CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

CNWRA
CONTROLLED
COPY 642

ISSUED TO Kuang-Tsan Kenneth Chiang K.T. Chiang

Brian K. Deeby - BKD

Department 20

Returned September 24, 2004

Table of Contents	Page
Initial Scientific Notebook Entry	5
Solubility of Boric Acid in Water	6
Test Plan	8
OLI Solubility Calculations	11
Autoclave Setup	17
H_3BO_3 - NaOH Tests	18
0.25 mol $ZnCO_3$ Test	20
0.25 mol $CaCO_3$ Test	24
ICP Test Request Form	26
ICP Sample Analysis Data Sheet	28
Autoclave Tests for 0.25 mol $ZnCO_3$, $CaCO_3$	30
ICP Test Request for Autoclave Test	31
ICP Sample Analysis	33

Table of Contents	Page
Autoclave Setup for 130°C Test	35
ICP Test Request for 0.01 Mol $ZnCO_3$, $CaCO_3$ Test	36
Solution chemistry for 0.01 mol $ZnCO_3$, $CaCO_3$ Test	38
ICP Sample Analysis Data Sheet	39
ICP Work Request for Starting Materials	44
Comparison of AA and ICP Results on Zn contents	46
Comparison of AA and ICP Results on Ca Contents	48
Preliminary ICP Data for Starting Materials	50
Picture of Teflon® cell	55
Solubility Test Using Teflon Cell	56
ICP Work Request for Teflon Cell Tests	57
Preliminary Sample Analysis Datasheet for Teflon Cell Tests	59
Tests Using Electrochemical Cell	63

Table of Contents	Page
Atomic Absorption Results for Ca	70
OLI Simulation Data Using 0.01 mol $ZnCO_3$, $CaCO_3$	71
Total ICP Analysis Work Request	89
$ZnCO_3$ Autoclave Test	91
Preliminary ICP Test Data	92
$CaCO_3$ Autoclave Test	94
Final Report on ICP Analysis Sample Submitted 6/14/04	97
Final Report Section for RES	111
Institute Quality Assurance Surveillance Report	119
Final Report-ICP Analysis-Sample Submitted 7/2/04	120
Final Report-ICP Analysis-Sample Submitted 7/12, 14, 20/04	142
Final Report-ICP Analysis-Sample Submitted 5/28, 6/2/04	163

Table of Contents | Page

Initial Scientific Notebook Entry for Experimental Validation Tests and Analysis for OLI Systems, Inc. Software Using Borated Water Containing $CaCO_3$ or $ZnCO_3$.

Title: Analysis supporting validation of the OLI System, Inc. Software for borated water.

Test Performed by: Kuang-Tsan Kenneth Chiang, Brian K. Derby

Objective: 1). Determination of solubility of compounds by mixing H_3BO_3, NaOH, and $ZnCO_3$ or $CaCO_3$ in 1,000 mL water; 2). Comparison of OLI Systems, Inc. simulation with experimental results.

Equipment: Thermo Jerrell Ash Inductively Coupled Plasma Spectrometer Model ICAP61 Trace Analyzer, Spectro Inductively Coupled Plasma Spectrometer Model FME-05, Perkin-Elmer Model 3100 Atomic Absorption Spectrophotometer.

Measurement Parameters: Temperature of solution for 25, 60, 90 and 130°C. Identify and quantify all metallic and non-metallic elements in aqueous solution using inductively coupled plasma (ICP) Emission Spectrophotometry. Verify ICP results for Zn and Ca concentration using atomic absorption (AA) Spectrophotometry.

Required Level of Accuracy: Temperature of solution ±2°C.
ICP analysis: 2.5×10^{-6} mol (0.1 ppm) for Ca, and 1.5×10^{-6} mol (0.01 ppm) for Zn. AA analysis: 5.0×10^{-6} mol (0.2 ppm) for Ca, and 7.6×10^{-7} mol (0.05 ppm) for Zn.

Uncertainty and Source of Error: For ICP analysis, precision is provided through analysis of duplicated specimens. Accuracy is also determined through analysis of sample spikes. Known amounts of NIST traceable analyte standards are added to a portion test sample. This is then processed through the same dilution/digestion and analysis as the samples. For AA analysis, five absorbency measurements are recorded for each sample, and the average values are reported.

