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Effect of Trona on the Leaching of Trace Elements from Coal Fly Ash

by

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16. Abstract

Fly ashes were sampled from the ESPs by on-site contractors during air emission control tests. The injection tests were short-term, lasting approximately three hours per test condition. EPRI received three batches of samples since November 2011, representing baseline conditions and selected injection conditions. The sample information are listed in respective tables. EPRI analyzed the samples for total composition and leaching characteristics.

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EPRI Project Final Report

Effect of Trona on the Leaching of Trace Elements from Coal Fly Ash

Submitted to EPRI and NUTC

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Section 1. General Testing Background and Methods

Fly ashes were sampled from the ESPs by on-site contractors during air emission control tests. The injection tests were short-term, lasting approximately three hours per test condition. EPRI received three batches of samples since November 2011, representing baseline conditions and selected injection conditions. The sample information are listed in respective tables. EPRI analyzed the samples for total composition and leaching characteristics.

Results presented here are believed to be representative of broad trends, but should used with caution due to some difficulties with sampling and analysis. In addition, as noted above these were short term injection tests, and obtaining discrete ash samples to represent a particular test condition was challenging. Finally, due to the small sample sizes for some samples, we were unable to perform all analyses, and in some cases complete QA/QC was not possible. That said, the general results appear to be reasonable for drawing broad inferences.

Moisture content and loss-on-ignition

The moisture content and loss-on-ignition (LOI) were measured for all samples using gravimetric method briefly described below:

(1) Place a crucible to a muffle furnace at 550 ^{0}C for 1 h. Transfer the crucible to a desiccator and allow it to cool, then weigh the crucible.

(2) Add 2 – 3 g fly ash sample to the crucible and record the total weight (crucible + raw ash). Dry the sample at 110 ^{o}C for 2 h, then move it to a desiccator to allow it to cool. Record the total weight of the crucible with the sample again (crucible + dried ash).

(3) Placed the crucible with the sample to a muffle furnace at 550^{o}C for 2 h. Transfer the crucible with the sample to a desiccator and allow it to cool, then weigh the crucible with the sample again (crucible + burned ash).

Based on these information total moisture content and LOI for each can be calculated:

Moisture content = [(crucible + raw ash) - (crucible + dried ash)]/[(crucible + raw ash) - (crucible)]

LOI = [(crucible + dried ash) - (crucible + burned ash)]/[(crucible + dried ash) - (crucible)]

Total Composition

This project performed total extractable digestion for all fly ashes following EPA method 3051A, using a Multiwave 3000 microwave digestor (Anton Paar). This method was designed to extract most environmental pollutants, but not intended to accomplish total decomposition of the sample. For each batch of digestion, a sample duplicate, a sample spike, and a blank were included for QA/QC check. Since there were more than 20 analytes, a mixture standard was used for quality assurance check. Liquid samples generated from the digestion were analyzed using a Perkin-Elmer ELAN DRC-e Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) or a Perkin-Elmer Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES), depending on the type and concentration of the element. XRF was also employed to directly determine the ash composition of the solid samples.

Effect of L/S ratio on leaching

The first batch of samples was leached using Synthetic Precipitation Leaching Procedure (SPLP, EPA Method 1312) with a normal 20:1 liquid/solid (L/S) ratio and with a 4:1 L/S ratio (Modified SPLP). The purpose was to determine the leaching equilibrium of various elements under simulated acid rain condition. The procedures are listed below.

1) Prepare sulfuric acid/nitric acid mixture: Add 6 g concentrated sulfuric acid and 4 g nitric acid into ~90 ml MQ water slowly with stirring, then bring to 100 mL with MQ water.
2) Prepare leaching fluid at pH 4.2: Transfer MQ water into a large plastic container (1 L or larger), adjust pH to 4.2 with the acid mixture prepared in step 1.
3) For L/S = 4:1 leaching, weigh 20 g fly ash and add 80 mL leaching fluid to a 125-ml plastic leaching bottle. For L/S = 20:1, weight 4 g fly ash and add 80 mL leaching fluid to the leaching bottle. Seal all leaching bottles.
4) Shake all bottles at 180 rpm for 24 hours, then allow the bottles settle for 2 hours.
5) Decant at least 45 mL leachate samples into 50 mL centrifuge tubes and centrifuge them at 4000 rpm (1750 g) for 10 min.
6) Filter the supernatant through a 0.22 µm pore size nylon membrane filter. Reserve 15 mL of filtrate for analysis of major anions using ion chromatography (IC) method.
7) Acidify remaining filtrate with trace metal grade nitric acid to a pH < 2 for ICP-MS and ICP-OES analysis.
8) Measure the final pH value of the suspension in the bottle.

Due to the high alkalinity of the fly ash samples, the SPLP leachant (pH 4.2 solution) did not significantly impact the leaching characteristics of the fly ash. Therefore, for batch 2 and batch 3 samples, leaching experiments were conducted using deionized (DI) water under the natural pH. This report illustrates the batch leaching results measured using ICP-MS, ICP-OES and IC.

Effect of pH on leaching

The effect of pH on leaching was tested based on EPA draft Method 1313, with a 10:1 L/S ratio. The purpose of batch leaching experiments was to determine the leaching equilibrium of various elements as a function of pH. The procedures are described below. The pH ranged from slightly above 7 to natural (above 11 for fly ashes tested), and one data point was obtained for approximately each pH unit. This report illustrates the batch leaching result for elements measured using ICP-OES, ICP-MS, and anions by IC.

1) Add 5 - 10 g of fly ash, appropriate volumes of MQ water, and appropriate volumes of 15 M trace metal grade nitric acid to a 125 mL bottles and to make a L/S of 10 (these volumes were determined based on titration results for a target pH).
2) Seal and shake the bottles at 180 rpm for 24 h, then settle for 2 h.
3) Decant at least 45 mL leachate samples into 50 mL centrifuge tubes and centrifuge them at 4000 (1750 g) for 10 min.
4) Reserve 5 mL centrifuged supernatant for TDS and ORP test.
5) Filter 35 mL centrifuged supernatant into another 50 mL centrifuge tube through 0.22 µm nylon membrane filter.
6) Decant 20 mL filtered supernatant to the third 50 mL centrifuge tube and add trace metal grade nitric acid into each tube to adjust the pH value to below 2, then set the tube for overnight.
7) If no further precipitation was observed, the acidified sample can be directly diluted for ICP-MS and ICP-OES analysis. Otherwise the acidified sample needs to be filtered again before dilution for or ICP-OES analysis.
8) Dilution was made with 1% trace metal grade nitric acid at ratios from 1:10 to 1:100 for ICP-OES analysis, depending on the concentration.

9) Use the 15 mL of filtered but unacidified supernatant in the second 50 mL centrifuge tube for analysis of major anions using IC.

Four general behavior groups were evident as a function of pH:

Group 1. Increasing concentration as pH increased (Al, Si, F, As, V, Cr, Mo, Se, Sb, B);
Group 2. Decreasing concentration as pH increased (Mg, Sr, Ca, Mn, Co, Ni, Cu, Tl, Zn);
Group 3. Concentrations with either little or no effect as a function of the pH change (SO4, Fe, K, Na, Cl, Br, Cd, Be, Pb); and
Group 4. Mixed behavior (Ba).

Example plots for each of these behaviors are provided. In the near term, Group 1 trace constituents will be important, due to the high natural pH of the fresh PRB ash and the pH increase resulting from the trona addition. Several trace constituents have maximum concentrations at high pH. This Group generally includes the oxyanions and amphoteric constituents. Arsenic concentrations increased by more than a factor of 100 in the trona injection samples at high pH compared to neutral pH. As pH decreases over time, the Group 1 constituents should become less leachable, and Group 2 constituents may become more important, although other weathering processes (e.g., clay formation) may also mitigate future leaching and release. Group 2 generally includes the metals, which tend to be released under more acidic conditions. The metals leaching, which is higher for the baseline and calcium injection samples compared to the sodium injection samples, appears to be somewhat exaggerated at lower pH due to the acid addition under the test condition. Group 3 generally contains the soluble salts which are not strongly affected by pH. These constituents are likely to initially leach rapidly at high concentrations. Over the long term, soluble salts will become depleted and weathering and carbonation may cause the pH to decrease to between 8 and 9.

Section 2. Quality Assurance/Quality Control

To ensure the high quality data, most of the QA/QC recommended by the EPA methods were followed. For the leaching study, US EPA method 1313 and 1312 QC guidelines were followed; for acid digestion, US EPA method 3051A QC guideline was followed; for analysis by ICP-MS and ICP-OES, US EPA 200.7 and 200.8 methods QC guidelines were followed. The similar QC procedures for the IC detection of the inions were also performed. The following sections describe the QC and other validations used in these reported test data. During sample analyses, when QC data were not good, the test was re-done after correction of possible cause.

Instrument calibration **-** For all of the detection methods and instruments used in this study, the instrument responses were calibrated with standard solutions using a range of concentrations. The estimated instrument detection limits were calculated at 3 to 5 times of signal/noise ratio. The linear ranges of the calibration were determined and used for the quantitative analysis of the samples.

Initial calibration was performed for each instrumentation method. For ICP-MS analysis, a calibration standard mixture containing all the elements (purchased from PerkinElmer) was used to prepare calibration standards at the concentrations range from 0.02 to 1,000 µg/L for initial calibration linearity check. Good linearity ($R^2 > 0.999$) were obtained from instrument quantification limit to 1,000 µg/L concentration range for all elements. For the daily calibration during sample analysis, the calibration was performed in the concentration range 0.02 to 50 µg/L. For ICP-OES analysis method, calibrations were performed at concentrations range from 0.02 to 100 mg/L. Good linearity ($R^2 > 0.998$) were obtained from instrument quantification limit to 100 mg/L concentration range for all elements. For IC analysis of cations (F^-, Cl^-, SO_4^{2-}), calibrations were performed at concentrations range from 0.01 to 1 ppm and 1 to 20 ppm, depending on the analyte concentration ranges of samples. Good linear ($R^2 > 0.997$) calibration range was used for quantification of samples.

Laboratory reagent blank (LRB) – The purpose of a LRB is to define error from sources external to the sample. These sources of error or contamination potentially can be introduced from the laboratory environment, the reagents used in the analysis, the analytical instruments, and the analyst. At least one LRB was prepared and measured for each batch of up to 20 samples. LRBs were prepared and measured using the same procedures as for the samples.

Method detection limit (MDL) – The quantitative MDL for this study was determined originally by following EPA method by fortifying reagent blanks with 2 to 5 times the concentration of the estimated instrument detection limit. This represents the lower limit of analyte detection with 99 percent confidence. Seven replicates were analyzed and results were used to calculate the MDL using the equation:

$$MDL = SD \times t$$

where:
SD is the standard deviation of the replicated analysis.
t is the student's t value for a 99 percent confidence level and a standard deviation estimate with n-1 degrees of freedom (t = 3.14 for 7 replicates).

However, the MDLs obtained by this method were lower than truly detectable limits. We then determined the instrumentation detection limits (IDLs) based on the signal to noise ratios of 3 to 5, and

got the MDLs at 5 to 10 times of IDLs. The MDLs for all the leaching samples are listed in **Table 1** and those for digestion samples were tabulated in **Table 2**.

Table 1. Method detection limits of fly ash samples leached by EPA method 1313 and 1312.

ICP-MS method		ICP-OES method		IC method	
Element	**MDL(ppb)**	**Element**	**MDL(ppm)**	**Anion**	**MDL(ppm)**
Be	0.6	Ca	0.2	F^-	0.2
V	1	Mg	0.5	Cl^-	0.2
Cr	5	Na	1	SO_4^{2-}	2
Mn	0.4	K	1		
Co	0.4	Fe	0.5		
Ni	5	Al	1		
Cu	5	Sr	0.5		
Zn	10	B	5		
As	0.6	Si	1		
Se	10				
Sr	0.4				
Mo	1				
Ag	1				
Cd	0.4				
Sb	1				
Ba	1				
Tl	0.6				
Pb	0.6				
Br	100				

Table 2. Method detection limits for fly ash samples digested by EPA method 3051A.

ICP-MS method		ICP-OES method	
Element	**MDL(ug/kg)**	**Element**	**MDL(mg/kg)**
Be	12	Ca	4
V	20	Mg	10
Cr	100	Na	20
Mn	8	K	20
Co	8	Fe	10
Ni	100	Al	20
Cu	100	Sr	10
Zn	200	B	100
As	12		
Se	200		
Sr	8		
Mo	20		
Ag	20		
Cd	8		
Sb	20		
Ba	20		
Tl	12		
Pb	12		

The XRF analysis was performed by a commercial laboratory (The Mineral Lab, Inc, Colorado). The MDLs are shown in Table 3.

Table 3. MDLs of XRF analysis.

Element	Na	Mg	Al	Si	S	K	Ca	Fe	Sr	Ba	Br
MDL (mg/kg)	100.0	20.0	20.0	5.0	2.0	10.0	10.0	1.0	0.5	2.0	0.5

Laboratory fortified sample – Laboratory fortified samples (LFS), also called sample spikes, are used to test or validate the recovery of analytes from spiked samples. When the appropriate sample reference is absent, the LFS is performed to validate the method performance and to confirm that the sample matrix is not interfering with analyte detection. A LFS was performed with each batch sample of up to 20 samples. A known amount of the standard was added to the sample and mixed well, and the sample preparation and analysis were performed using the same procedures as those for the samples. The percent recovery of the LFS was calculated by the equation listed below:

Recovery (5) = 100 x $(C_{fs} - C_s)/C_{add}$
where:
C_{fs} is the detected fortified sample concentration,
C_s is the detected sample concentration, and
C_{add} is the concentration of standard added.

For the spike recovery of fly ashes leached by EPA method 1313, the most of spiked recoveries were very good. Most of the spiked recoveries were in the range of 100±15% for ICP-MS analysis of trace concentration elements and most of the spiked recoveries were in the range of 100±10% for the major elements and anions concentration detected by ICP-OES and IC. However, spiked recoveries for V were mostly low by ICP-MS detection method and a few elements got the recoveries out of this range in a few samples. The spiked recoveries for EPA method 1312 leaching were also very good for most of the elements and anions. Most of the recoveries were in the ranges of 100±10% for all the analysis methods with a few exceptions.

The spiked recoveries for EPA digestion method 3051A were mostly for the major components elements and anions. Most of the trace element recoveries were also acceptable.

Calibration check - To monitor the instrument performance, standard solutions were measured during batch runs. At least one standard solution was measured for every 10 to15 samples to ensure the instrument is calibrated and working properly. If the calibrations check drafts over the QC limits (10%), the calibration curve was re-run and the samples were reanalyzed.

Precision of duplicated samples - One or more duplicate samples were analyzed for each batch of up to 20 samples. The precision of the duplication is expressed as the relative percent difference (RPD) and is calculated using the equation below.

RPD (%) = 100 x $(C_h - C_l)/C_{av}$

where
C_h is detected high concentration of duplicated sample,
C_l is detected low concentration of duplicated sample, and
C_{av} is the average of the C_h and C_l

RPDs for EPA method 1313 leaching samples for EPA method 3051A are mostly <10% for all the detection methods. A few of RPDs were high (>20%) those mainly because of the concentration of the elements were low (close to MDLs). Based on USEPA guidance for sampling and analysis of sediments, the quality control criterion for analysis precision should be no greater than 30% to 50% RPD. Considering this criterion, the precision of analysis for the samples is excellent.

Section 3. Coal Fly Ash Test Results

3.1 Batch 1 Fly Ashes Results

Table 4. Batch 1 fly ash sample description.

Bucket Date	Headwaters Bucket number	Amount (gallon)	GRE Sample ID	Conditions	Moisture (%)	LOI (%)
7/25/2011	1451	0.33	#0725111100	Baseline	0.195	0.509
7/25/2011	1452	0.33	#0725111830	Baseline+2ppm Cl	0.143	0.454
7/26/2011	1453	0.33	#0726111115	Trona 0.5 TPH	0.118	1.517
7/26/2011	1454	0.4	#0726112040	Trona 6.0 TPH	0.103	1.484
7/27/2011	1508	0.4	#0727111925	MC Maxx - 8.0lb/Mmacf + Mercontrol + Trona 1TPH	0.148	0.191
7/28/2011	1511	0.33	#0728111900	MC Plus - 8.8 lb/Mmacf + Trona 1 TPH	0.194	2.712
7/31/2011	1518	0.25	None	Milled Bicarb – 1.0 TPH	0.143	0.899
7/30/2011	1519	0.33	#0730111700	MC Plus 3.0 lb/Mmacf + Milled Bicarb - 3.5TPH	0.114	0.12
7/26/2011	1520	0.33	#0731111500	Hydrated Lime - 0.5 TPH	0.195	0.114

Table 5. Results of batch 1 total composition by digestion (EPA Method 3051A).

Element	Unit	Smaple ID								
		1451	1452	1453	1454	1508	1511	1518	1519	1520
Ca	%	13.45	12.35	11.45	6.35	7.30	7.30	11.30	6.45	14.95
Mg	%	2.66	2.42	2.38	1.35	1.52	1.39	2.13	1.18	2.12
Na	%	7.95	6.95	9.85	24.65	20.05	20.15	6.60	22.15	7.65
K	%	0.46	0.42	0.55	0.26	0.36	0.39	0.48	0.26	0.51
Sr	%	0.73	0.69	0.72	0.38	0.45	0.40	0.54	0.31	0.62
Fe	%	2.72	2.56	2.81	1.45	2.12	1.95	2.75	1.59	2.93
Al	%	0.95	0.96	0.97	0.52	0.64	0.60	1.00	0.56	0.91
B	%	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Be	mg/kg	2.49	2.73	2.61	1.53	1.85	2.58	4.08	2.12	4.29
V	mg/kg	144.54	137.43	143.76	69.31	85.24	101.24	134.44	97.47	138.03
Cr	mg/kg	42.47	41.20	40.71	24.02	29.60	28.50	39.60	25.80	39.09
Mn	mg/kg	461.75	315.43	294.53	178.30	204.35	130.70	216.03	136.28	191.41
Co	mg/kg	11.00	11.22	10.85	6.80	8.38	9.14	12.91	7.95	12.83
Ni	mg/kg	22.64	22.92	23.25	14.71	19.15	17.88	26.38	16.45	26.73
Cu	mg/kg	120.67	103.81	9.78	59.65	68.95	67.05	91.58	56.10	94.36
Zn	mg/kg	48.25	46.07	50.02	30.89	37.41	45.20	59.21	34.83	62.38
As	mg/kg	32.69	27.93	35.30	5.21	10.26	26.48	29.33	26.96	34.98
Se	mg/kg	9.38	8.38	9.17	4.19	8.09	7.85	10.31	4.52	11.85
Mo	mg/kg	11.41	12.28	14.61	7.98	6.76	7.62	12.89	9.04	15.01
Cd	mg/kg	1.08	1.11	1.01	0.75	1.31	0.86	1.41	0.87	1.27
Sb	mg/kg	3.19	3.21	3.95	1.32	0.07	1.79	2.89	1.89	2.50
Ba	mg/kg	13084	10959	11059	5220	6310	7202	10242	5081	8481
Tl	mg/kg	0.74	1.90	1.27	1.03	3.29	1.06	1.10	1.66	1.55
Pb	mg/kg	18.71	18.19	18.04	9.08	12.22	11.41	16.54	9.15	16.45

Table 6. Batch 1 fly ash chemical composition by XRF.

