.5*	*0.2*	*< 0.02*	*13*	*1.1*	**3700**	*< 0.05*
CB4SUNMM1ANN	*2.2*	*0.6*	*1*	**0.16**	*1.2*	*< 0.05*	**14**	*< 0.02*	*0.33*	*< 0.1*	*0.57*	*1.0*	*0.54*	*0.16*	*1.4*	*0.3*	*< 0.02*	*13*	*1.0*	**3700**	*< 0.05*
CB4SUNMM1D	*6.3*	*0.3*	*0.7*	**8.1**	*1.3*	*< 0.05*	**23**	*< 0.02*	*0.35*	*< 0.1*	*0.75*	*1.1*	*0.3*	*0.18*	*1.5*	*0.3*	*< 0.02*	*13*	*1.1*	**4200**	*0.06*
CB4SUNMM1DNN	*2.2*	*0.4*	*0.7*	**0.16**	*1.0*	*< 0.05*	**14**	*0.02*	*0.34*	*< 0.1*	*0.55*	*2.0*	*< 0.05*	*0.18*	*1.5*	*2*	*0.2*	*13*	*1.1*	**3700**	*0.2*
CB4VENMM1A	*0.3*	*2*	*2*	**4.1**	*2.6*	*< 0.05*	**24**	*< 0.02*	*0.46*	*< 0.1*	*7.7*	*3.7*	*0.1*	*0.18*	*7.5*	*0.5*	*0.08*	*12*	*1.1*	**960**	*0.1*
CB4VENMM1ANN	*0.2*	*2*	*2*	**0.11**	*2.5*	*< 0.05*	**18**	*< 0.02*	*0.43*	*< 0.1*	*7.8*	*2.9*	*0.09*	*0.18*	*7.6*	*0.2*	*< 0.02*	*13*	*1.0*	**980**	*< 0.05*
CB4YUKMM1A	*5.0*	*0.6*	*2*	**13**	*0.56*	*< 0.05*	**37**	*< 0.02*	*0.079*	*< 0.1*	*0.88*	*10*	*0.2*	*0.02*	*0.30*	*2*	*0.2*	*1.4*	*0.08*	**590**	*0.58*
CB4YUKMM1ANN	*0.66*	*0.4*	*0.4*	**0.12**	*0.50*	*< 0.05*	**14**	*< 0.02*	*0.064*	*< 0.1*	*0.52*	*1.5*	*< 0.05*	*0.02*	*0.28*	*< 0.1*	*< 0.02*	*1.2*	*0.07*	**590**	*0.89*
CB4RFSM142	*1.9*	*0.4*	*3*	**3.6**	*< 0.01*	*0.08*	**640**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*1*	*< 0.05*	*< 0.005*	*3.2*	*2*	*1.0*	*0.07*	*< 0.01*	**<10**	*0.1*
CB4RFST147	*9.0*	*1*	*11*	**11**	*< 0.01*	*0.1*	**290**	*< 0.02*	*< 0.005*	*< 0.1*	*< 0.005*	*0.3*	*31*	*< 0.005*	*2.4*	*13*	*0.3*	*0.05*	*< 0.01*	**17**	*0.58*
YUKB1LCHFA	*2.5*	*4*	*14*	**6.1**	*10*	*0.5*	**560**	*0.06*	*0.93*	*< 0.1*	*7.1*	*12*	*4.2*	*0.16*	*2.1*	*54*	*0.62*	*12*	*0.83*	**3800**	*0.4*
MAY WRD1 FA	*1.4*	*24*	*5*	*nd*	*< 0.05*	*nd*	*210*	*< 0.02*	*7.8*	*< 0.1*	*6.1*	*8.6*	*0.59*	*1.2*	*5.2*	*65*	*0.04*	*86*	*5.2*	*3400*	*< 0.05*
MAY WRD2 FA	*3.9*	*12*	*0.4*	*nd*	*< 0.05*	*nd*	*89*	*< 0.02*	*1.2*	*< 0.1*	*3.3*	*8.4*	*0.4*	*0.18*	*1.3*	*130*	*< 0.02*	*17*	*0.96*	*1600*	*< 0.05*
MAY WRD3 FA	*2.2*	*22*	*1*	*nd*	*< 0.05*	*nd*	*170*	*< 0.02*	*2.4*	*< 0.1*	*6.0*	*9.4*	*0.4*	*0.59*	*2.1*	*46*	*< 0.02*	*40*	*2.2*	*1900*	*< 0.05*
MAY WRD4 FU	*0.4*	*3*	*< 0.2*	*nd*	*< 0.05*	*nd*	*31*	*< 0.02*	*0.067*	*< 0.1*	*0.03*	*3.5*	*< 0.05*	*0.02*	*0.25*	*< 0.1*	*< 0.02*	*0.95*	*0.05*	*1500*	*< 0.05*
MAY WRD5 FU	*0.09*	*< 0.1*	*< 0.2*	*nd*	*< 0.05*	*nd*	*24*	*< 0.02*	*0.11*	*< 0.1*	*0.01*	*3.8*	*< 0.05*	*0.02*	*0.42*	*< 0.1*	*< 0.02*	*1.6*	*0.07*	*1600*	*< 0.05*

Anions by IC. Concentrations in bold by ICP-AES. Concentrations in italics by ICP-MS. nd=not determined.