Data Transferred from Lietai Yang

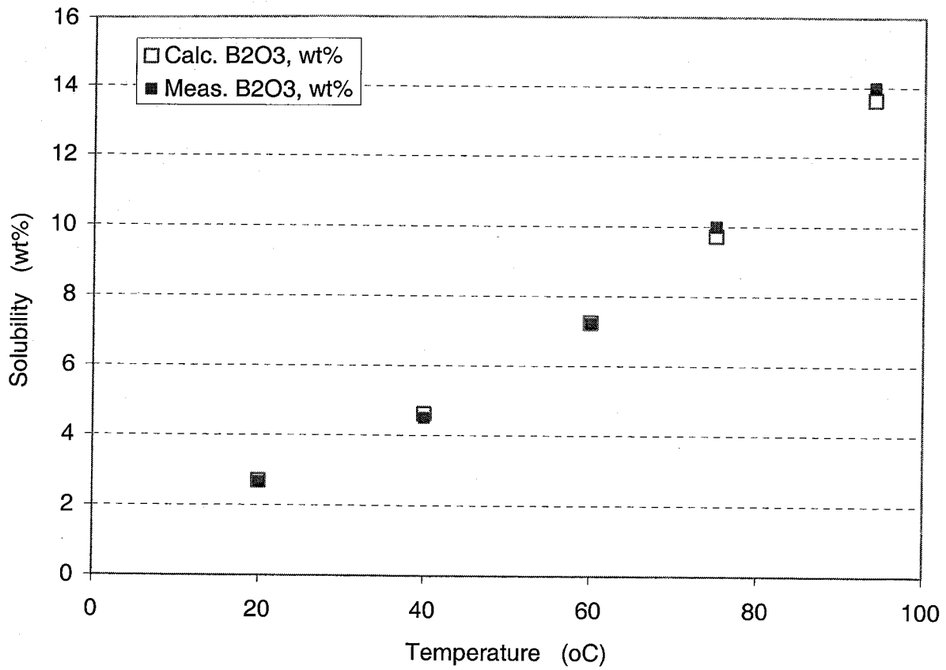


Figure 1. Solubility of Boric Acid [$B(OH)_3$] in Water

Table 1. Speciation in Liquid and Solid phases at the solubility of Boric Acid at 1 atm pressure (molal)

Stream	20	20	40	40	60	60	75	75	94	94
Phase	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid
pH	3.63		3.32		3.04		2.85		2.62	
B(OH)3	8.13E-01	1	1.45E+00	1	2.38E+00	1	3.37E+00	1	5.16E+00	1
OHION	3.01E-11		6.19E-11		1.08E-10		1.48E-10		1.95E-10	
B3O3OH4ION	2.34E-04		4.84E-04		9.21E-04		1.45E-03		2.54E-03	
B4O5OH4ION	7.99E-09		6.30E-09		6.18E-09		6.90E-09		9.11E-09	
BOH4ION	1.83E-06		2.40E-06		2.93E-06		3.24E-06		3.50E-06	
HION	2.37E-04		4.92E-04		9.36E-04		1.47E-03		2.58E-03	
B2OOH5ION	1.96E-06		5.48E-06		1.24E-05		2.07E-05		3.66E-05	
Ionic Strength	2.37E-04		4.92E-04		9.36E-04		1.47E-03		2.58E-03	