Element	Sampple ID						
	1451	**1452**	**1453**	**1454**	**1511**	**1518**	**1520**
Na (%)*	4.53	4.18	5.96	13.80	11.20	4.26	4.49
Mg (%)	2.64	2.44	2.36	1.29	1.53	2.08	2.30
Al (%)	6.54	6.02	5.82	2.76	4.00	6.95	6.26
Si (%)	11.52	10.56	10.59	5.40	7.42	12.72	10.52
S (%)	3.41	3.21	3.47	2.81	5.09	2.44	3.38
K (%)	0.52	0.49	0.54	0.34	0.47	0.65	0.55
Ca (%)	12.84	12.90	11.61	7.30	7.24	11.18	15.16
Fe (%)	2.27	2.26	2.28	1.65	2.11	2.80	2.26
Sr (%)	0.65	0.67	0.62	0.47	0.44	0.55	0.52
Ba (%)	0.90	1.27	1.09	0.56	0.82	1.21	0.86
Br (mg/kg)	9.90	9.70	47.80	17.90	591.40	41.70	21.80

* Na data from XRF had large error due to the low concentration in the NIST standard.

Table 7. Batch 1 fly ash SPLP leaching data, 20:1 L/S ratio.

Element	Unit	Sample ID								
		1451	**1452**	**1453**	**1454**	**1508**	**1511**	**1518**	**1519**	**1520**
pH		12.27	12.30	12.38	12.68	12.66	12.58	12.15	12.54	12.48
Ca	ppm	25.50	23.60	21.50	<MDL	<MDL	<MDL	29.00	<MDL	28.80
Mg	ppm	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Na	ppm	1750	1620	2860	11200	8990	7680	1480	10300	2520
K	ppm	70.90	66.40	68.60	37.90	52.20	31.80	39.20	23.40	70.50
Sr	ppm	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Si	ppm	<MDL	<MDL	<MDL	27.70	29.50	19.50	<MDL	21.30	27.20
Fe	ppm	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	ppm	23.90	22.70	45.10	63.40	72.00	52.30	18.30	47.80	22.70
B	ppm	<MDL	<MDL	<MDL	18.50	17.00	12.40	<MDL	10.40	<MDL
F^-	ppm	8.62	7.67	13.67	26.07	27.55	25.69	7.72	27.97	10.72
Cl^-	ppm	32.08	59.91	79.75	107.64	47.18	41.62	80.58	120.57	163.44
Br	ppm	0.99	0.85	4.60	1.06	89.52	49.61	4.04	8.22	2.58
SO_4^{2-}	ppm	2854	2389	4619	4237	7566	7285	2314	5006	3563
Be	ppb	<MDL	<MDL	<MDL	0.93	0.79	0.78	<MDL	0.89	<MDL
V	ppb	504	474	818	3425	3467	3201	489	2956	398
Cr	ppb	434	392	349	327	362	328	258	292	264
Mn	ppb	0.84	0.97	1.39	4.01	5.06	3.17	0.47	2.82	0.43
Co	ppb	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Ni	ppb	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	ppb	12.98	12.32	21.27	93.40	69.23	58.55	11.46	80.34	18.73
Zn	ppb	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
As	ppb	13.41	11.94	67.37	674.01	801.20	777.68	1026	664.81	35.73
Se	ppb	107.72	109.93	464.21	341.20	896.76	718.03	151.68	367.41	413.09
Mo	ppb	428.67	435.28	480.94	410.32	519.75	367.71	324.43	374.71	447.38
Cd	ppb	1.46	1.52	1.71	1.54	1.91	1.43	1.13	1.44	1.72
Sb	ppb	7.39	6.45	13.10	65.33	71.94	51.48	5.07	49.08	2.14
Ba	ppb	196.05	478.47	384.38	323.75	211.99	202.47	342.39	245.52	331.02
Tl	ppb	1.17	2.06	3.71	2.15	2.29	0.48	1.25	2.27	4.50
Pb	ppb	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

Table 8. Batch 1 fly ash SPLP leaching data, 4:1 L/S ratio (Modified Method 1312).

Element	Unit	Sample ID								
		1451	**1452**	**1453**	**1454**	**1508**	**1511**	**1518**	**1519**	**1520**
Ca	ppm	12.80	10.90	12.40	<MDL	<MDL	<MDL	16.00	<MDL	11.40
Mg	ppm	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Na	ppm	8270	7100	13300	48100	39600	34300	7090	47700	10400
K	ppm	372.00	356.00	311.00	161.00	233.00	137.00	170.00	110.00	100.00
Sr	ppm	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Si	ppm	16.60	14.30	17.60	63.40	70.60	54.40	10.50	36.60	64.20
Fe	ppm	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	ppm	109.00	106.00	180.00	223.00	266.00	190.00	76.50	169.00	167.00
B	ppm	<MDL	<MDL	<MDL	53.30	61.80	50.70	<MDL	40.10	<MDL
F^-	ppm	33.67	33.11	45.29	81.27	77.98	12.86	3.55	149.08	53.52
Cl^-	ppm	63.90	218.53	315.95	447.68	118.18	35.16	52.23	92.81	652.39
Br	ppm	5.17	4.44	23.48	6.02	416.13	237.62	20.47	40.55	13.14
SO_4^{2-}	ppm	13527	12221	23184	19519	38699	39246	11900	28968	15853
Be	ppb	<MDL	<MDL	<MDL	6.52	5.25	5.95	<MDL	6.12	1.57
V	ppb	2694	2385	3917	12596	14187	12416	2061	11327	2352
Cr	ppb	2075	1902	1583	1162	1563	1438	1178	1165	817
Mn	ppb	3.66	3.63	5.39	8.29	10.78	5.66	1.89	6.84	4.39
Co	ppb	<MDL	<MDL	<MDL	1.06	0.64	0.45	<MDL	1.89	2.28
Ni	ppb	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	ppb	54.64	52.13	88.21	471.44	362.26	268.37	52.93	410.40	74.76
Zn	ppb	1.49	32.16	10.53	12.04	31.14	24.64	<MDL	28.32	32.07
As	ppb	348	344	1139	2634	3461	3444	269	2738	760
Se	ppb	565	563	468	1176	3746	2964	755	1554	2230
Mo	ppb	2045	2015	2110	1540	2135	1528	1476	1532	1931
Cd	ppb	7.31	7.24	8.13	5.52	7.48	5.13	4.65	6.61	8.62
Sb	ppb	22.17	15.91	27.53	163.75	186.90	152.60	13.07	139.33	9.24
Ba	ppb	143.11	156.11	117.67	866.69	251.25	182.06	144.88	583.98	138.56
Tl	ppb	2.52	3.51	7.44	8.50	5.68	1.59	2.03	9.54	9.46
Pb	ppb	0.46	0.67	0.61	1.15	0.66	0.51	<MDL	1.20	2.92

Table 9. Batch 1 fly ash leaching data for sample 1451 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample ID						
		1451-1-7	1451-1-6	1451-1-5	1451-1-4	1451-1-3	1451-1-2	1451-1-1
pH		7.61	8.61	9.82	10.32	11.46	12.22	12.26
Ca	mg/L	6120	5060	3510	2080	503.00	16.40	16.20
Mg	mg/L	1650	226.00	93.30	6.38	<MDL	<MDL	<MDL
Na	mg/L	4430	4060	3860	3750	3270	3140	3170
K	mg/L	215.00	195.00	182.00	167.00	169.00	173.00	184.00
Sr	mg/L	220.00	192.00	141.00	98.20	61.40	7.61	7.71
Si	mg/L	1.46	<MDL	<MDL	<MDL	<MDL	8.06	8.27
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	<MDL	2.08	40.50	314.00	307.00
B	mg/L	7.58	12.80	16.10	21.70	16.30	<MDL	<MDL
F^-	mg/L	4.62	5.18	7.17	11.23	<MDL	12.43	11.31
Cl^-	mg/L	30.91	31.21	31.33	31.25	30.86	30.85	31.21
SO_4^{2-}	mg/L	1370	1157	1266	1594	5041	3670	4923
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	2.45	9.13	21.06	24.80	75.99	1013	1026
Cr	µg/L	282.00	343.60	404.10	523.40	875.10	981.20	994.30
Mn	µg/L	4180	26.57	0.54	0.43	<MDL	0.97	0.94
Co	µg/L	22.52	9.40	6.06	3.27	0.81	<MDL	<MDL
Ni	µg/L	470.70	336.60	182.00	57.05	14.27	<MDL	<MDL
Cu	µg/L	119.80	74.29	43.36	31.61	27.49	17.49	15.20
Zn	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
As	µg/L	1.98	1.82	1.47	1.01	3.37	42.00	42.91
Se	µg/L	<MDL	15.87	71.19	222.50	283.00	113.00	139.10
Mo	µg/L	261.30	525.80	589.30	640.50	797.20	899.10	795.00
Cd	µg/L	5.99	6.15	4.13	3.18	3.32	2.77	2.90
Sb	µg/L	1.88	2.38	2.17	2.05	<MDL	7.47	7.83
Ba	µg/L	2157	2733	3769	2058	804.00	285.40	302.10
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Tl	µg/L	3.50	2.51	1.78	1.45	2.27	1.66	1.76
Br	µg/L	2492	2502	2368	2329	2223	2215	2262

Table 10. Batch 1 fly ash leaching data for sample 1452 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	Sample ID						
		1452-2-0	**1452-2-1**	**1452-2-2**	**1452-2-4**	**1452-2-5**	**1452-2-6**	**1452-2-7**
pH		7.78	8.23	9.56	10.30	11.89	12.33	12.34
Ca	mg/L	6890	6920	5150	759.00	24.40	16.70	17.20
Mg	mg/L	1600	520.00	<MDL	<MDL	<MDL	<MDL	<MDL
Na	mg/L	4530	4460	4120	3480	3510	3350	3310
K	mg/L	216.00	226.00	206.00	165.00	168.00	152.00	165.00
Sr	mg/L	239.00	259.00	222.00	83.70	13.20	6.84	7.06
Si	mg/L	<MDL	<MDL	<MDL	<MDL	5.84	8.89	8.55
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	8.23	22.90	226.00	332.00	329.00
B	mg/L	6.21	7.24	11.90	6.44	<MDL	<MDL	<MDL
F^-	mg/L	4.24	4.26	8.75	<MDL	8.62	15.29	13.27
Cl^-	mg/L	79.99	85.36	87.17	88.98	90.52	85.64	87.46
SO_4^{2-}	mg/L	1291	1111	1144	3412	3578	4349	4431
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	8.31	10.07	30.16	56.12	875.22	978.69	987.87
Cr	µg/L	265.66	202.95	338.17	900.36	1026	1052	1059
Mn	µg/L	1223	228.38	1.75	1.19	1.88	2.15	2.47
Co	µg/L	17.55	16.30	11.01	1.49	<MDL	<MDL	<MDL
Ni	µg/L	282.63	348.81	224.46	27.96	<MDL	<MDL	<MDL
Cu	µg/L	122.33	170.05	115.26	71.54	41.42	32.73	29.62
Zn	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	10.74	<MDL
As	µg/L	1.06	1.25	1.20	1.75	36.69	46.27	50.35
Se	µg/L	71.75	50.62	98.47	231.27	214.04	203.91	225.68
Mo	µg/L	376.71	441.11	597.07	767.34	1037	974.85	938.40
Cd	µg/L	2.81	3.39	3.56	3.80	4.25	3.88	3.77
Sb	µg/L	<MDL	<MDL	<MDL	<MDL	4.56	6.78	9.77
Ba	µg/L	1869	2213	3896	914.11	517.12	321.29	295.39
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	0.69
Tl	µg/L	4.05	3.94	2.98	4.15	2.48	3.37	3.47
Br	µg/L	2229	2431	2120	2012	2091	2040	2060

Table 11. Batch 1 fly ash leaching data for sample 1453 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	Sample ID						
		1453-3-1	1453-3-2	1453-3-3	1453-3-4	1453-3-5	1453-3-6	1453-3-7
pH		7.16	8.87	9.94	10.72	11.04	12.36	12.38
Ca	mg/L	2380	1070	815.00	634.00	245.00	17.70	17.40
Mg	mg/L	1250	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Na	mg/L	6520	6050	6100	6040	6200	5330	5680
K	mg/L	193.00	162.00	151.00	138.00	142.00	129.00	134.00
Sr	mg/L	92.80	67.90	56.80	41.60	36.00	5.56	5.35
Si	mg/L	5.44	<MDL	<MDL	<MDL	<MDL	8.77	8.89
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	33.60	83.20	116.00	145.00	553.00	579.00
B	mg/L	14.90	13.80	16.10	15.70	10.50	<MDL	<MDL
F^-	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	21.66	23.43
Cl^-	mg/L	116.56	115.75	120.39	88.98	117.64	109.72	118.48
SO_4^{2-}	mg/L	2659	3639	4431	5200	6807	7419	7910
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	35.03	63.31	71.79	121.77	246.28	1544	1617
Cr	µg/L	92.38	183.32	194.62	482.95	591.24	813.00	868.33
Mn	µg/L	1884	1.33	0.89	0.79	1.12	2.64	2.72
Co	µg/L	88.47	1.61	1.17	0.92	0.40	<MDL	<MDL
Ni	µg/L	241.68	28.64	19.52	15.22	5.17	<MDL	<MDL
Cu	µg/L	219.94	123.32	108.81	136.70	160.79	103.69	123.76
Zn	µg/L	8.60	<MDL	<MDL	11.16	20.54	<MDL	<MDL
As	µg/L	1.62	1.75	2.18	3.73	10.80	192.56	210.90
Se	µg/L	221.56	325.37	403.61	437.11	496.98	820.04	867.05
Mo	µg/L	433.55	880.31	922.32	982.66	1017	942.41	1008
Cd	µg/L	2.60	3.72	3.74	4.24	4.27	3.55	3.62
Sb	µg/L	11.65	5.07	3.47	1.94	<MDL	14.47	14.60
Ba	µg/L	657.79	792.43	756.46	740.79	784.54	267.21	244.47
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	0.36	0.46
Tl	µg/L	10.60	4.88	4.57	5.38	4.75	5.48	5.55
Br	µg/L	10659	10553	10882	10770	10551	9955	10685

Table 12. Batch 1 fly ash leaching data for sample 1454 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample ID						
		1454-4-0	**1454-4-1**	**1454-4-3**	**1454-4-5**	**1454-4-6**	**1454-4-7**	**1454-4-8**
pH		7.84	8.79	9.44	10.77	11.19	12.58	12.60
Ca	mg/L	1650	30.30	13.10	<MDL	<MDL	<MDL	<MDL
Mg	mg/L	415.00	90.70	21.60	1.33	1.07	<MDL	<MDL
Na	mg/L	21300	20100	21900	20400	18800	22200	21200
K	mg/L	86.80	76.10	75.20	72.40	73.50	72.70	73.30
Sr	mg/L	19.10	1.48	1.46	<MDL	<MDL	<MDL	<MDL
Si	mg/L	<MDL	<MDL	<MDL	2.09	1.81	31.40	32.00
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	5.22	7.41	479.00	616.00	672.00	689.00
B	mg/L	10.00	15.00	17.10	19.50	16.00	18.20	17.20
F^-	mg/L	3.43	1.88	15.74	23.67	33.23	34.63	40.12
Cl^-	mg/L	166.85	156.88	151.78	151.82	158.27	163.51	172.04
SO_4^{2-}	mg/L	6357	6588	6732	6902	6846	7228	7174
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	111.15	1032	1579	2994	3131	5719	5756
Cr	µg/L	61.42	193.75	253.23	451.51	498.54	550.72	570.61
Mn	µg/L	12.58	7.30	3.86	1.92	1.15	5.81	5.58
Co	µg/L	5.67	1.37	1.83	0.53	0.54	<MDL	0.47
Ni	µg/L	24.57	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	µg/L	3172	3089	2604	2428	2056	1757	1522
Zn	µg/L	20.98	16.39	12.29	10.50	<MDL	<MDL	<MDL
As	µg/L	4.40	55.82	182.45	371.09	403.36	989.74	996.86
Se	µg/L	174.79	326.64	442.60	500.86	513.95	540.99	518.59
Mo	µg/L	460.67	651.84	679.44	719.22	738.63	738.57	742.10
Cd	µg/L	1.98	2.95	3.40	2.73	2.68	2.42	2.28
Sb	µg/L	19.91	48.63	59.26	78.34	85.62	82.16	82.49
Ba	µg/L	434.65	678.47	802.16	491.56	523.84	482.84	506.14
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Tl	µg/L	12.67	7.48	7.15	6.15	6.32	2.18	1.93
Br	µg/L	3.19	3.15	3.22	3.19	3.22	2.72	2.67

Table 13. Batch 1 fly ash leaching data for sample 1508 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	Sample ID						
		1508-5-1	1508-5-2	1508-5-3	1508-5-4	1508-5-5	1508-5-6	1508-5-6D
pH		7.66	8.80	9.76	10.36	11.65	12.70	12.71
Ca	mg/L	576.00	27.70	13.60	12.20	<MDL	<MDL	<MDL
Mg	mg/L	447.00	121.00	<MDL	<MDL	<MDL	<MDL	<MDL
Na	mg/L	16200	16500	17300	17900	15600	15400	14100
K	mg/L	108.00	103.00	111.00	93.40	101.00	95.30	89.90
Sr	mg/L	25.40	5.24	1.59	1.65	<MDL	<MDL	<MDL
Si	mg/L	<MDL	<MDL	<MDL	1.26	4.87	31.00	32.60
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	5.87	58.10	199.00	818.00	747.00	752.00
B	mg/L	10.90	10.70	9.42	14.70	21.60	19.00	17.50
F^-	mg/L	2.06	10.99	20.67	23.57	35.55	45.38	39.82
Cl	mg/L	50.27	49.71	49.31	49.21	50.89	52.27	49.21
SO_4^{2-}	mg/L	12667	14383	13457	13680	13925	13686	13775
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	1.21	1.08
V	µg/L	111.45	470.06	2101	2371	4769	5690	6080
Cr	µg/L	29.44	88.71	170.11	355.81	704.62	694.08	713.08
Mn	µg/L	50.03	19.13	2.95	2.46	16.03	7.46	7.15
Co	µg/L	6.84	1.31	1.05	0.62	0.59	<MDL	<MDL
Ni	µg/L	57.15	2.61	0.60	<MDL	12.63	<MDL	<MDL
Cu	µg/L	458.28	592.02	502.86	439.10	407.36	317.68	274.34
Zn	µg/L	37.98	47.34	37.66	34.45	28.39	23.97	24.25
As	µg/L	4.23	24.86	304.71	339.70	942.11	1425	1482
Se	µg/L	853.99	1132	1452	1537	1597	1534	1689
Mo	µg/L	611.75	767.50	777.18	803.64	1030.70	957.85	1005.62
Cd	µg/L	2.59	3.36	3.24	2.83	2.77	2.55	2.67
Sb	µg/L	31.32	50.01	62.45	66.29	104.04	97.37	100.97
Ba	µg/L	170.22	392.07	453.63	294.29	108.86	160.44	159.44
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Tl	µg/L	34.47	17.35	15.01	19.13	5.09	2.85	2.77
Br	µg/L	173648	175525	182352	177647	179671	182688	182453

Table 14. Batch 1 fly ash leaching data for sample 1511 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	Sample ID						
		1511-6-1	1511-6-2	1511-6-3	1511-6-4	1511-6-5	1511-6-6	1511-6-6D
pH		7.54	8.78	9.33	10.76	11.88	12.56	12.58
Ca	mg/L	225.00	39.90	15.30	<MDL	<MDL	<MDL	<MDL
Mg	mg/L	309.00	150.00	17.10	<MDL	<MDL	<MDL	<MDL
Na	mg/L	13800	15000	15100	14600	14200	14800	15200
K	mg/L	80.00	72.60	73.40	72.80	62.50	63.80	62.10
Sr	mg/L	12.70	4.02	2.07	<MDL	<MDL	<MDL	<MDL
Si	mg/L	4.10	<MDL	<MDL	3.74	6.61	31.00	30.50
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	5.18	22.90	549.00	682.00	647.00	643.00
B	mg/L	7.68	7.29	7.19	14.90	17.70	16.70	17.30
F^-	mg/L	4.13	10.23	21.23	33.91	36.09	38.56	38.38
Cl^-	mg/L	41.77	39.11	40.72	39.89	39.71	39.61	40.22
SO_4^{2-}	mg/L	12707	13108	13247	13968	14044	13280	13472
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	1.17	1.25
V	µg/L	654.47	933.94	1645	4366	6016	5736	5922
Cr	µg/L	29.11	77.07	63.55	602.69	678.32	686.99	616.50
Mn	µg/L	23.98	5.54	2.27	2.31	1.14	4.55	3.94
Co	µg/L	6.34	4.54	2.53	<MDL	<MDL	<MDL	<MDL
Ni	µg/L	51.73	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	µg/L	256.09	304.02	285.23	279.78	244.66	217.77	184.82
Zn	µg/L	34.35	45.17	31.85	29.35	36.93	24.91	22.22
As	µg/L	26.51	93.80	279.83	907.26	1313	1614	1397
Se	µg/L	945.00	1188	1301	1407	1370	1433	1241
Mo	µg/L	553.76	587.79	592.09	782.49	802.55	789.07	683.68
Cd	µg/L	2.44	2.43	2.45	2.04	2.15	2.13	1.73
Sb	µg/L	28.21	35.53	40.66	76.87	86.34	89.48	75.66
Ba	µg/L	123.39	208.43	446.26	119.00	92.24	132.65	117.27
Pb	µg/L	<MDL	<MDL	<MDL	0.73	<MDL	<MDL	<MDL
Tl	µg/L	10.46	6.35	4.81	1.52	0.94	0.69	0.62
Br	µg/L	99984	97417	99240	103325	98960	103481	103312

Table 15. Batch 1 fly ash leaching data for sample 1518 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	Sample B22-2							
		B22-2-35	**B22-2-31**	**B22-2-15**	**B22-2-11**	**B22-2-8**	**B22-2-5**	**B22-2-33**	**B22-2-33D**
pH		7.05	7.92	8.82	9.85	10.75	11.84	12.46	12.43
Ca	mg/L	8589	1775	3675	2478	976.50	46.73	19.22	18.59
Mg	mg/L	2195	1974	265.65	6.98	<MDL	<MDL	<MDL	<MDL
Na	mg/L	2741	2888	2594	2615	2615	2615	2741	2783
K	mg/L	14.60	17.85	7.85	7.00	6.03	6.05	6.44	6.55
Sr	mg/L	126.00	117.60	64.05	44.73	30.03	0.22	2.53	2.63
Si	mg/L	15.75	3.85	1.74	1.41	1.24	4.44	11.13	10.38
Fe	mg/L	0.50	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	0.47	<MDL	<MDL	0.97	24.57	119.70	304.50	311.85
B	mg/L	18.59	15.02	16.59	15.44	9.09	<MDL	<MDL	<MDL
Ba	mg/L	0.55	0.28	0.51	0.22	<MDL	<MDL	<MDL	<MDL
F^-	mg/L	1.58	4.86	6.01	7.63	2.04	5.87	14.72	14.63
Cl^-	mg/L	15.08	17.19	16.81	16.12	15.62	15.84	15.69	16.55
SO_4^-	mg/L	1403	1261	1784	1777	1430	1347	2539	2479
Br	mg/L	989.46	1038.23	917.98	861.09	851.38	817.41	831.31	834.61
V	µg/L	15.06	7.52	20.66	49.71	38.64	172.43	694.39	693.00
Cr	µg/L	37.40	56.93	75.33	141.77	257.86	401.42	429.83	429.26
Mn	µg/L	1079	284.55	3.74	22.39	1.07	0.84	1.91	0.84
Co	µg/L	120.04	23.98	4.73	3.51	1.53	0.38	0.42	0.27
Ni	µg/L	703.02	235.68	97.27	65.56	25.12	2.42	1.85	1.58
Cu	µg/L	50.13	36.77	32.72	40.32	31.04	28.96	30.32	29.02
Zn	µg/L	35.30	37.78	33.05	90.99	35.45	33.75	44.71	43.45
As	µg/L	3.28	3.99	3.59	3.51	3.21	8.27	90.03	88.28
Se	µg/L	251.81	331.65	352.21	390.33	383.33	317.04	912.18	898.28
Mo	µg/L	191.79	232.39	258.34	255.74	263.00	283.19	228.02	226.49
Cd	µg/L	3.17	1.24	0.88	1.05	0.02	0.76	0.74	0.59
Sb	µg/L	4.73	3.00	3.57	3.55	0.99	2.75	6.36	6.38
Tl	µg/L	4.26	2.29	2.84	2.63	2.18	1.32	1.13	1.13
Pb	µg/L	8.99	1.28	0.78	5.88	0.88	0.90	2.12	1.49

Table 16. Batch 1 fly ash leaching data for sample 1452 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	Sample ID						
		1519-8-1	**1519-8-2**	**1519-8-3**	**1519-8-4**	**1519-8-5**	**1519-8-6**	**1519-8-6D**
pH		7.64	8.25	9.60	10.08	11.05	12.64	12.66
Ca	mg/L	290.00	80.70	7.20	5.88	<MDL	<MDL	<MDL
Mg	mg/L	295.00	213.00	6.70	2.41	<MDL	<MDL	<MDL
Na	mg/L	18200	19400	18900	17800	18300	19400	19300
K	mg/L	56.00	56.60	58.80	49.20	48.10	47.20	50.20
Sr	mg/L	19.70	9.24	<MDL	<MDL	<MDL	<MDL	<MDL
Si	mg/L	5.13	1.67	<MDL	<MDL	1.87	23.70	23.30
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	37.20	83.60	377.00	491.00	512.00
B	mg/L	<MDL	<MDL	9.23	9.25	9.92	13.80	13.40
F^-	mg/L	2.85	7.44	17.11	24.65	30.11	35.28	36.31
Cl	mg/L	177.03	169.13	175.59	173.48	174.37	179.83	184.32
SO_4^{2-}	mg/L	8927	9391	9624	9716	9821	9389	9131
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	2.05	1.88
V	µg/L	627.85	1078	1103	2341	3068	5017	5000
Cr	µg/L	37.58	90.39	357.22	434.81	496.17	540.82	527.48
Mn	µg/L	43.07	11.90	3.27	1.31	0.91	4.14	4.09
Co	µg/L	21.75	10.36	0.65	0.51	<MDL	<MDL	<MDL
Ni	µg/L	111.05	36.80	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	µg/L	376.00	385.64	214.27	160.70	8.64	175.66	180.83
Zn	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
As	µg/L	13.36	54.75	122.61	382.73	563.07	1068	1054
Se	µg/L	359.40	480.19	557.25	593.80	599.47	599.24	592.83
Mo	µg/L	431.16	450.57	625.57	651.38	670.45	671.95	676.23
Cd	µg/L	2.64	2.49	5.04	5.13	2.87	2.36	2.43
Sb	µg/L	34.37	39.29	59.99	76.47	71.17	74.42	73.30
Ba	µg/L	333.32	336.86	259.23	600.51	429.89	258.48	249.19
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Tl	µg/L	20.61	18.44	8.44	9.07	7.21	2.87	2.74
Br	µg/L	17212	16697	17475	17675	17645	17706	17374

Table 17. Batch 1 fly ash leaching data for sample 1520 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	Sample ID						
		1520-9-1	1520-9-2	1520-9-3	1520-9-4	1520-9-5	1520-9-6	1520-9-6D
pH		7.03	8.07	9.02	10.79	11.90	12.51	12.53
Ca	mg/L	5280	4700	4890	911.00	48.00	16.30	16.40
Mg	mg/L	1140	1030	60.80	<MDL	<MDL	<MDL	<MDL
Na	mg/L	4900	4670	4620	4280	4250	4070	4230
K	mg/L	205.00	195.00	172.00	151.00	129.00	134.00	139.00
Sr	mg/L	146.00	136.00	156.00	73.00	13.20	6.93	6.66
Si	mg/L	2.66	<MDL	<MDL	5.42	15.40	38.40	39.20
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	<MDL	<MDL	19.30	50.40	54.70
B	mg/L	10.10	5.65	5.72	<MDL	<MDL	<MDL	<MDL
F^-	mg/L	1.15	3.53	5.46	<MDL	4.00	16.42	16.82
Cl^-	mg/L	215.82	215.82	213.73	222.47	220.59	213.82	214.78
SO_4^{2-}	mg/L	1370	1431	1131	2872	3345	5711	5667
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	9.62	6.93	14.67	154.43	647.79	815.82	808.18
Cr	µg/L	64.26	95.73	111.32	316.98	386.28	433.86	434.58
Mn	µg/L	376.77	56.82	4.67	0.69	0.79	1.13	1.33
Co	µg/L	63.81	22.08	19.96	4.85	<MDL	<MDL	<MDL
Ni	µg/L	394.75	272.38	276.50	43.19	<MDL	<MDL	<MDL
Cu	µg/L	53.63	51.73	44.10	37.55	32.08	29.37	29.09
Zn	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	10.48	<MDL
As	µg/L	1.27	<MDL	1.11	2.63	24.36	109.97	113.10
Se	µg/L	251.47	211.41	188.65	310.11	327.44	714.21	742.94
Mo	µg/L	344.03	522.74	698.17	871.51	852.72	796.77	814.63
Cd	µg/L	1.94	3.54	4.10	4.42	3.98	3.37	3.19
Sb	µg/L	10.38	9.29	5.78	<MDL	1.90	2.97	2.89
Ba	µg/L	1281.12	1304.09	2330.58	779.78	379.86	255.19	248.60
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	0.95	0.89
Tl	µg/L	13.84	9.78	7.84	8.63	6.65	6.57	6.59
Br	µg/L	5085	5040	4938	4730	4779	4651	4737

Figure 1. Comparison of total composition for selected soluble salts for all batch 1 samples (Acid digestion data).

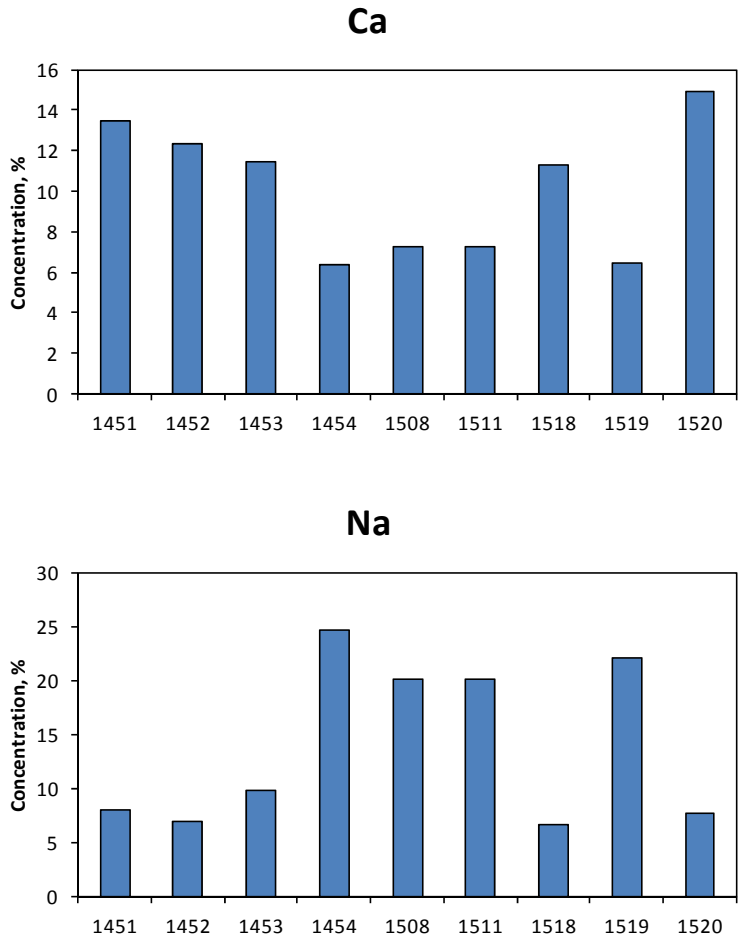

Figure 2. Comparison of total composition for selected trace constituents for all batch 1 samples (Acid digestion data).

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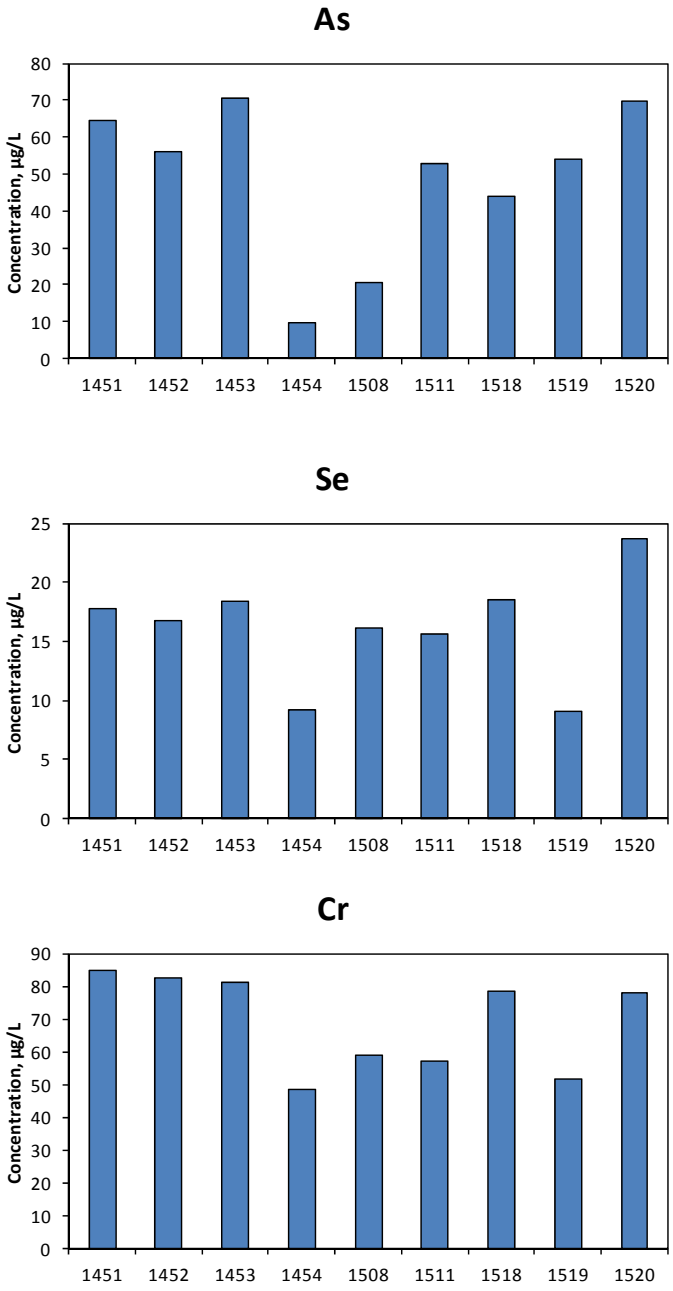


Figure 3. Comparison of leachate concentrations for selected soluble salts for all batch 1 samples using three different leaching L/S ratios at natural pH.

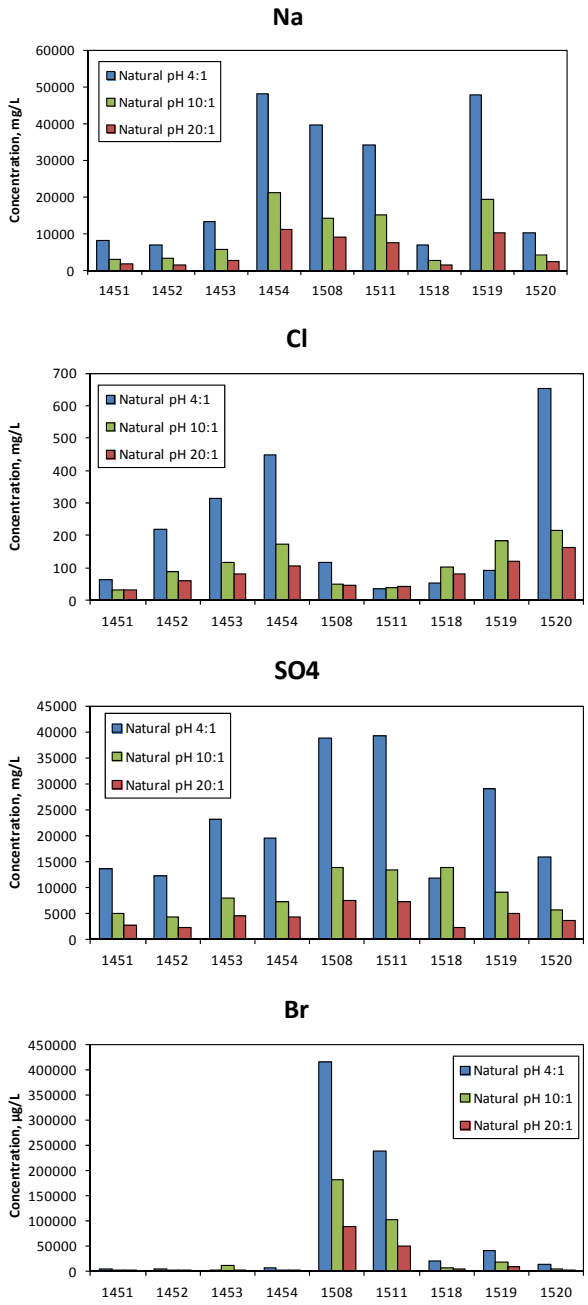


Figure 4. Comparison of leachate concentrations for selected trace constituents for all batch 1 samples using three different leaching L/S ratios at natural pH.

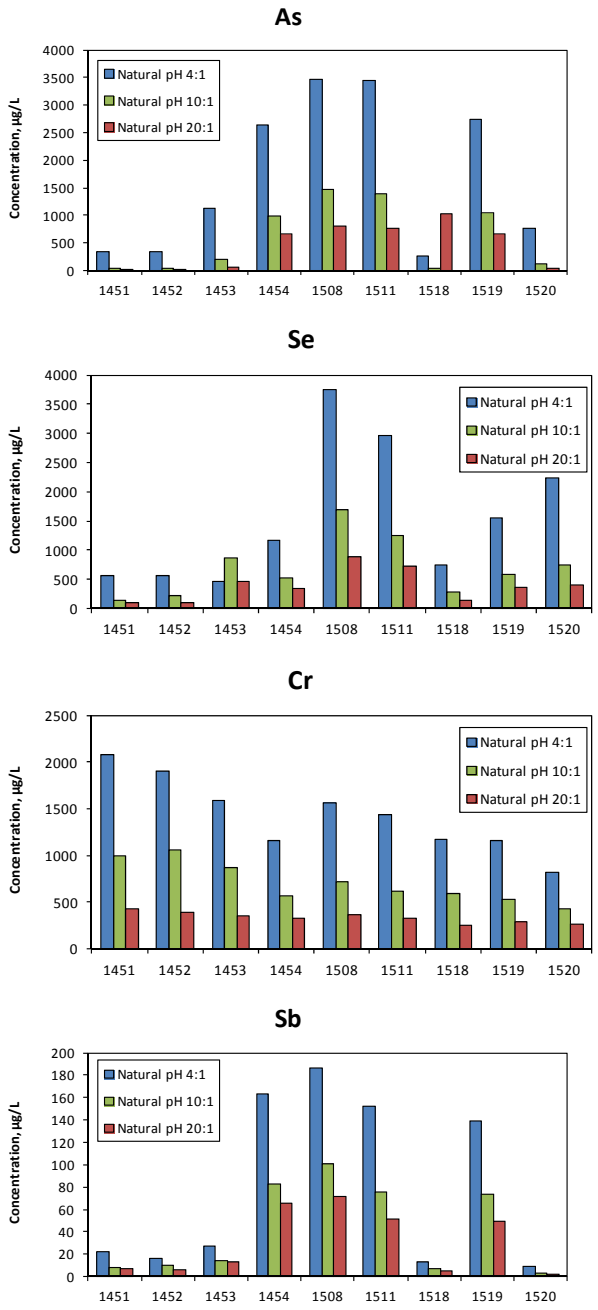


Figure 5a. Batch 1 fly ash leaching versus pH, Group 1.