K. T. Chang 4/29/04

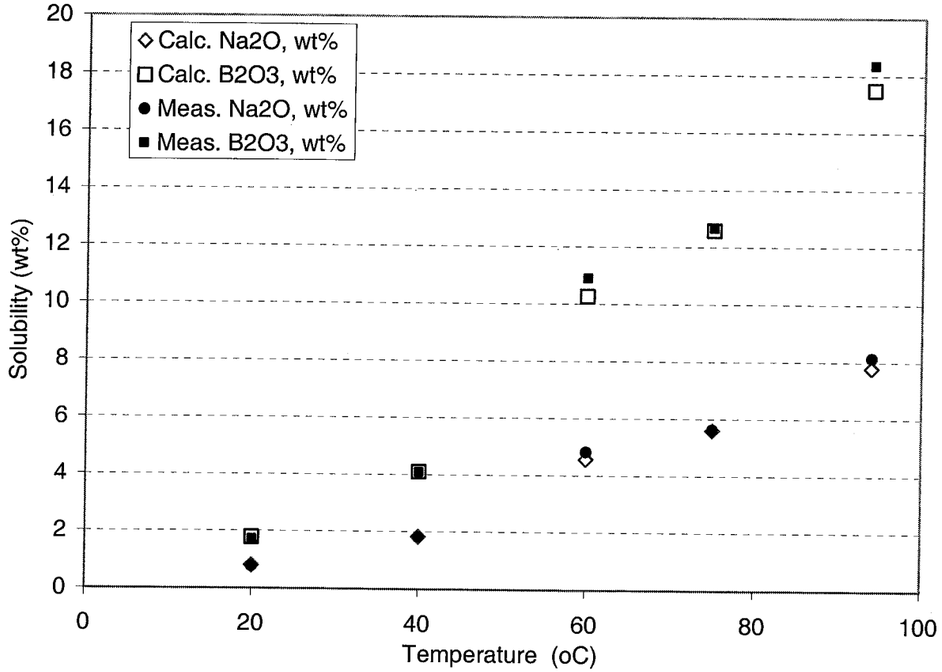


Figure 2. Solubility of Borax [$Na_2B_4O_7$] in Water

Table 2. Speciation in Liquid and Solid phases at the solubility of Borax at 1 atm pressure (molal)

Temp (oC)	20	20	40	40	60	60	75	75	94	94
Phase	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid	Aqueous	Solid
pH	9.30		9.16		9.08		9.01		8.95	
B(OH)3	4.35E-02		7.03E-02		9.35E-02		1.07E-01		1.14E-01	
NABOH4	4.92E-03		1.85E-02		6.88E-02		1.02E-01		1.69E-01	
OHION	1.89E-05		6.20E-05		1.70E-04		3.16E-04		6.27E-04	
B3O3OH4ION	2.71E-02		8.05E-02		2.08E-01		2.81E-01		3.97E-01	
B4O5OH4ION	8.13E-02		1.95E-01		6.20E-01		7.85E-01		1.29E+00	
BOH4ION	6.56E-02		1.32E-01		2.32E-01		2.86E-01		3.41E-01	
HION	7.37E-10		1.12E-09		1.55E-09		1.86E-09		2.19E-09	
NAION	2.59E-01		6.20E-01		1.74E+00		2.24E+00		3.50E+00	
B2OOH5ION	4.13E-03		1.75E-02		5.96E-02		1.01E-01		1.81E-01	
NA2B4O7.10H2O		1		1						
NA2B4O7.4H2O						1		1		1
Ionic Strength	0.34		0.81		2.36		3.02		4.79	

K. T. Chang 4/29/04

Kuang-Tsan Ken Chiang

From: Vijay Jain [vjain@cnwra.swri.edu]
Sent: Thursday, April 29, 2004 8:20 AM
To: gcragno@swri.edu; vjain@swri.edu; 'Lietai Yang'; 'Ken Chiang'; 'Gustavo Cragnolino'; 'Roberto Pabalan'
Subject: RE: Videocon/validation

However, NaOH is used after LOCA to adjust the pH to around 10.

Vijay -----Original Message-----
From: Gustavo Cragnolino [mailto:gcragno@swri.edu]
Sent: Thursday, April 29, 2004 8:17 AM
To: vjain@swri.edu; 'Lietai Yang'; 'Ken Chiang'; 'Gustavo Cragnolino'; 'Roberto Pabalan'
Subject: RE: Videocon/validation

I suggest to add LiOH instead of NaOH because it's the alkali used in PWRs.

-----Original Message-----
From: Vijay Jain [mailto:vjain@cnwra.swri.edu]
Sent: Thursday, April 29, 2004 8:06 AM
To: Lietai Yang; Ken Chiang; Gustavo Cragnolino; Roberto Pabalan
Subject: Videocon/validation

A videocon with NRC is planned for May 10 at 1:30 PM to 3:30 PM to present our data to NRC staff. Please make sure you all are available for the meeting.
Second, after discussions with Al, we should conduct two set of experiments for validation.
1) at 60 C
2) above 100 C in autoclave

I would suggest the following combination

Boric acid (H3BO3) with NaOH to adjust the pH. (pH 8 and 10) at 60 C and 130 C

Boric acid (H3BO3) with Zinc, NaOH added to adjust the pH at 10 at 60 and 130 C.

Lietai, can you estimate what would be the best concentration for H3BO3 to use. Also, in your validation can you please check how CRC handbook number matches with your data. If we need to order Zn powder please do so promptly.

Vijay

K.T. Chiang 4/29/04

Planed test

1 kg pure water

solubility for H_3BO_3 @ 20°C 0.812817 mole

60°C 2.38394 mole

94°C 5.16171 mole

Test 1, 60°C test max. solubility for H_3BO_3

Add NaOH to reach pH 8 record NaOH wt

pH 10 NaOH wt

Test 2 60°C test 1/10 max solubility of H_3BO_3 moles

Add Zn until precipitate, record max. solubility of Zn

Add NaOH to reach pH 10 record NaOH wt.