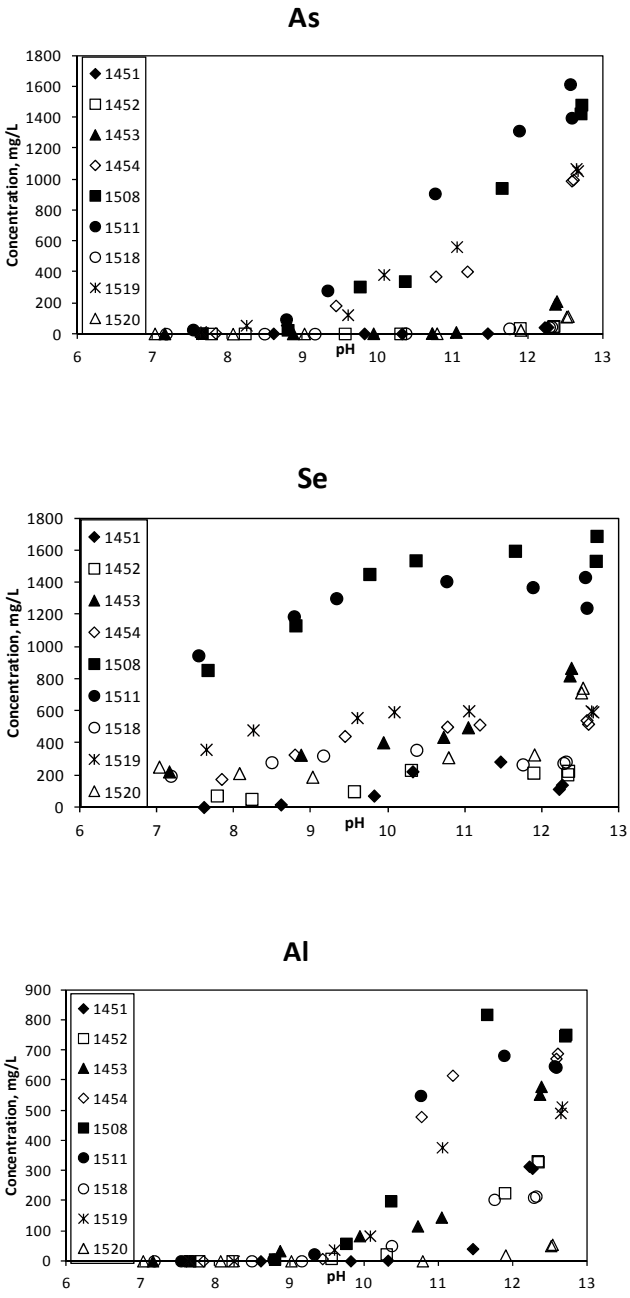
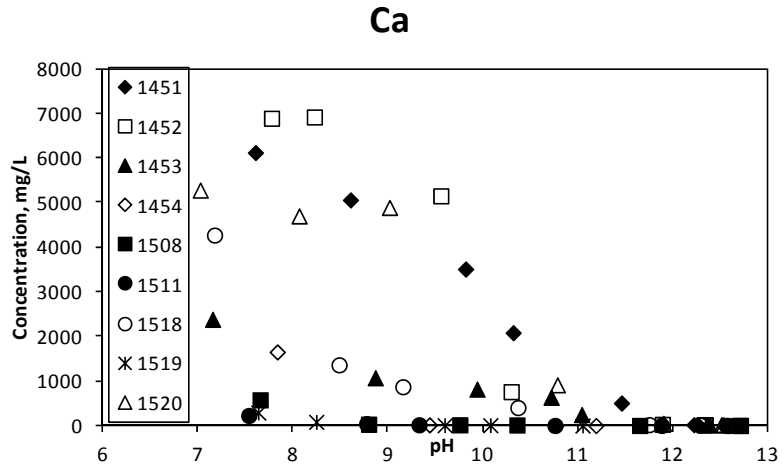


Figure 5b. Batch 1 fly ash leaching versus pH, Group 2



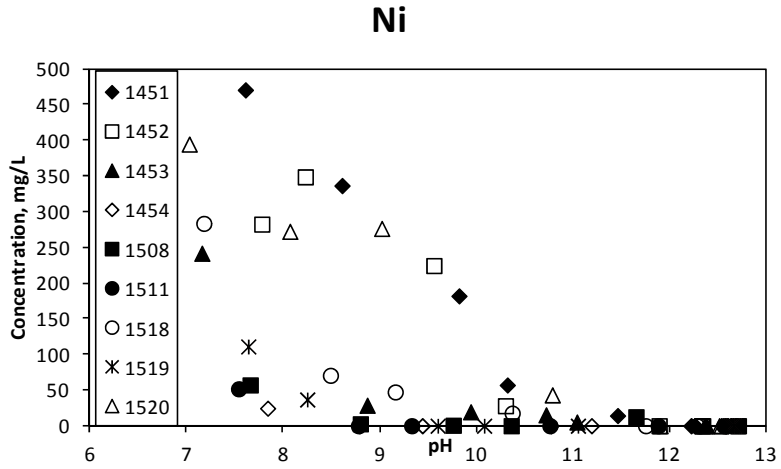


Figure 5c. Batch 1 fly ash leaching versus pH, Group 3.

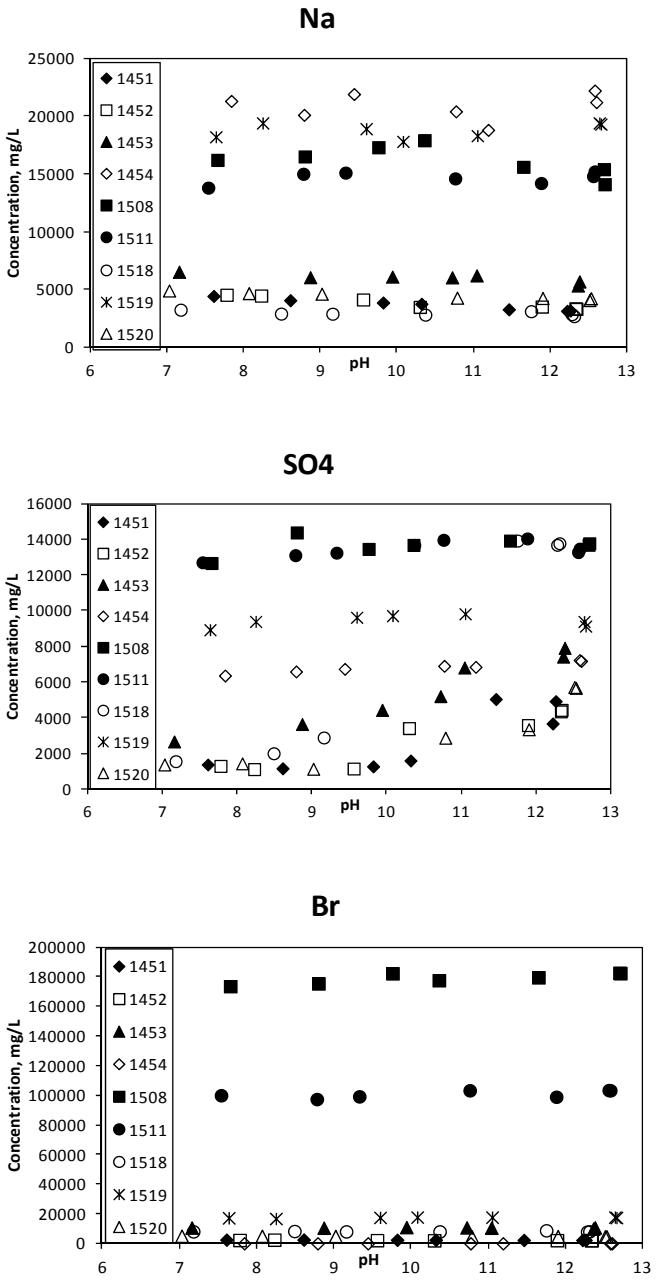
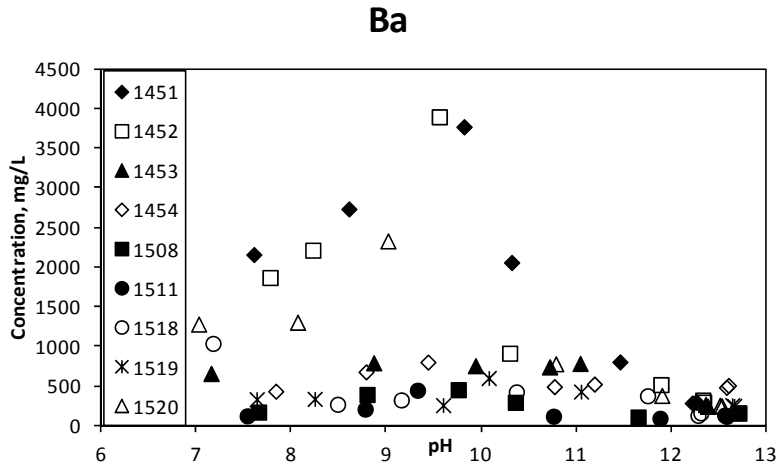
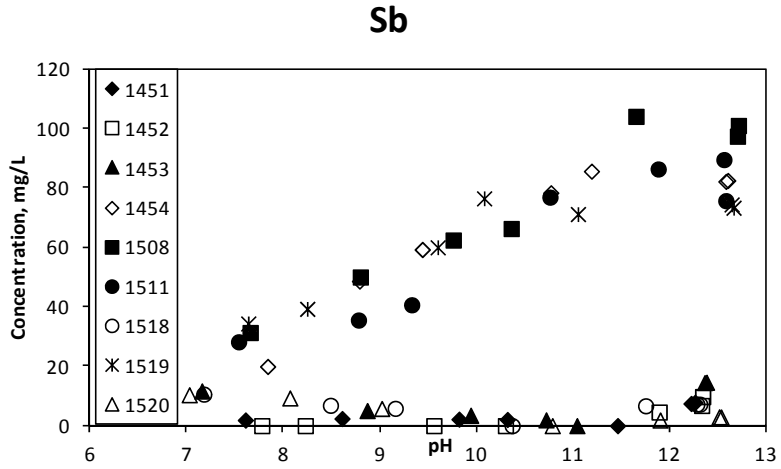


Figure 5d. Batch 1 fly ash leaching versus pH, Group 4.





3.2 Batch 2 NRT Fly Ashes Results

Table 18. Batch 2 fly ash sample description (sample numbers in the text refer to the Headwaters Bucket Number).

Sample ID	Bucket Date	GRE Sample ID	Conditions	Moisture(%)	LOI(%)
NRT 339	5/18/2012		650 lbs/hr trona, no carbon	0.086	1.63
NRT 340	5/24/2012		870 lbs/hr trona, confidential brominated carbon	0.028	1.83
NRT 341	5/29/2012		1200 lbs/hr trona, mix of MC Plus and confidential brominated carbon	0.005	1.68
NRT 342	5/30/2012		3000 lbs/hr trona, mix of MC Plus and confidential brominated carbon	0.008	1.51
NRT 343			Control		

Table 19. Batch 2 fly ash total composition of batch 2 fly ash by digestion (EPA Method 3051A).

Element	Unit	Sample ID				
		NRT 339	NRT 340	NRT 341	NRT 342	NRT 343
Ca	(%)	9.30	11.47	10.50	10.57	10.67
Mg	(%)	2.00	2.29	2.00	2.03	2.20
Na	(%)	15.30	8.83	13.37	13.60	4.60
K	(%)	0.35	0.37	0.27	0.23	0.38
Sr	(%)	0.43	0.54	0.46	0.47	0.54
Fe	(%)	2.22	3.62	2.69	2.56	2.74
Al	(%)	6.65	8.47	7.13	7.00	7.73
B	(%)	<MDL	<MDL	<MDL	<MDL	<MDL
Ba	(%)	0.28	0.55	0.26	0.43	0.65
Be	mg/kg	3.02	2.78	2.30	2.43	2.11
V	mg/kg	153.33	172.00	129.33	148.67	179.67
Cr	mg/kg	35.40	39.45	30.37	29.97	38.68
Mn	mg/kg	265.50	338.23	265.93	263.47	269.25
Co	mg/kg	14.80	18.62	14.87	15.10	14.05
Ni	mg/kg	33.05	44.55	33.67	34.93	29.78
Cu	mg/kg	127.52	144.82	136.78	140.92	100.81
Zn	mg/kg	50.02	70.45	61.62	55.90	60.68
As	mg/kg	30.37	44.16	29.44	28.25	24.69
Se	mg/kg	10.03	20.57	18.70	15.07	8.67
Mo	mg/kg	12.49	15.57	2.45	11.85	10.58
Cd	mg/kg	0.92	3.20	1.22	1.33	1.29
Sb	mg/kg	1.32	2.65	0.18	1.32	0.51
Tl	mg/kg	0.70	2.47	1.18	0.90	0.64
Pb	mg/kg	14.40	17.45	15.45	15.97	11.70
Br	mg/kg	18.28	540.62	790.91	364.15	5.66

(Br data is calculated from leaching data at natural pH of Method 1313)

Table 20. Batch 2 fly ash chemical composition by XRF.

Element	Unit	Sample ID				
		NRT 339	NRT 340	NRT 341	NRT 342	NRT 343
Al	Wt %	6.04	9.05	6.88	6.56	9.74
Ca	Wt %	9.29	12.07	10.57	10.71	12.36
Fe	Wt %	2.43	3.85	2.87	2.73	3.64
Mg	Wt %	1.48	2.11	1.63	1.60	2.44
K	Wt %	0.45	0.53	0.37	0.32	0.70
Si	Wt %	7.93	12.04	8.96	8.12	15.96
Na	Wt %	21.77	14.32	19.88	20.63	8.24
Sr	Wt %	0.50	0.62	0.54	0.53	0.64
Cl	Wt %	0.13	<0.02	0.03	0.03	<0.02
S	Wt %	7.76	5.02	6.26	5.07	2.29
Ba	Wt %	0.95	1.42	1.36	1.22	1.16

Table 21. Batch 2 fly ash natural leaching data, 20:1 L/S ratio.

Element	Unit	Sample ID						
		339	340	341	341D	342	343	343D
pH		12.53	12.35	12.51	12.65	12.73	12.17	12.45
Ca	mg/L	13.55	16.07	12.29	11.66	7.12	32.76	34.55
Mg	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Na	mg/L	6036	2623	4990	5093	5195	800.74	829.89
K	mg/L	50.30	41.90	45.99	46.73	37.49	28.04	25.83
Sr	mg/L	2.34	5.69	1.73	1.84	1.11	11.34	10.92
Si	mg/L	11.97	5.48	11.34	11.76	15.33	2.98	2.87
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	537.60	334.95	569.10	610.05	724.50	124.95	115.50
B	mg/L	11.03	<MDL	10.32	10.92	13.55	<MDL	<MDL
F^-	mg/L	<MDL	5.14	8.66	8.89	11.17	19.62	22.00
Cl^-	mg/L	116.26	12.08	17.33	17.14	15.26	15.17	15.64
SO_4^{2-}	mg/L	8936	3940	6367	6471	5379	1219	1173
Br	mg/L	0.70	28.95	40.50	39.34	18.99	0.26	0.24
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	2057	745.82	1849	1872	2500	274.58	277.37
Cr	µg/L	430.79	269.01	369.85	377.22	401.06	244.31	248.09
Mn	µg/L	1.95	1.11	1.89	1.93	2.31	<MDL	<MDL
Co	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Ni	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	µg/L	66.99	28.39	54.81	54.60	56.60	10.35	10.02
Zn	µg/L	36.90	37.93	33.47	35.60	31.40	40.19	40.99
As	µg/L	461.03	67.79	388.40	392.55	551.84	7.67	7.31
Se	µg/L	609.69	218.04	609.69	625.86	518.60	117.56	104.81
Mo	µg/L	573.05	693.53	565.78	576.24	589.93	411.83	415.44
Cd	µg/L	1.81	1.91	1.49	1.55	1.64	1.20	1.22
Sb	µg/L	26.99	9.28	22.85	23.46	29.61	3.30	3.26
Ba	µg/L	192.30	339.59	277.70	287.64	306.89	899.28	926.14
Tl	µg/L	2.94	<MDL	0.80	0.82	0.84	0.50	0.50
Pb	µg/L	0.29	<MDL	0.44	0.46	0.65	<MDL	<MDL

Table 22. Batch 2 fly ash natural leaching data, 4:1 L/S ratio (Modified Method 1312).

Element	Unit	Sample ID						
		339	**340**	**341**	**341D**	**342**	**343**	**343D**
pH		12.92	12.76	12.93	12.90	12.84	12.47	12.45
Ca	mg/L	12.18	9.53	9.38	8.15	7.91	15.96	16.70
Mg	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Na	mg/L	29492	13117	23834	24348	24348	3995	3944
K	mg/L	224.70	191.10	214.20	206.85	163.80	127.05	130.20
Sr	mg/L	2.47	3.30	1.73	1.73	1.30	7.39	7.54
Si	mg/L	32.55	13.34	30.14	32.55	42.11	5.68	5.40
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	2195	1376	2667	2667	3014	484.05	492.45
B	mg/L	31.08	<MDL	17.96	18.59	35.49	<MDL	<MDL
F^-	mg/L	12.21	35.06	38.90	39.89	45.88	30.43	31.85
Cl^-	mg/L	290.67	104.69	119.13	119.41	114.45	113.66	113.45
SO_4^{2-}	mg/L	48285	20995	35541	34173	28378	5945	5820
Br	mg/L	1.74	142.20	197.55	191.12	95.18	1.27	1.26
Be	µg/L	1.07	<MDL	<MDL	<MDL	1.34	<MDL	<MDL
V	µg/L	8773	3402	8006	7857	10423	841.28	884.28
Cr	µg/L	1824	1204	1889	1791	1636	1098	1089
Mn	µg/L	10.88	4.28	9.22	9.11	9.33	1.30	1.09
Co	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Ni	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	µg/L	373.17	159.43	308.41	310.65	326.35	39.44	38.89
Zn	µg/L	76.10	47.52	75.35	62.50	53.31	41.18	39.94
As	µg/L	3739	1400	4672	4611	3872	124.45	127.87
Se	µg/L	3297	1464	3850	3530	2683	693.27	633.55
Mo	µg/L	2865	3459	3274	3015	2788	1964	2035
Cd	µg/L	9.18	10.10	10.04	9.62	8.32	5.82	5.67
Sb	µg/L	43.49	22.87	30.03	23.35	39.45	9.09	8.76
Ba	µg/L	86.39	89.75	107.42	104.10	126.94	498.58	377.12
Tl	µg/L	10.58	<MDL	2.54	2.63	3.21	<MDL	<MDL
Pb	µg/L	2.08	0.84	3.76	4.07	5.41	<MDL	<MDL

Table 23. Batch 2 fly ash leaching data for sample NRT 339 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	NRT 339						
		339-1-8	339-1-13	339-1-7	339-1-6	339-1-5	339-1-15	339-1-15D
pH		7.67	8.61	9.44	10.08	11.60	12.64	12.64
Ca	mg/L	549.18	527.82	842.08	369.17	113.90	14.85	14.75
Mg	mg/L	734.27	431.21	22.37	1.35	<MDL	<MDL	<MDL
Na	mg/L	12509	12306	12306	12509	12204	12204	12102
K	mg/L	115.94	117.97	109.84	111.87	106.79	104.75	103.73
Sr	mg/L	15.76	19.53	34.68	23.59	13.22	2.49	2.49
Si	mg/L	1.55	<MDL	<MDL	<MDL	1.38	11.49	11.39
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	2.62	19.32	90.31	565.45	1058	1078
B	mg/L	18.61	16.37	15.36	17.49	27.15	25.22	24.51
F^-	mg/L	<MDL	<MDL	2.92	5.09	8.32	14.14	12.90
Cl	mg/L	149.33	150.68	150.28	151.64	153.69	153.32	148.72
SO_4^{2-}	mg/L	14898	15764	14575	15419	16028	16429	15264
Br	mg/L	1.55	1.89	1.56	1.57	1.58	1.87	1.79
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	37.78	48.84	65.72	179.67	1044	3141	3158
Cr	µg/L	62.26	91.97	190.36	310.39	606.22	788.45	775.55
Mn	µg/L	114.46	19.89	1.42	<MDL	<MDL	3.58	3.33
Co	µg/L	13.95	1.42	1.26	0.63	<MDL	<MDL	<MDL
Ni	µg/L	62.08	18.10	27.88	11.39	<MDL	<MDL	<MDL
Cu	µg/L	232.13	491.88	196.95	204.41	165.07	283.83	218.81
Zn	µg/L	23.38	49.53	<MDL	<MDL	<MDL	39.12	34.89
As	µg/L	3.15	4.29	5.21	12.10	128.38	908.49	939.60
Se	µg/L	716.63	730.33	770.78	867.56	1085	1043	1100
Mo	µg/L	817.75	792.33	1072	1093	1256	933.61	961.36
Cd	µg/L	3.86	3.27	4.47	4.21	4.62	3.78	3.80
Sb	µg/L	23.53	21.07	15.66	21.70	30.38	40.65	40.63
Ba	µg/L	139.34	102.72	224.32	189.20	290.30	82.76	81.21
Tl	µg/L	12.83	6.89	8.24	7.16	4.58	5.25	5.47
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	0.69	0.75

Table 24. Batch 2 fly ash leaching data for sample NRT 340 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	NRT 340						
		340-2-9	**340-2-7**	**340-2-12**	**340-2-4**	**340-2-3**	**340-2-16**	**340-2-16D**
pH		7.58	8.44	8.76	10.26	11.72	12.40	12.40
Ca	mg/L	1454	893.94	587.83	492.23	36.71	12.10	12.20
Mg	mg/L	1058	369.17	303.07	<MDL	<MDL	<MDL	<MDL
Na	mg/L	5705	5573	5532	5400	5268	5319	5268
K	mg/L	101.19	92.45	86.34	81.36	80.95	81.16	88.28
Sr	mg/L	63.46	43.63	32.65	41.09	12.61	4.58	4.31
Si	mg/L	1.10	<MDL	<MDL	<MDL	2.45	7.91	7.38
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	1.23	81.97	302.05	633.59	666.14
B	mg/L	13.83	13.12	13.02	10.48	5.26	<MDL	<MDL
F^-	mg/L	1.39	1.81	1.79	1.63	6.73	9.47	9.22
Cl^-	mg/L	18.77	19.97	20.14	19.87	22.40	20.11	19.77
SO_4^{2-}	mg/L	3029	3535	5980	6619	6093	7662	6852
Br	mg/L	46.63	45.49	54.12	45.69	46.51	53.95	54.17
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	<MDL	2.50	18.97	74.54	573.01	1207	1190
Cr	µg/L	<MDL	43.76	68.20	124.91	240.32	474.99	467.40
Mn	µg/L	7.10	22.45	8.48	<MDL	<MDL	1.69	1.65
Co	µg/L	<MDL	1.36	0.94	0.59	<MDL	<MDL	<MDL
Ni	µg/L	<MDL	33.08	18.38	14.68	<MDL	<MDL	<MDL
Cu	µg/L	<MDL	65.37	91.64	56.79	53.70	66.69	54.17
Zn	µg/L	<MDL	<MDL	18.04	<MDL	<MDL	15.49	12.06
As	µg/L	<MDL	1.38	3.23	8.64	83.37	252.60	254.41
Se	µg/L	<MDL	471.12	484.44	635.44	777.40	457.60	453.84
Mo	µg/L	6.52	975.02	923.64	1285	1455	1349	1344
Cd	µg/L	<MDL	4.53	3.97	5.23	5.61	4.82	4.66
Sb	µg/L	<MDL	10.86	12.83	2.09	7.99	12.71	12.02
Ba	µg/L	4.25	328.30	300.51	397.98	421.06	191.64	192.50
Tl	µg/L	<MDL	3.84	3.72	1.32	<MDL	<MDL	<MDL
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

Table 25. Batch 2 fly ash leaching data for sample NRT 341 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	NRT 341						
		341-3-20	341-3-3	341-3-24	341-3-4	341-3-5	341-3-14	341-3-14D
pH		7.44	8.67	9.12	10.40	11.49	12.58	12.59
Ca	mg/L	874.65	508.20	446.25	290.85	162.75	11.55	11.66
Mg	mg/L	876.75	239.40	83.58	<MDL	<MDL	<MDL	<MDL
Na	mg/L	10682	10479	10288	10458	10269	11970	10416
K	mg/L	107.10	95.24	97.02	94.19	93.24	99.02	101.43
Sr	mg/L	24.05	17.01	17.85	15.96	14.70	1.81	1.77
Si	mg/L	2.32	<MDL	<MDL	<MDL	<MDL	18.17	17.85
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	3.79	9.82	112.35	500.85	1260	1250
B	mg/L	16.59	14.49	12.81	17.85	22.68	20.48	19.74
F^-	mg/L	2.56	2.08	6.13	9.47	11.83	51.91	54.35
Cl	mg/L	35.42	30.86	34.52	28.96	28.07	28.46	28.37
SO_4^{2-}	mg/L	7305	12634	12861	12241	12405	12702	12544
Br	mg/L	77.95	79.00	77.59	78.58	77.47	79.90	78.28
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	6.20	54.26	62.43	229.13	610.95	3532	3484
Cr	µg/L	34.15	71.57	79.65	101.68	301.69	737.67	728.57
Mn	µg/L	1229	13.02	5.12	<MDL	0.44	3.51	3.51
Co	µg/L	31.56	1.07	0.97	0.65	0.44	<MDL	<MDL
Ni	µg/L	94.82	19.91	18.23	9.89	5.42	<MDL	<MDL
Cu	µg/L	178.54	187.97	191.33	195.95	183.96	165.77	169.28
Zn	µg/L	49.50	53.38	64.49	46.60	42.42	44.73	38.58
As	µg/L	0.76	5.19	2.86	13.63	41.31	980.87	966.08
Se	µg/L	563.62	695.86	670.68	750.14	1065	1308	1286
Mo	µg/L	613.35	963.04	954.39	1065	1163	1145	1153
Cd	µg/L	3.42	4.12	4.45	4.01	4.49	4.26	3.80
Sb	µg/L	9.98	18.84	14.85	17.56	15.02	33.03	31.82
Ba	µg/L	323.21	89.19	120.71	120.35	281.44	151.22	154.46
Tl	µg/L	18.06	11.63	10.06	4.98	3.09	1.37	1.41
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	1.05	1.03

Table 26. Batch 2 fly ash leaching data for sample NRT 342 as a function of pH, 10:1 (draft Method 1313)

Element	Unit	NRT 342						
		342-5-14	342-5-17	342-5-23	342-5-2	342-5-3	342-5-9	342-5-9D
pH		7.01	7.99	9.32	10.40	11.47	12.74	12.75
Ca	mg/L	3791	1061	1250	711.90	190.05	7.25	6.67
Mg	mg/L	1386	813.75	29.51	<MLD	<MDL	<MDL	<MDL
Na	mg/L	12285	11655	11445	10920	11865	10605	10710
K	mg/L	121.80	100.38	102.27	89.67	87.36	84.21	80.43
Sr	mg/L	132.30	37.07	56.39	34.55	16.59	1.14	1.08
Si	mg/L	2.52	1.00	<MDL	<MDL	<MDL	23.63	24.15
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	4.27	119.70	490.35	1376	1397
B	mg/L	5.45	13.13	12.39	15.33	19.32	24.47	25.52
F^-	mg/L	3.28	3.84	10.75	17.29	18.34	13.42	13.88
Cl^-	mg/L	27.96	27.39	23.93	23.88	24.16	21.14	22.61
SO_4^{2-}	mg/L	2281.72	6047	4746	9438	10746	11069	11171
Br	mg/L	37.70	37.31	38.64	36.91	36.83	36.88	35.95
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	7.61	7.00
V	µg/L	<MDL	3.63	15.83	124.03	392.49	5198	5282
Cr	µg/L	13.92	59.56	145.59	107.58	250.55	750.60	744.66
Mn	µg/L	8215	240.03	2.16	0.57	0.84	4.75	4.85
Co	µg/L	131.80	11.63	2.98	1.43	0.44	<MDL	<MDL
Ni	µg/L	303.85	75.60	60.96	27.93	5.40	<MDL	<MDL
Cu	µg/L	294.99	350.68	370.82	89.75	109.49	110.78	108.17
Zn	µg/L	27.22	37.57	32.34	53.97	43.01	20.39	18.04
As	µg/L	2.21	1.13	0.78	6.43	36.39	1762	1832
Se	µg/L	364.01	438.12	431.66	660.01	992.08	1463	1490
Mo	µg/L	118.92	708.67	1001	944.27	1042	1288	1309
Cd	µg/L	3.44	3.72	5.02	4.43	3.82	4.22	4.01
Sb	µg/L	3.91	7.83	3.95	8.27	11.30	37.44	39.17
Ba	µg/L	1012	284.70	373.23	372.23	275.67	137.19	131.54
Tl	µg/L	10.90	9.58	3.51	6.09	3.57	1.39	1.49
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	1.24	1.32

Table 27. Batch 2 fly ash leaching data for sample NRT 343 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample ID						
		343-4-13	343-4-6	343-4-7	343-4-8	343-4-16	343-4-10	343-4-10D
pH		7.72	8.35	9.38	10.24	11.59	12.15	12.16
Ca	mg/L	6426	5733	4263	893.55	43.16	21.53	21.32
Mg	mg/L	1449	750.75	11.87	<MDL	<MDL	<MDL	<MDL
Na	mg/L	2961	2589	2298	1766	1775	1579	1627
K	mg/L	134.40	119.70	99.75	65.00	57.02	56.70	55.97
Sr	mg/L	198.45	194.25	158.55	72.77	20.06	8.63	8.48
Si	mg/L	1.10	<MDL	<MDL	<MDL	1.65	4.77	4.73
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	4.97	29.40	139.65	252.00	254.10
B	mg/L	<MDL	<MDL	9.06	7.62	<MDL	<MDL	<MDL
F^-	mg/L	4.91	5.66	7.87	<MDL	5.35	8.15	8.05
Cl^-	mg/L	27.76	24.08	25.02	24.89	24.94	24.41	24.42
SO_4^{2-}	mg/L	1272.74	1347	1283	2208	1268.40	2066	2026
Br	mg/L	0.47	0.69	0.66	0.58	0.49	0.56	0.57
Be	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
V	µg/L	6.15	<MDL	10.96	33.87	265.88	543.77	535.61
Cr	µg/L	26.75	49.75	87.13	453.24	557.03	542.05	534.32
Mn	µg/L	3665	249.56	5.61	<MDL	1.39	<MDL	<MDL
Co	µg/L	38.26	10.19	8.00	1.47	<MDL	<MDL	<MDL
Ni	µg/L	309.10	233.04	187.15	35.99	2.21	<MDL	<MDL
Cu	µg/L	26.21	63.02	50.55	30.91	11.66	23.08	20.92
Zn	µg/L	13.61	38.91	39.75	46.98	46.89	42.80	41.77
As	µg/L	3.42	5.42	3.84	1.53	12.92	16.74	17.35
Se	µg/L	170.67	150.68	184.49	296.77	265.50	222.71	223.04
Mo	µg/L	303.68	465.63	635.00	693.63	903.65	827.97	832.44
Cd	µg/L	2.81	2.63	3.19	3.49	4.43	3.72	3.55
Sb	µg/L	2.29	2.60	2.46	<MDL	3.86	5.71	5.52
Ba	µg/L	1614	1822	2558	1343	1086	736.53	709.21
Tl	µg/L	2.63	2.00	1.34	1.07	0.57	<MDL	<MDL
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

Figure 6. Comparison of total composition for selected soluble salts for all batch 2 samples (Acid digestion data).

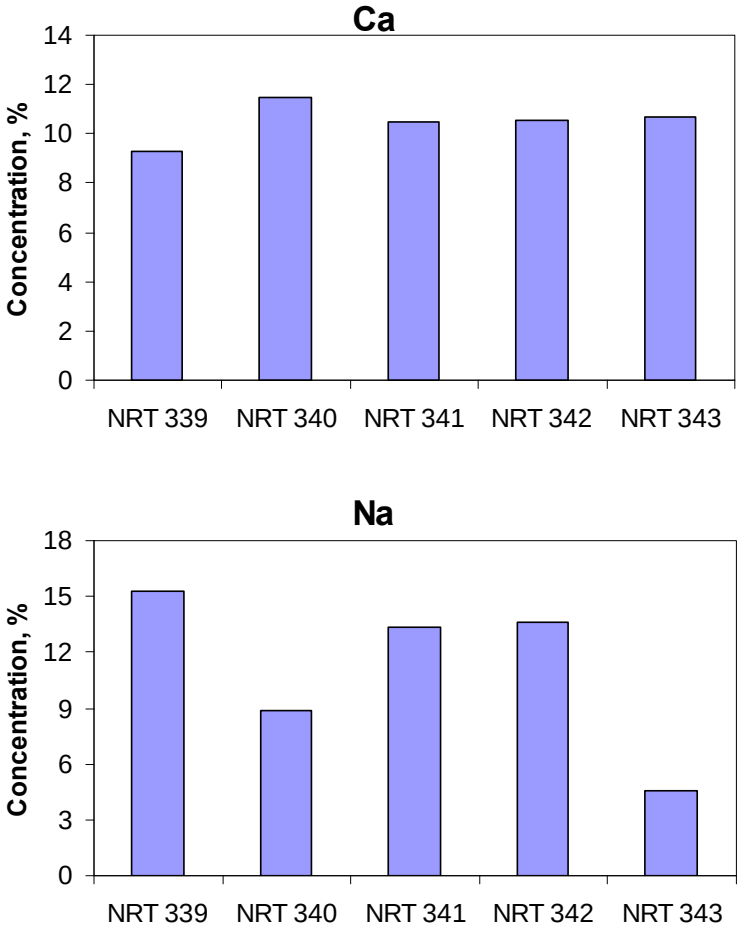


Figure 7. Comparison of total composition for selected trace constituents for all batch 2 samples (Acid digestion data).

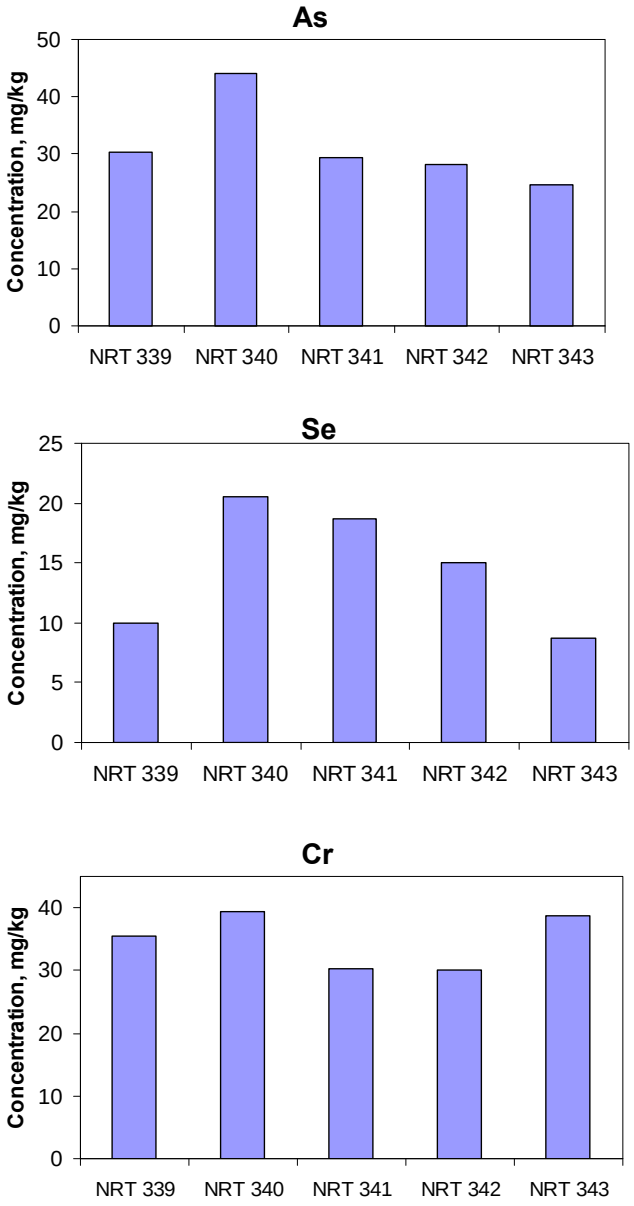


Figure 8. Comparison of leachate concentrations for selected soluble salts for all batch 2 samples using three different leaching L/S ratios at natural pH.

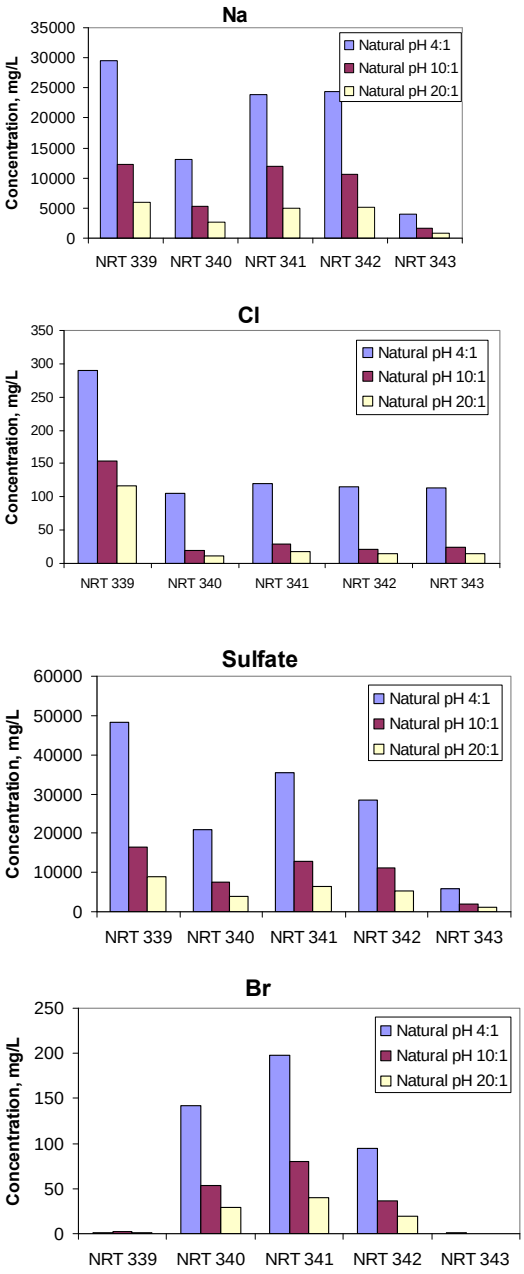


Figure 9. Comparison of leachate concentrations for selected trace constituents for all batch 2 samples using three different leaching ratios at natural pH.