See Next Pg. #10 for Conditions

5/6/04

Test #1

Solubility of H_3BO_3 @ 60°C with 2.38 M solution = 147.1554g

Measured 1000 m/s of DI water with Graduated Cylinder
Heated DI water To 60.4°C pH of DI = 5.98
Used Thermometer sn# C98-106 cal 3/16/04 Due 3/10/05
Used pH Meter Orion EA920 sn# 7064A cal 7/15/03 Due 7/15/04
pH probe # 13-620-296 sn# 2291257 P6

Solution was At Temperature Added 147.16g H_3BO_3 Lot # C20H17
To Solution pH went To 2.37

Adjusted pH To 8.12 with NaOH 28.824g Lot # 033972
then Adjusted pH To 10.06 used A Total Volume
of 62.115g NaOH To Do pH Adjustments

Test #2

measured 1000mls DI water with Graduated Cylinder
Heated DI water To 60.2°C pH of DI = 6.18
Used thermometer sn# C98-106 cal 3/10/04 Due 3/10/04
Used pH Meter Orion EA920 sn# 7064A cal 7/15/03 Due 7/15/04
pH probe # 13-620-296 sn# 2291257 P6
Added 14.718g H_3BO_3 To Solution Same Lot # pH went To 6.08
Added 3.339g Zinc Metal Lot# 028036 Small Amount of Precipitates
out of Solution - then Added 9.174g NaOH Lot# 033972
End pH = 10.27

5/6/04

Data transferred from Li-tai Yang

Inputs	1	2	3
B(OH)3	3.38394	2.38394	2.38394
NAOH	0	1.553	0.7206
Zn	0	0	0

Stream	20	20	20	60
Phase	Aqueous	Solid	Aqueous	Aqueous
Temperatu	20	20	60	60
Pressure, ε	1	1	1	1
pH	3.63221	2.57038	3.04466	6.79081
Total mol/h	56.32179	2.57038	57.89561	57.52306
Flow Units	molality	molality	molality	molality
H2O	55.50868		55.50868	55.50868
H2			6.12E-28	
O2			3.06E-28	
NABOH4				3.23E-04
BOH3	0.81282	1	2.383892	0.643744
ZNOH2				
OHION	3.01E-11		1.08E-10	5.82E-08
B3O3OH4I	2.34E-04		9.21E-04	0.291887
B4O5OH4I	7.99E-09		6.19E-09	0.045044
BOH4ION	1.82E-06		2.93E-06	0.003085
HION	2.37E-04		9.36E-04	2.37E-07
NAION				0.388041
B2OOH5IC	1.96E-06		1.24E-05	0.002981
ZNION				
ZNOH3ION				
ZNOH4ION				
ZNOHION				
NA2B4O7				
NAB5O8				
ZNEL				
NAOH				
NABO2				
NA2B4O7.				
NA2B4O7.				

Stream	20	20	20	60
Phase	Aqueous	Solid	Aqueous	Solid
Temperatu	20	20	60	60
Pressure, ε	1	1	1	1
pH	7.47129		11.6332	10.0373
Total mol/h	59.26902	0.163935	55.82694	0.394729
Flow Units	molality	molality	molality	molality
H2O	55.50868		55.50868	55.50868
H2	5.72E-28			5.32E-28
O2	2.86E-28			2.66E-28
NABOH4	0.004068		0.112586	0.162876
BOH3	0.489464		0.001804	0.028642
ZNOH2				
OHION	4.22E-06		0.003902	0.001537
B3O3OH4I	0.451977		5.39E-04	0.046726
B4O5OH4I	0.093386		0.020724	0.319623
BOH4ION	0.02608		0.61838	0.608338
HION	5.39E-08		3.47E-12	1.59E-10
NAION	0.692517		0.666106	1.340266
B2OOH5IC	0.027685		0.001837	0.044422
ZNION				
ZNOH3ION				
ZNOH4ION				
ZNOHION				
NA2B4O7				
NAB5O8				
ZNEL				
NAOH				
NABO2				
NA2B4O7.		1		1
NA2B4O7.				

K. T. Chuang 5/20/04

(2)

NA2B4O7.				
NAB5O8.5				
NABO2.0.5				
NABO2.2H				
NABO2.4H				
NAOH.1H2				
NAH2BO3				
Total g/hr	1050.3	158.932	1147.57	61.6572
Volume, L/	1.03327		1.1135	
Enthalpy, c	-4.01E+06	-6.74E+05	-4.37E+06	-2.61E+05
Density, g/l	1016.48		1030.6	
Vapor fract				
Solid fracti		1		1
Organic fra				
Osmotic Pr	0.011149		0.047369	
Redox Pot,	0.602432		0.618428	
E-Con, 1/ol	8.69E-05		5.14E-04	
E-Con, cm:	0.026544		0.169228	
Abs Visc, c	1.00207		0.466576	
Rel Visc	1.00005		1.00014	
Ionic Stren	2.37E-04		9.36E-04	

NA2B4O7.				
NAB5O8.5				
NABO2.0.5				
NABO2.2H				
NABO2.4H				
NAOH.1H2				
NAH2BO3				
Total g/hr	1113.7	62.5199	1176.22	
Volume, L/	1.03946	0.036508	1.07699	
Enthalpy, c	-4.26E+06	-2.48E+05	-4.46E+06	
Density, g/l	1071.42	1712.48	1092.13	
Vapor fract				
Solid fracti		1		
Organic fra				
Osmotic Pr	0.124061		1.16863	
Redox Pot,	0.418707		0.325819	
E-Con, 1/ol	0.026185		0.087349	
E-Con, cm:	8.76731		168.996	
Abs Visc, c	1.03883		0.495977	
Rel Visc	1.03674		1.06317	
Ionic Stren	0.433086		0.785903	

NA2B4O7.			
NAB5O8.5			
NABO2.0.5			
NABO2.2H			
NABO2.4H			
NAOH.1H2			
NAH2BO3			
Total g/hr	1058.98	150.537	1209.51
Volume, L/	0.989396	0.087906	1.07
Enthalpy, c	-4.02E+06	-5.96E+05	-4.56E+06
Density, g/l	1070.33	1712.48	1130.39
Vapor fract			
Solid fracti		1	
Organic fra			
Osmotic Pr	27.5355		27.3199
Redox Pot,	0.137213		0.156356
E-Con, 1/ol	0.044586		0.137849
E-Con, cm:	11.205		127.343
Abs Visc, c	1.06388		0.522823
Rel Visc	1.06174		1.12072
Ionic Stren	0.686829		1.65989

K. T. Chang 5/20/04

(3)

Solubility= 0.003927

0.238

0.238

0.1

Stream	20	60
Phase	Aqueous	Aqueous
Temperatu	20	60
Pressure, a	1	1
pH	4.41152	4.46819
Total mol/h	55.74607	55.74598
Flow Units	molality	molality
H2O	55.50868	55.50868
H2		6.12E-28
O2		3.06E-28
NABOH4		
BOH3	0.237893	0.237918
ZNOH2		
OHION	1.79E-10	2.78E-09
B3O3OH4I	3.49E-05	2.36E-05
B4O5OH4I	2.04E-09	3.83E-10
BOH4ION	3.18E-06	7.52E-06
HION	3.91E-05	3.43E-05
NAION		
B2OOH5IC	1.00E-06	3.18E-06
ZNION		
ZNOH3ION		
ZNOH4ION		
ZNOHION		
NA2B4O7		
NAB5O8		
ZNEL		
NAOH		
NABO2		
NA2B4O7.		
NA2B4O7..		

Stream	20	20	20	60	60	60
Phase	Aqueous	Solid	Vapor	Aqueous	Solid	Vapor
Temperatu	20	20	20	60	60	60
Pressure, a	1	1	1	1	1	1
pH	7.34494			6.79821		
Total mol/h	55.57333	0.089309	0.101573	55.53067	0.096074	0.123875
Flow Units	molality	molality	molality	molality	molality	molality
H2O	55.50868		0.023208	55.50868		0.197429
H2	7.86E-04		0.976792	5.83E-04		0.802572
O2						
NABOH4						
BOH3	0.182302			0.222107		
ZNOH2	6.83E-06	1		1.50E-05	1	
OHION	1.80E-07			6.57E-07		
B3O3OH4I	0.016156			0.004575		
B4O5OH4I	0.001043			2.05E-05		
BOH4ION	0.002492			0.001672		
HION	5.37E-08			1.78E-07		
NAION						
B2OOH5IC	6.03E-04			6.60E-04		
ZNION	0.010625			0.003023		
ZNOH3ION	1.18E-09			1.10E-08		
ZNOH4ION	4.33E-15			6.67E-14		
ZNOHION	8.77E-05			9.04E-04		
NA2B4O7						
NAB5O8						
ZNEL						
NAOH						
NABO2						
NA2B4O7.						
NA2B4O7..						