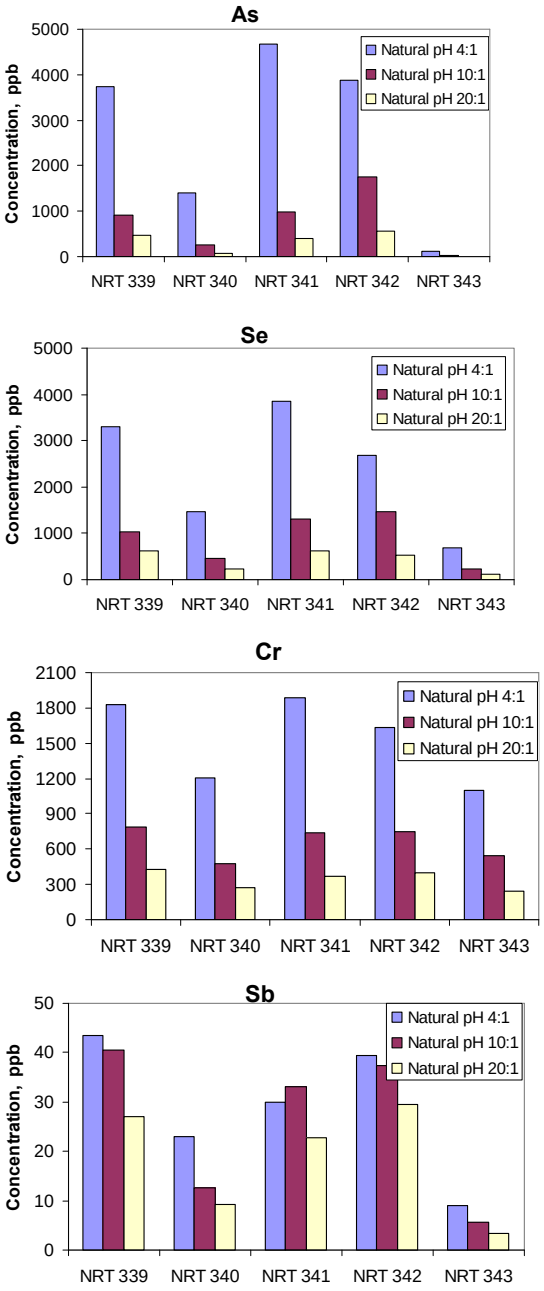
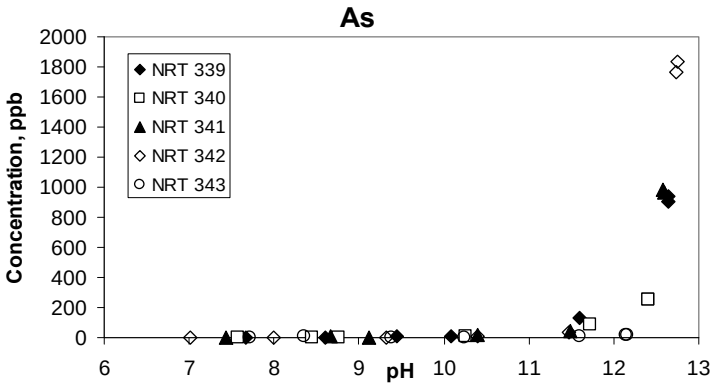
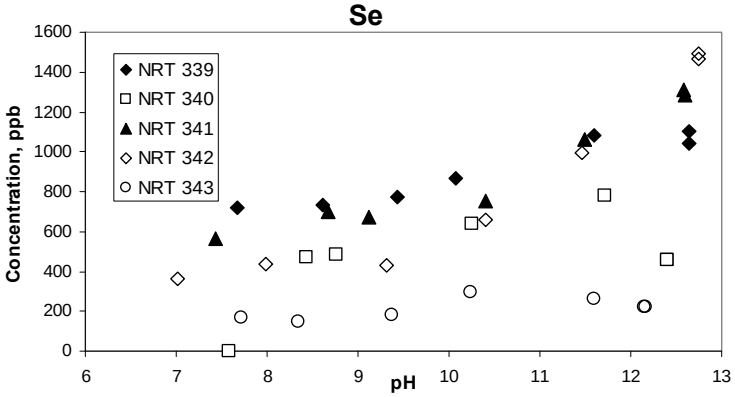


Figure 10a. Batch 2 flay ash leaching versus pH, Group 1.


As
Concentration, ppb
pH
NRT 339
NRT 340
NRT 341
NRT 342
NRT 343


Se
Concentration, ppb
pH
NRT 339
NRT 340
NRT 341
NRT 342
NRT 343

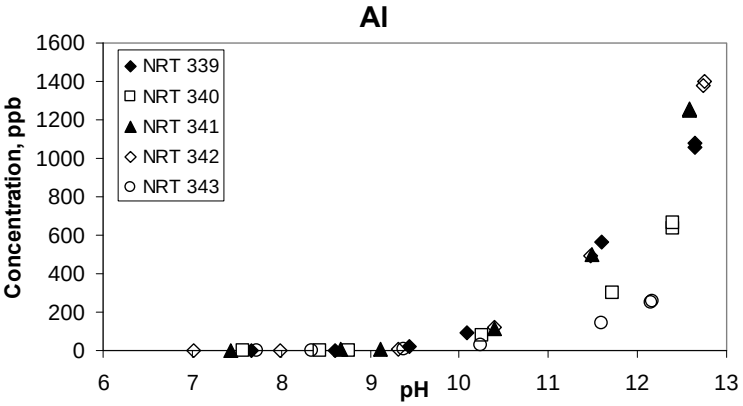

Al
Concentration, ppb
pH
NRT 339
NRT 340
NRT 341
NRT 342
NRT 343

Figure 10b. Batch 2 flay ash leaching versus pH, Group 2

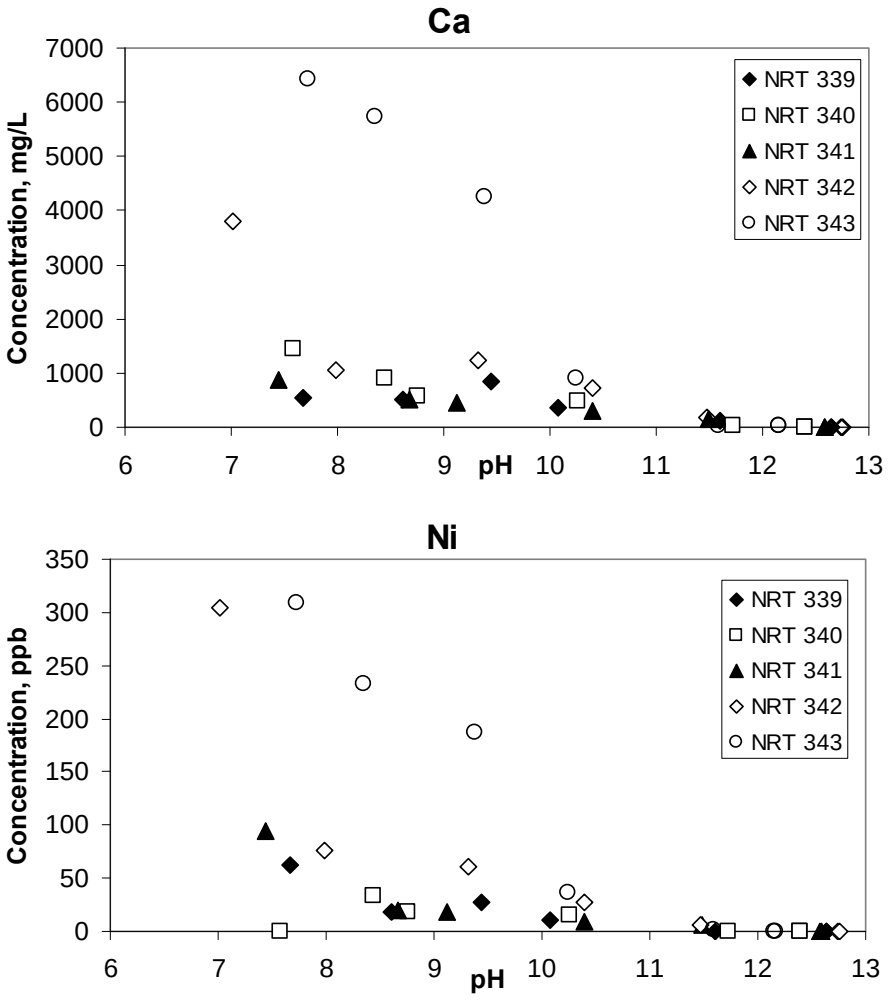


Figure 10c. Batch 2 flay ash leaching versus pH, Group 3.

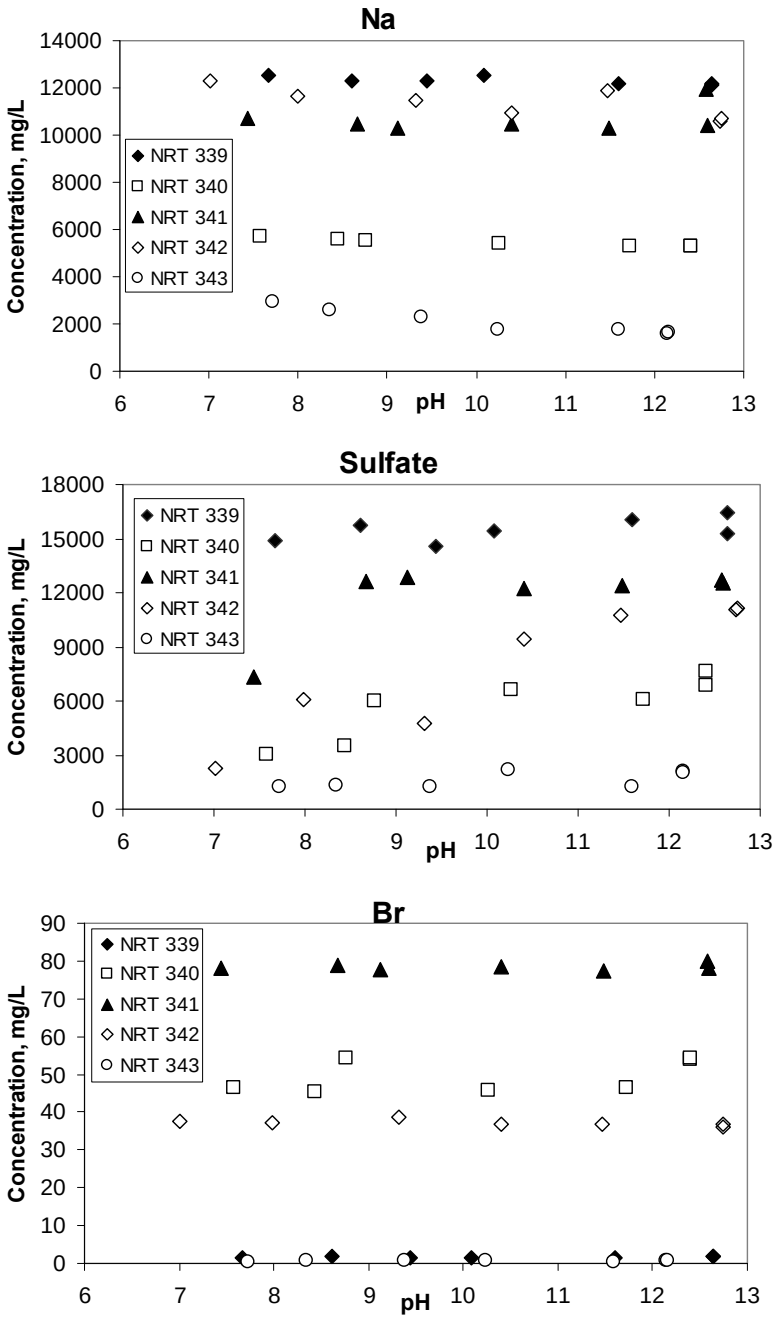
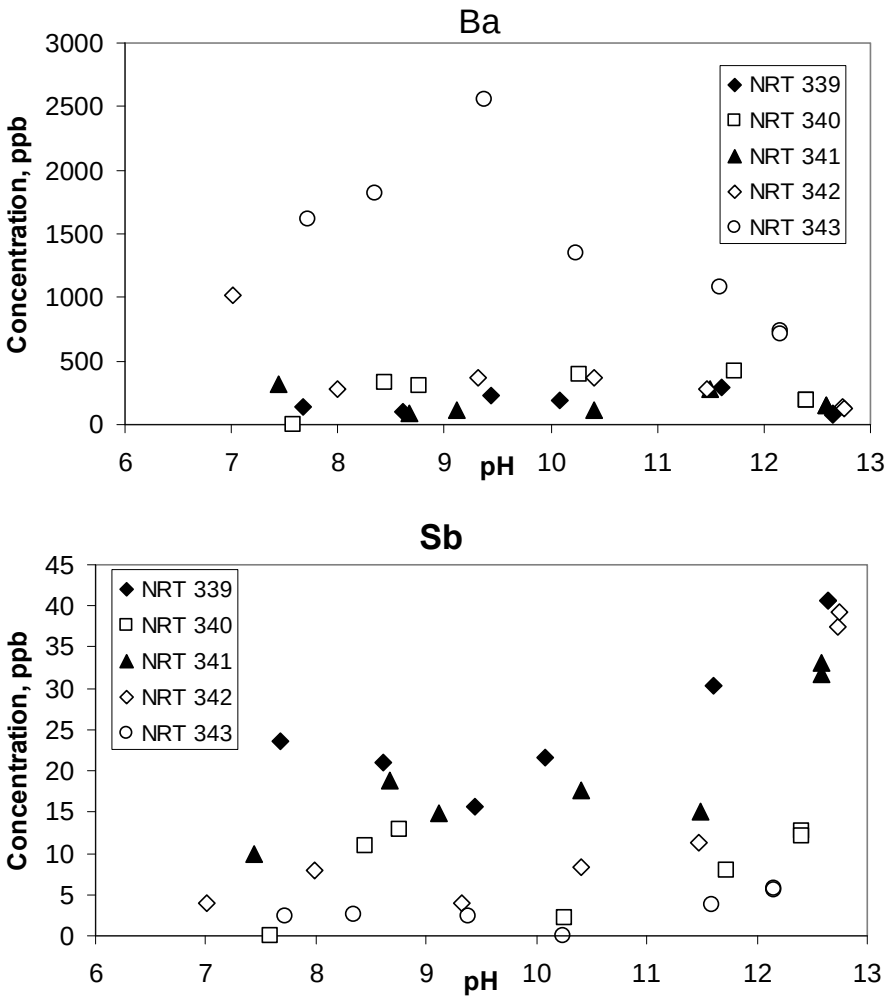


Figure 10d. Batch 2 flay ash leaching versus pH, Group 4.



3.3 Batch 3 B22 Fly Ashes results

Table 28. Batch 3 fly ash sample description.

Sample ID	Bucket Date	Time	Hopper	Sorbent	Rate (tons/hr)	Moisture(%)	LOI(%)
B22-1	6/10/2012	10:30 AM	22	None (Baseline)	--	0.03	0.21
B22-2	6/14/2012	12:30 PM	22	Trona	3	0.12	0.73
B22-3	6/15/2012	1:30 PM	22	SBC	4-Feb	0.20	0.84
B22-4	6/17/2012	NA	22	PAC & Br	NA	0.08	0.80
B22-5	6/24/2012	12:00 PM	22	Trona	1	0.08	0.86
B22-6	6/28/2012	NA	22	None (Baseline)	--	0.15	0.86

Table 29. Batch 3 fly ash total composition by digestion (EPA Method 3051A).

Element	Unit	Sample ID					
		B22-1	B22-2	B22-3	B22-4	B22-5	B22-6
Ca	%	21	17	16.02	15.93	16.23	18
Mg	%	4.32	3.57	3.33	3.29	3.32	3.80
Na	%	1.40	3.63	7.08	6.87	8.13	4.20
K	%	0.18	0.16	0.13	0.12	0.11	0.13
Sr	%	0.44	0.34	0.33	0.33	0.32	0.35
Fe	%	4.11	3.51	3.43	3.50	3.54	3.84
Al	%	8.13	7.13	6.50	6.34	5.86	6.53
B	%	0.10	0.09	0.08	0.08	0.08	0.09
Ba	%	0.63	0.51	0.49	0.52	0.49	0.57
Be	mg/kg	3.21	2.41	2.34	2.22	2.18	2.07
V	mg/kg	209.29	196.59	189.61	189.48	163.43	152.39
Cr	mg/kg	41.56	34.49	31.11	30.91	29.12	28.88
Mn	mg/kg	113.29	79.99	81.70	81.60	87.27	78.12
Co	mg/kg	13.76	11.74	12.72	12.67	11.01	11.64
Ni	mg/kg	45.09	38.82	41.59	41.23	36.82	36.02
Cu	mg/kg	98.06	88.62	91.61	92.39	78.40	82.91
Zn	mg/kg	86.66	114.22	120.68	124.84	95.79	106.99
As	mg/kg	48.93	44.17	42.68	40.07	37.20	46.67
Se	mg/kg	29.53	18.50	21.98	22.12	19.91	17.16
Mo	mg/kg	7.28	8.16	8.15	8.09	7.13	7.97
Cd	mg/kg	1.80	1.59	1.10	1.12	1.05	1.25
Sb	mg/kg	1.41	1.28	1.03	1.74	0.54	1.43
Tl	mg/kg	1.30	0.64	0.40	0.44	0.34	0.42
Pb	mg/kg	32.99	29.53	24.09	24.65	21.01	25.24

Table 30. Batch 3 fly ash chemical composition by XRF.

Element	Unit	Sample ID					
		B22-1	**B22-2**	**B22-3**	**B22-4**	**B22-5**	**B22-6**
Al	Wt %	9.42	8.47	7.41	7.30	6.24	7.46
Ca	Wt %	21.16	17.22	16.51	16.37	16.01	18.80
Fe	Wt %	4.78	4.32	4.08	4.10	3.83	4.48
Mg	Wt %	4.36	3.43	3.14	3.07	3.00	3.84
K	Wt %	0.36	0.37	0.27	0.26	0.24	0.28
Si	Wt %	14.26	16.13	13.09	12.39	11.45	13.84
Na	Wt %	2.26	6.71	13.72	13.06	15.43	8.68
Sr	Wt %	0.48	0.39	0.37	0.36	0.34	0.40
Cl	Wt %	<0.02	<0.02	<0.02	<0.02	0.02	<0.02
S	Wt %	1.68	1.51	2.71	2.63	3.67	2.70
Ba	Wt %	0.74	0.59	0.59	0.58	0.54	0.67

Table 31. Batch 3 fly ash natural leaching data. 20:1 L/S ratio (Modified Method 1312).

Element	Unit	Sample ID							
		B22-1	**B22-1D**	**B22-2**	**B22-2D**	**B22-3**	**B22-4**	**B22-5**	**B22-6**
pH		11.88	11.92	12.18	12.17	12.48	12.48	12.48	12.19
Ca	mg/L	164.85	160.65	24.78	25.83	9.82	10.15	9.19	23.42
Mg	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Na	mg/L	106.05	106.05	1271	1271	3140	3108	3854	1733
K	mg/L	10.42	10.43	1.51	1.72	3.22	3.34	5.79	5.31
Sr	mg/L	25.83	25.73	3.28	3.59	0.70	0.74	0.70	3.97
Si	mg/L	1.87	1.92	5.07	4.98	20.48	21.74	22.89	7.88
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	17.01	16.91	149.10	147.00	299.25	278.25	316.05	132.30
B	mg/L	<MDL	<MDL	<MDL	<MDL	11.87	11.76	12.50	<MDL
Ba	mg/L	5.54	5.44	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
F^-	mg/L	4.53	4.60	10.48	10.61	14.56	14.46	18.84	9.85
Cl^-	mg/L	<MDL	<MDL	<MDL	<MDL	7.15	7.20	12.76	7.52
SO_4^-	mg/L	39.13	53.51	1464	1477	3355	3414	4102	2135
Br	mg/L	469.80	459.65	434.94	436.61	731.60	753.32	3247	4741
V	µg/L	10.96	11.24	333.03	312.69	1194	1172	876.39	178.53
Cr	µg/L	22.28	23.15	211.38	212.63	249.04	231.65	209.90	162.70
Mn	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Co	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Ni	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	µg/L	<MDL	<MDL	11.22	11.16	31.45	23.58	30.80	15.76
Zn	µg/L	44.65	45.34	39.01	37.74	36.28	28.73	36.40	35.65
As	µg/L	0.99	0.62	21.47	18.69	287.71	280.59	261.84	17.48
Se	µg/L	<MDL	<MDL	476.84	501.54	697.24	630.30	523.39	185.80
Mo	µg/L	73.29	73.75	117.43	122.34	161.40	157.23	146.18	122.88
Cd	µg/L	<MDL	<MDL	<MDL	0.42	0.60	0.57	0.46	0.44
Sb	µg/L	<MDL	<MDL	4.42	4.59	15.06	14.47	12.10	2.50
Tl	µg/L	2.35	2.45	0.77	0.88	<MDL	<MDL	<MDL	<MDL
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

Table 32. Batch 3 fly ash natural leaching data. 4:1 L/S ratio (Modified Method 1312).

Element	Unit	Sample ID							
		B22-1	**B22-1D**	**B22-2**	**B22-2D**	**B22-3**	**B22-4**	**B22-5**	**B22-6**
pH		11.88	11.92	12.18	12.17	12.48	12.48	12.48	12.19
Ca	mg/L	164.85	160.65	24.78	25.83	9.82	10.15	9.19	23.42
Mg	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Na	mg/L	106.05	106.05	1271	1271	3140	3108	3854	1733
K	mg/L	10.42	10.43	1.51	1.72	3.22	3.34	5.79	5.31
Sr	mg/L	25.83	25.73	3.28	3.59	0.70	0.74	0.70	3.97
Si	mg/L	1.87	1.92	5.07	4.98	20.48	21.74	22.89	7.88
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	17.01	16.91	149.10	147.00	299.25	278.25	316.05	132.30
B	mg/L	<MDL	<MDL	<MDL	<MDL	11.87	11.76	12.50	<MDL
Ba	mg/L	5.54	5.44	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
F^-	mg/L	4.53	4.60	10.48	10.61	14.56	14.46	18.84	9.85
Cl^-	mg/L	<MDL	<MDL	<MDL	<MDL	7.15	7.20	12.76	7.52
SO_4^-	mg/L	39.13	53.51	1464	1477	3355	3414	4102	2135
Br	mg/L	469.80	459.65	434.94	436.61	731.60	753.32	3247	4741
V	µg/L	10.96	11.24	333.03	312.69	1194	1172	876.39	178.53
Cr	µg/L	22.28	23.15	211.38	212.63	249.04	231.65	209.90	162.70
Mn	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Co	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Ni	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Cu	µg/L	<MDL	<MDL	11.22	11.16	31.45	23.58	30.80	15.76
Zn	µg/L	44.65	45.34	39.01	37.74	36.28	28.73	36.40	35.65
As	µg/L	0.99	0.62	21.47	18.69	287.71	280.59	261.84	17.48
Se	µg/L	<MDL	<MDL	476.84	501.54	697.24	630.30	523.39	185.80
Mo	µg/L	73.29	73.75	117.43	122.34	161.40	157.23	146.18	122.88
Cd	µg/L	<MDL	<MDL	<MDL	0.42	0.60	0.57	0.46	0.44
Sb	µg/L	<MDL	<MDL	4.42	4.59	15.06	14.47	12.10	2.50
Tl	µg/L	2.35	2.45	0.77	0.88	<MDL	<MDL	<MDL	<MDL
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL

Table 33. Batch 3 fly ash leaching data for sample B22-1 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample B22-1					
		B22-1-43	**B22-1-34**	**B22-1-24**	**B22-1-8**	**B22-1-33**	**B22-1-33D**
pH		8.17	8.93	10.24	11.31	12.25	12.22
Ca	mg/L	11865	11025	7497	1806	178.50	171.15
Mg	mg/L	2289.00	33.08	<MDL	<MDL	<MDL	<MDL
Na	mg/L	446.25	329.70	270.90	205.80	184.80	179.55
K	mg/L	48.51	33.50	27.83	21.74	19.95	19.74
Sr	mg/L	214.20	198.45	169.05	98.60	32.55	32.55
Si	mg/L	1.13	<MDL	<MDL	<MDL	1.21	1.24
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	5.68	26.67	29.19	28.25
B	mg/L	5.07	13.44	9.29	<MDL	<MDL	<MDL
Ba	mg/L	2.42	10.20	23.63	38.96	10.02	10.00
F^-	mg/L	3.73	6.44	0.52	3.26	5.47	6.27
Cl^-	mg/L	<MDL	<MDL	1	1.39	2.18	2.60
SO_4^-	mg/L	1086	907.22	225.31	6.06	9.28	7.89
Br	mg/L	1205	1151	1144	1003	926.92	898.77
V	µg/L	23.60	12.81	11.40	4.28	5.08	5.25
Cr	µg/L	205.00	113.44	67.01	28.50	9.72	9.79
Mn	µg/L	1.62	1.07	<MDL	<MDL	<MDL	<MDL
Co	µg/L	30.45	17.77	10.31	2.58	<MDL	<MDL
Ni	µg/L	657.95	401.12	231.76	56.97	<MDL	<MDL
Cu	µg/L	12.81	5.06	3.93	2.35	<MDL	<MDL
Zn	µg/L	68.31	29.99	<MDL	<MDL	23.69	22.13
As	µg/L	7.96	5.02	1.93	0.69	<MDL	<MDL
Se	µg/L	692.20	122.64	<MDL	<MDL	<MDL	<MDL
Mo	µg/L	706.38	365.09	209.29	67.39	46.24	45.23
Cd	µg/L	3.15	1.76	0.90	<MDL	<MDL	<MDL
Sb	µg/L	4.10	2.77	<MDL	<MDL	<MDL	<MDL
Tl	µg/L	6.97	3.51	3.42	4.07	3.42	3.40
Pb	µg/L	<MDL	0.46	<MDL	<MDL	<MDL	<MDL

Table 34. Batch 3 fly ash leaching data for sample B22-2 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample B22-2							
		B22-2-35	**B22-2-31**	**B22-2-15**	**B22-2-11**	**B22-2-8**	**B22-2-5**	**B22-2-33**	**B22-2-33D**
pH		7.05	7.92	8.82	9.85	10.75	11.84	12.46	12.43
Ca	mg/L	8589	1775	3675	2478	976.50	46.73	19.22	18.59
Mg	mg/L	2195	1974	265.65	6.98	<MDL	<MDL	<MDL	<MDL
Na	mg/L	2741	2888	2594	2615	2615	2615	2741	2783
K	mg/L	14.60	17.85	7.85	7.00	6.03	6.05	6.44	6.55
Sr	mg/L	126.00	117.60	64.05	44.73	30.03	0.22	2.53	2.63
Si	mg/L	15.75	3.85	1.74	1.41	1.24	4.44	11.13	10.38
Fe	mg/L	0.50	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	0.47	<MDL	<MDL	0.97	24.57	119.70	304.50	311.85
B	mg/L	18.59	15.02	16.59	15.44	9.09	<MDL	<MDL	<MDL
Ba	mg/L	0.55	0.28	0.51	0.22	<MDL	<MDL	<MDL	<MDL
F^-	mg/L	1.58	4.86	6.01	7.63	2.04	5.87	14.72	14.63
Cl^-	mg/L	15.08	17.19	16.81	16.12	15.62	15.84	15.69	16.55
SO_4^-	mg/L	1403	1261	1784	1777	1430	1347	2539	2479
Br	mg/L	989.46	1038.23	917.98	861.09	851.38	817.41	831.31	834.61
V	µg/L	15.06	7.52	20.66	49.71	38.64	172.43	694.39	693.00
Cr	µg/L	37.40	56.93	75.33	141.77	257.86	401.42	429.83	429.26
Mn	µg/L	1079	284.55	3.74	22.39	1.07	0.84	1.91	0.84
Co	µg/L	120.04	23.98	4.73	3.51	1.53	0.38	0.42	0.27
Ni	µg/L	703.02	235.68	97.27	65.56	25.12	2.42	1.85	1.58
Cu	µg/L	50.13	36.77	32.72	40.32	31.04	28.96	30.32	29.02
Zn	µg/L	35.30	37.78	33.05	90.99	35.45	33.75	44.71	43.45
As	µg/L	3.28	3.99	3.59	3.51	3.21	8.27	90.03	88.28
Se	µg/L	251.81	331.65	352.21	390.33	383.33	317.04	912.18	898.28
Mo	µg/L	191.79	232.39	258.34	255.74	263.00	283.19	228.02	226.49
Cd	µg/L	3.17	1.24	0.88	1.05	0.02	0.76	0.74	0.59
Sb	µg/L	4.73	3.00	3.57	3.55	0.99	2.75	6.36	6.38
Tl	µg/L	4.26	2.29	2.84	2.63	2.18	1.32	1.13	1.13
Pb	µg/L	8.99	1.28	0.78	5.88	0.88	0.90	2.12	1.49

Table 35. Batch 3 fly ash leaching data for sample B22-3 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample B22-3						
		B22-3-41	**B22-3-20**	**B22-3-39**	**B22-3-13**	**B22-3-9**	**B22-3-33**	**B22-3-33D**
pH		7.12	8.67	9.68	10.66	11.67	12.60	12.66
Ca	mg/L	7571	2132	2174	741.30	114.45	7.46	8.96
Mg	mg/L	2237	324.45	<MDL	<MDL	<MDL	<MDL	<MDL
Na	mg/L	6258	6458	6248	6447	6731	6185	6584
K	mg/L	18.27	26.36	9.92	17.22	26.04	9.47	19.85
Sr	mg/L	126.00	38.85	48.20	20.27	6.28	0.97	1.00
Si	mg/L	13.34	<MDL	1.07	<MDL	<MDL	27.30	30.77
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	12.50	68.46	340.20	532.35	547.05
B	mg/L	16.38	13.23	15.54	10.82	21.11	18.90	20.16
Ba	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
F^-	mg/L	3.08	5.29	5.75	1.63	7.75	19.53	20.42
Cl	mg/L	11.02	9.79	11.13	11.27	11.31	16.94	16.98
SO_4^-	mg/L	1506	2590	2469	5135	6021	6349	6416
Br	mg/L	1917	1543	1450	1382	1399	1285	1297
V	µg/L	13.44	19.43	28.77	28.77	71.21	1937	1925
Cr	µg/L	35.64	53.40	114.93	114.93	158.78	469.06	474.29
Mn	µg/L	781.14	20.62	1.47	1.47	0.69	0.99	1.64
Co	µg/L	105.15	3.42	4.81	4.81	1.22	<MDL	<MDL
Ni	µg/L	582.27	68.40	106.45	106.45	21.25	<MDL	<MDL
Cu	µg/L	218.02	82.07	104.66	104.66	78.67	71.34	73.29
Zn	µg/L	35.51	29.80	25.62	25.62	31.06	34.82	36.60
As	µg/L	3.53	3.32	1.39	1.39	6.20	677.84	685.08
Se	µg/L	302.78	513.28	307.10	307.10	837.02	1599	1637
Mo	µg/L	158.15	295.87	273.06	273.06	304.12	318.65	319.47
Cd	µg/L	2.23	1.03	2.00	2.00	0.88	0.78	0.82
Sb	µg/L	5.48	3.80	4.37	4.37	1.13	19.76	19.32
Tl	µg/L	3.26	2.25	1.70	1.70	1.32	<MDL	<MDL
Pb	µg/L	5.12	1.55	0.21	0.21	<MDL	0.99	1.26

Table 36. Batch 3 fly ash leaching data for sample B22-4 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample B22-4						
		B22-4-34	**B22-4-23**	**B22-4-18**	**B22-4-14**	**B22-4-9**	**B22-4-33**	**B22-4-33D**
pH		7.34	8.55	9.46	10.57	11.66	12.63	12.63
Ca	mg/L	6122	2877	2163	1313	71.82	12.18	9.82
Mg	mg/L	1995	790.65	23.94	<MDL	<MDL	<MDL	<MDL
Na	mg/L	6447	6342	6342	6258	6531	6206	6143
K	mg/L	24.26	15.02	10.41	9.49	9.00	8.56	8.28
Sr	mg/L	99.65	53.97	47.15	31.19	6.98	0.83	0.78
Si	mg/L	2.17	0.55	<MDL	<MDL	0.74	31.40	30.03
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	3.27	40.95	260.40	490.35	478.80
B	mg/L	17.85	16.78	15.65	14.91	15.96	20.79	20.90
Ba	mg/L	1.34	0.89	1.15	0.23	0.24	0.43	0.32
F^-	mg/L	1.43	4.56	8.57	1.86	6.80	19.34	17.22
Cl^-	mg/L	11.59	12.85	13.44	9.96	9.74	15.12	14.87
SO_4^-	mg/L	1685	2192	2398	3673	4624	5182	5346
Br	mg/L	2026	1786	1652	1551	1517	1449	1402
V	µg/L	5.75	12.71	18.75	18.75	44.69	1994	2006
Cr	µg/L	31.19	66.78	92.36	92.36	141.69	448.35	473.95
Mn	µg/L	484.47	7.01	0.63	0.63	<MDL	2.18	0.71
Co	µg/L	69.41	5.46	3.84	3.84	2.33	<MDL	<MDL
Ni	µg/L	444.93	136.16	92.97	92.97	56.34	<MDL	<MDL
Cu	µg/L	89.48	90.93	87.65	87.65	84.23	72.51	73.96
Zn	µg/L	56.60	51.16	51.18	51.18	56.76	63.71	59.20
As	µg/L	0.78	1.20	0.95	0.95	1.30	675.42	725.21
Se	µg/L	<MDL	<MDL	<MDL	172.45	1159	1380	1894
Mo	µg/L	171.02	277.47	314.08	314.08	326.55	319.98	328.19
Cd	µg/L	1.45	1.79	1.81	1.81	1.55	1.41	1.47
Sb	µg/L	3.74	3.68	3.36	3.36	0.95	20.33	20.98
Ba	µg/L	1336	893.87	1154	228.23	235.54	426.57	323.06
Tl	µg/L	2.37	2.54	1.95	1.95	1.76	0.71	0.67
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	2.18	1.43

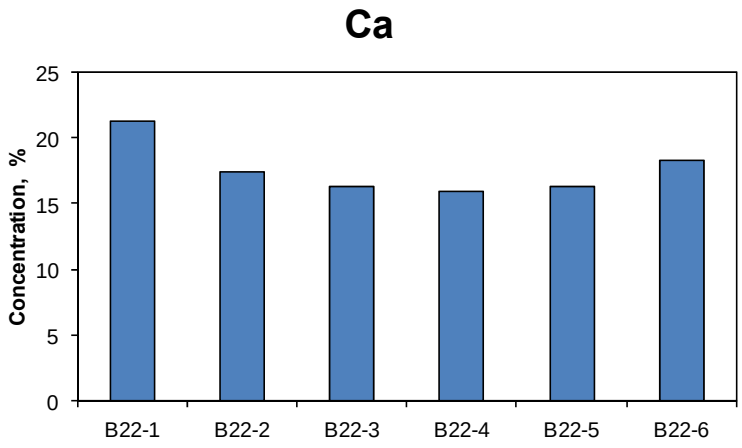
Table 37. Batch 3 fly ash leaching data for sample B22-5 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample B22-5						
		B22-5-34	**B22-5-24**	**B22-5-20**	**B22-5-13**	**B22-5-12**	**B22-5-33**	**B22-5-33D**
pH		7.57	8.63	9.35	10.70	11.47	12.66	12.66
Ca	mg/L	5229	2426	1712	490.35	164.85	10.48	10.46
Mg	mg/L	2006	507.15	30.56	<MDL	<MDL	<MDL	<MDL
Na	mg/L	7854	7917	7560	7088	7277	7077	7256
K	mg/L	25.83	23.31	22.89	23.52	23.52	21.11	21.32
Sr	mg/L	88.94	47.15	39.80	20.37	12.08	0.79	0.79
Si	mg/L	8.05	2.27	0.12	0.82	3.53	34.34	34.86
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	2.18	69.72	106.05	611.10	605.85
B	mg/L	17.01	17.12	16.38	12.81	9.15	24.68	24.57
Ba	mg/L	1.81	1.02	1.21	0.71	0.53	0.23	0.24
F^-	mg/L	3.33	7.43	9.70	0.52	1.48	20.64	20.02
Cl	mg/L	22.29	18.87	19.21	19.14	19.51	26.42	25.64
SO_4^-	mg/L	1671	2145	2533	6187	5883	7311	7793
Br	mg/L	6562	6080	5992	6002	6034	6290	5824
V	µg/L	14.93	16.97	20.92	75.77	152.71	1603	1546
Cr	µg/L	36.71	62.35	82.59	82.59	165.42	395.98	379.72
Mn	µg/L	287.28	7.08	0.61	0.61	0.55	1.74	1.45
Co	µg/L	41.79	4.35	2.79	2.79	0.92	0.53	0.23
Ni	µg/L	266.64	93.95	50.42	50.42	13.71	<MDL	<MDL
Cu	µg/L	94.94	95.34	93.47	93.47	84.06	75.16	70.90
Zn	µg/L	48.51	40.66	36.39	36.39	46.43	54.60	51.77
As	µg/L	4.16	2.81	1.28	1.28	6.03	618.05	610.18
Se	µg/L	<MDL	116.61	277.56	649.57	784.83	1550	1443
Mo	µg/L	182.68	257.94	279.89	279.89	274.74	286.42	282.72
Cd	µg/L	1.24	1.20	1.41	1.41	1.13	1.11	0.97
Sb	µg/L	3.82	3.34	3.53	3.53	<MDL	18.21	17.56
Tl	µg/L	2.18	1.93	1.58	1.58	1.41	<MDL	<MDL
Pb	µg/L	3.32	2.10	1.13	1.51	1.37	2.65	2.71

Table 38. Batch 3 fly ash leaching data for sample B22-6 as a function of pH, 10:1 (draft Method 1313).

Element	Unit	Sample B22-6						
		B22-6-22	B22-6-13	B22-6-6	B22-6-5	B22-6-32	B22-6-26	B22-6-26D
pH		7.37	8.42	9.39	10.58	11.28	12.38	12.28
Ca	mg/L	9797	5523	2132	1743	300.30	17.43	17.12
Mg	mg/L	2678	998.55	28.77	<MDL	<MDL	<MDL	<MDL
Na	mg/L	3402	3266	3213	3171	3318	3150	3224
K	mg/L	39.17	22.79	18.06	17.96	17.33	15.12	14.70
Sr	mg/L	168.00	106.05	46.83	41.06	21.32	3.01	2.96
Si	mg/L	2.51	1.07	<MDL	<MDL	4.38	9.65	9.57
Fe	mg/L	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL	<MDL
Al	mg/L	<MDL	<MDL	<MDL	23.10	12.71	239.40	244.65
B	mg/L	14.39	19.53	19.11	27.51	9.86	5.32	<MDL
Ba	mg/L	2.32	2.50	2.13	1.67	0.91	0.71	0.63
F^-	mg/L	1.95	6.28	6.94	2.64	0.85	5.21	5.33
Cl^-	mg/L	11.76	16.24	6.66	6.63	6.68	6.31	6.40
SO_4^-	mg/L	1152	1160	1444	1531	2595	3992	4027
Br	mg/L	9481	9207	9938	10507	6034	8647	8874
V	µg/L	0.65	6.66	34.19	18.44	64.58	353.81	362.82
Cr	µg/L	25.66	33.37	113.93	146.94	287.28	345.98	348.26
Mn	µg/L	1105	16.02	<MDL	<MDL	<MDL	<MDL	<MDL
Co	µg/L	61.28	8.46	3.26	2.71	0.55	<MDL	<MDL
Ni	µg/L	383.10	160.97	62.98	52.84	8.59	<MDL	<MDL
Cu	µg/L	51.70	43.76	42.97	42.53	39.33	30.18	32.70
Zn	µg/L	40.11	29.32	36.14	36.12	28.37	38.66	41.60
As	µg/L	1.81	3.11	2.02	1.58	3.97	66.68	70.94
Se	µg/L	<MDL	<MDL	69.05	120.77	445.24	577.12	650.73
Mo	µg/L	180.31	284.19	254.84	266.07	300.53	245.32	250.89
Cd	µg/L	1.66	1.45	1.05	1.05	1.28	0.99	1.01
Sb	µg/L	2.84	3.07	3.51	1.47	1.70	3.59	3.74
Tl	µg/L	2.04	1.95	1.05	0.65	<MDL	<MDL	<MDL
Pb	µg/L	<MDL	<MDL	<MDL	<MDL	<MDL	1.24	1.13

Figure 11. Comparison of total composition for selected soluble salts for all batch 3 samples (Acid digestion data).



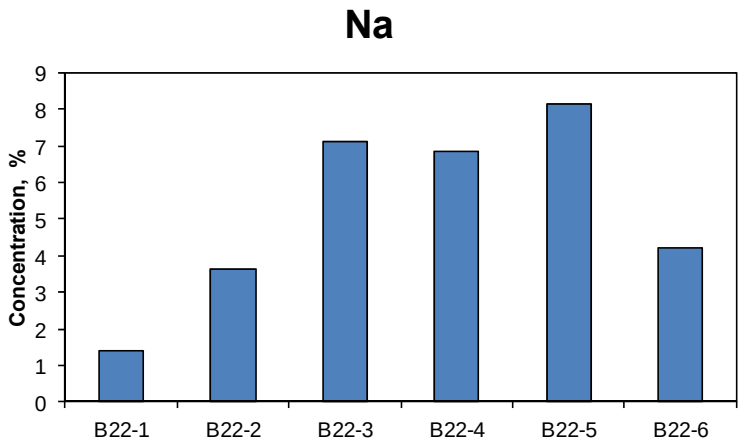


Figure 12. Comparison of total composition for selected trace constituents for all batch 3 samples (Acid digestion data).

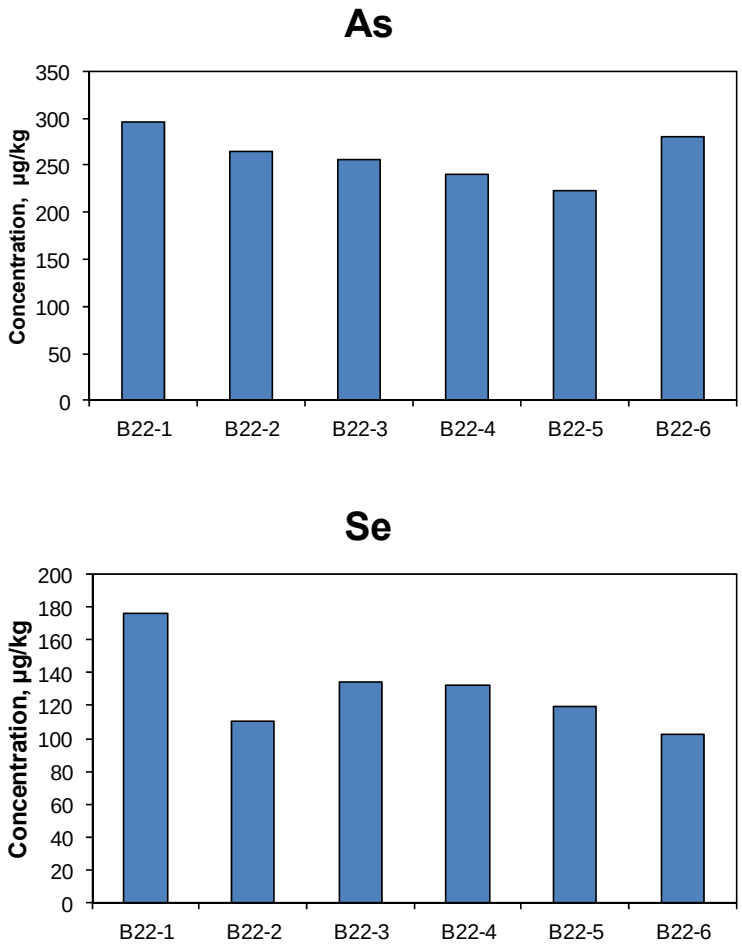


Figure 13. Comparison of leachate concentrations for selected soluble salts for all batch 3 samples using three different leaching ratios at natural pH.

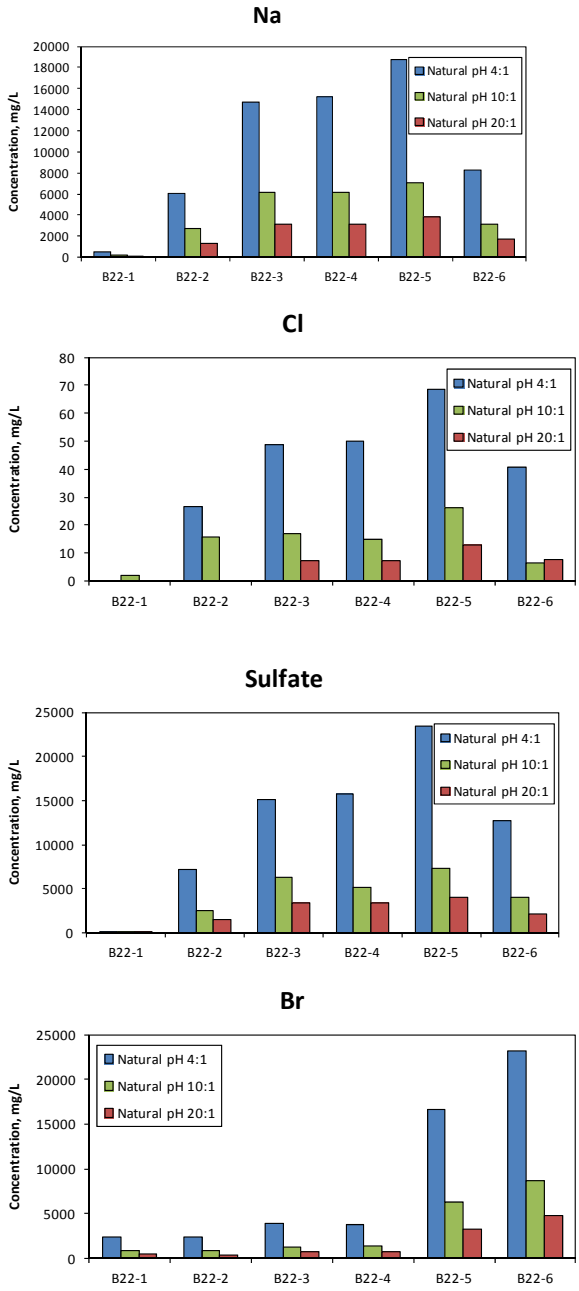


Figure 14. Comparison of leachate concentrations for selected trace constituents for all batch 3 samples using three different leaching ratios at natural pH.

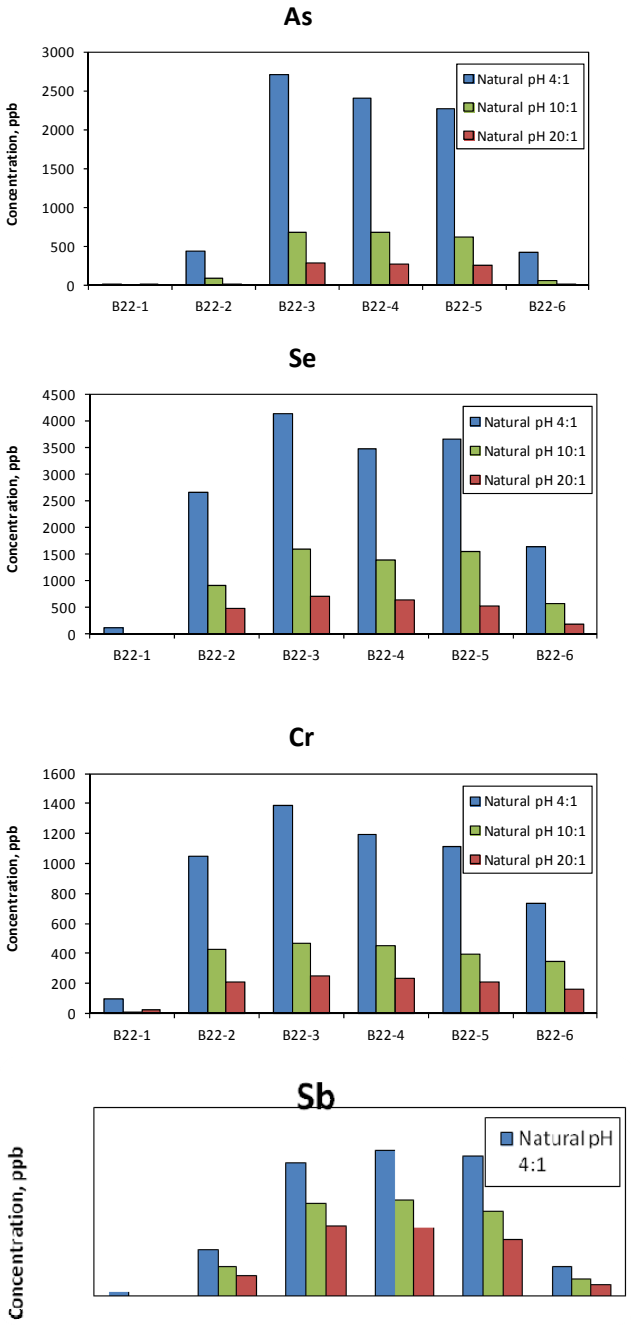
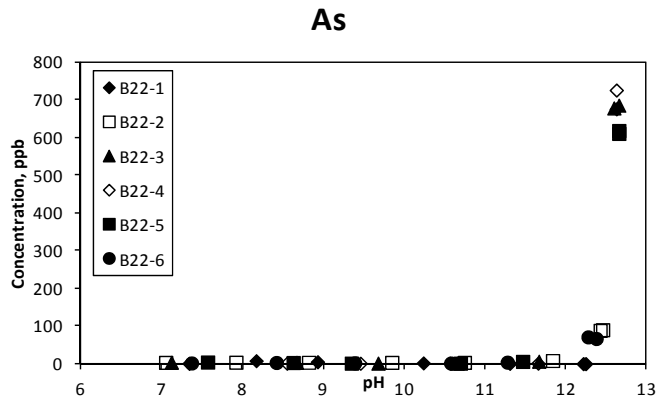
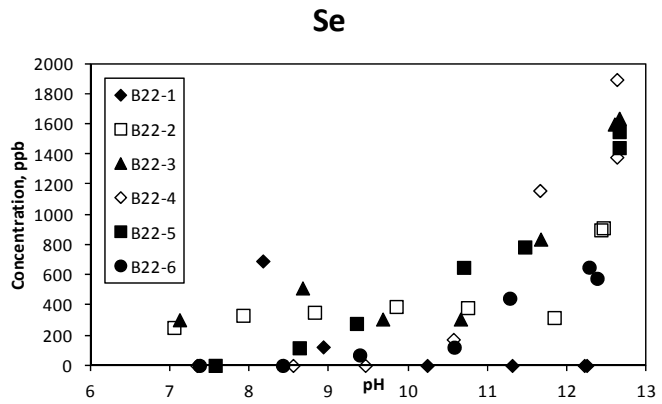


Figure 15a. Batch 3 fly ash leaching versus pH. Group 1.





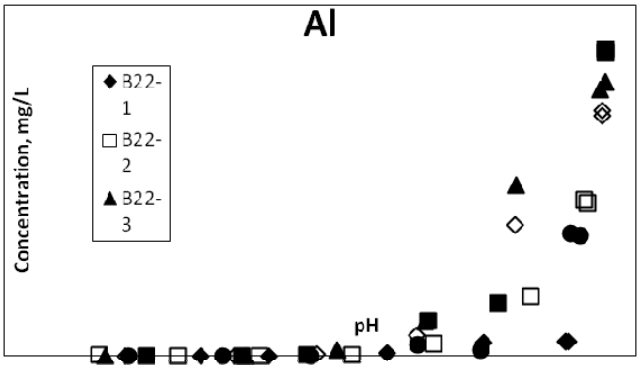


Figure 15b. Batch 3 fly ash leaching versus pH, Group 2.

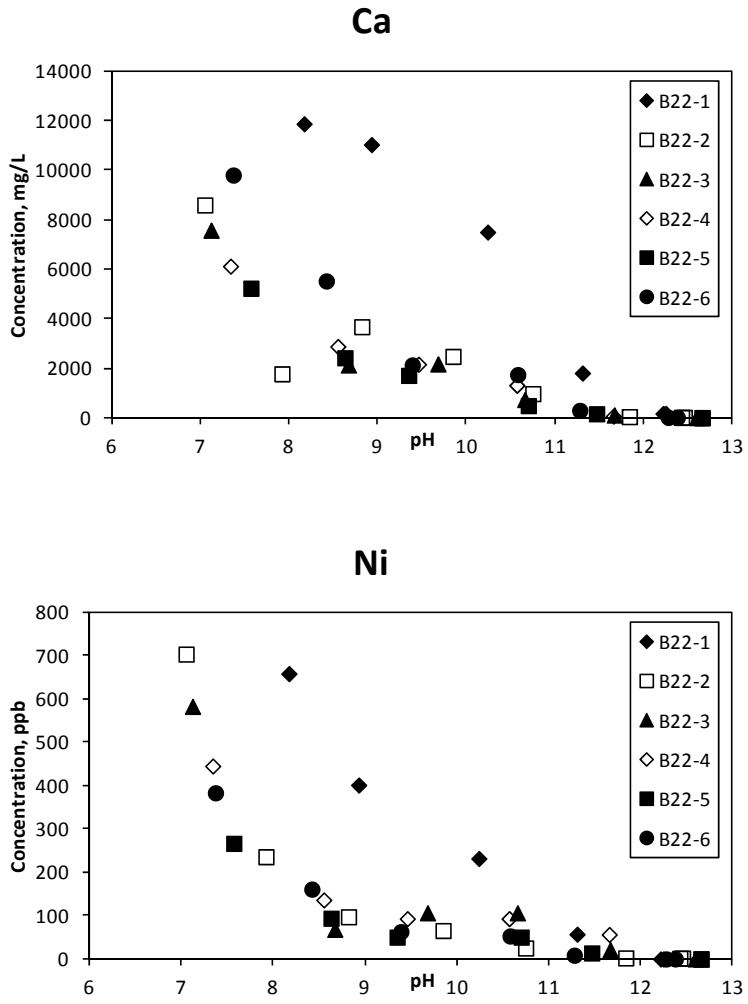


Figure 15c. Batch 3 fly ash leaching versus pH. Group 3.

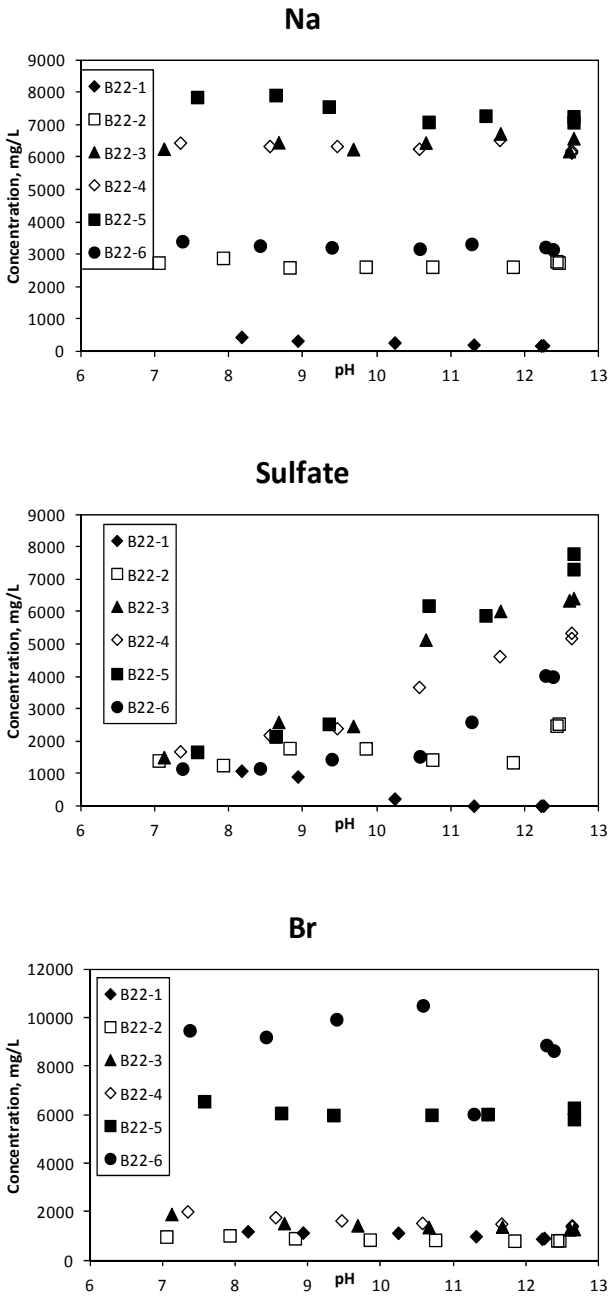
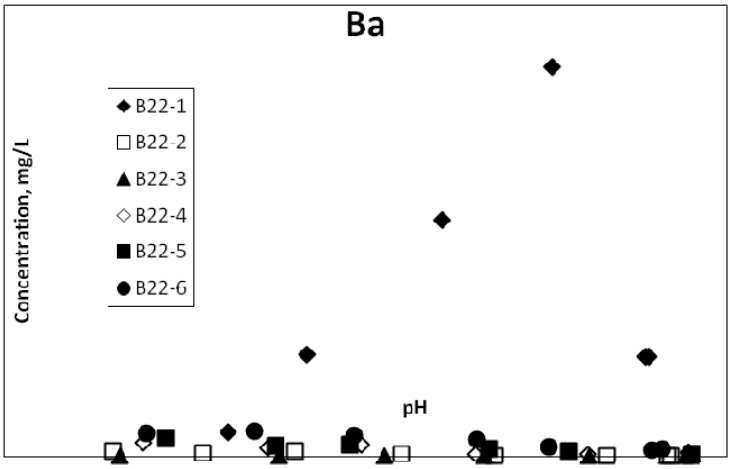
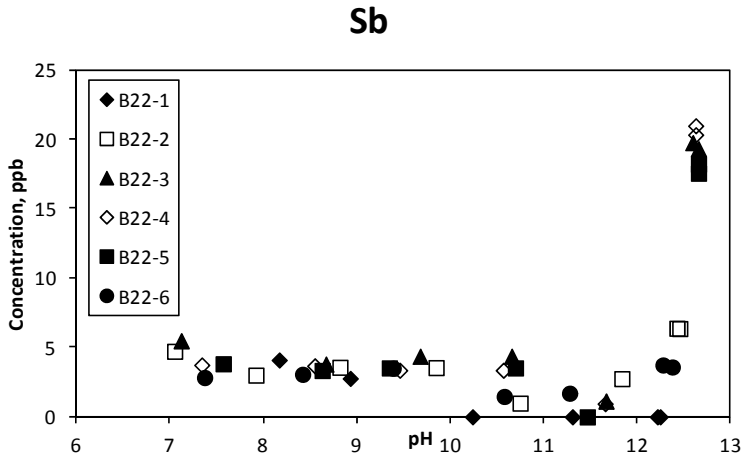


Figure 15d. Batch 3 fly ash leaching versus pH. Group 4.


Ba
B22-1
B22-2
B22-3
B22-4
B22-5
B22-6
Concentration, mg/L
pH


Sb
B22-1
B22-2
B22-3
B22-4
B22-5
B22-6
Concentration, ppb
pH
0
5
10
15
20
25
6
7
8
9
10
11
12
13