Stream	20
Phase	Aqueous
Temperatu	20
Pressure, a	1
pH	7.34539
Total mol/h	55.67227
Flow Units	molality
H2O	55.50868
H2	7.86E-04
O2	
NABOH4	
BOH3	0.182056
ZNOH2	6.83E-06
OHION	1.80E-07
B3O3OH4I	0.016103
B4O5OH4I	0.001039
BOH4ION	0.002491
HION	5.36E-08
NAION	
B2OOH5IC	6.02E-04
ZNION	0.010593
ZNOH3ION	1.18E-09
ZNOH4ION	4.33E-15
ZNOHION	8.76E-05
NA2B4O7	
NAB5O8	
ZNEL	
NAOH	
NABO2	
NA2B4O7.	
NA2B4O7..	

K. T. Chang 5/20/04

④

NA2B4O7.			NA2B4O7.							NA2B4O7.		
NAB5O8.5			NAB5O8.5							NAB5O8.5		
NABO2.0.5			NABO2.0.5							NABO2.0.5		
NABO2.2H			NABO2.2H							NABO2.2H		
NABO2.4H			NABO2.4H							NABO2.4H		
NAOH.1H2			NAOH.1H2							NAOH.1H2		
NAH2BO3			NAH2BO3							NAH2BO3		
Total g/hr	1014.71	1014.71	Total g/hr	1012.13	8.87777	0.24248	1011.06	9.55016	0.641015	Total g/hr	1013.91	
Volume, L/	1.01107	1.02662	Volume, L/	1.00602		2.44512	1.02204		3.38675	Volume, L/	1.00781	
Enthalpy, c	-3.86E+06	-3.82E+06	Enthalpy, c	-3.85E+06	-13520.5	-139.725	-3.80E+06	-14475.4	-1382.66	Enthalpy, c	-3.85E+06	
Density, g/l	1003.6	988.404	Density, g/l	1006.07		0.099169	989.254		0.189271	Density, g/l	1006.06	
Vapor fract			Vapor fract			1			1	Vapor fract		
Solid fracti			Solid fracti		1			1		Solid fracti		
Organic fra			Organic fra							Organic fra		
Osmotic Pr	0.001862	0.001829	Osmotic Pr	7.23E-06			3.26E-05			Osmotic Pr	7.23E-06	
Redox Pot,	0.557102	0.524327	Redox Pot,	-0.430292			-0.422275			Redox Pot,	-0.430319	
E-Con, 1/ol	1.46E-05	2.06E-05	E-Con, 1/ol	0.001771			0.00128			E-Con, 1/ol	0.001766	
E-Con, cm:	0.062227	0.088731	E-Con, cm:	5.27179			2.98787			E-Con, cm:	6.15841	
Abs Visc, c	1.00204	0.466517	Abs Visc, c	1.00784			0.467609			Abs Visc, c	1.00783	
Rel Visc	1.00002	1.00002	Rel Visc	1.00581			1.00236			Rel Visc	1.0058	
Ionic Stren	3.91E-05	3.43E-05	Ionic Stren	0.033006			0.009993			Ionic Stren	0.032905	

K.T. Chang 4/29/04

⑤

Solubility= 0.003922

0.238

0.05106

	20	20	60	60	60
Solid	Vapor	Aqueous	Solid	Vapor	
	20	20	60	60	60
	1	1	1	1	1
			6.79882		
0.040382	0.051469	55.64059	0.047138	0.062895	
molality	molality	molality	molality	molality	
	0.023208	55.50868		0.197428	
	0.976792	5.83E-04		0.802572	
		0.221697			
	1	1.50E-05	1		
		6.58E-07			
		0.004555			
		2.04E-05			
		0.001671			
		1.78E-07			
		6.59E-04			
		0.003012			
		1.10E-08			
		6.68E-14			
		9.02E-04			

Solubility= 6.15E-05

0.238

0.05106

Stream	20	20	20	60	60	60
Phase	Aqueous	Solid	Vapor	Aqueous	Solid	Vapor
Temperatu	20	20	20	60	60	60
Pressure, a	1	1	1	1	1	1
pH	11.0241			10.3108		
Total mol/h	55.86447	0.051047	0.051475	55.85061	0.050999	0.062801
Flow Units	molality	molality	molality	molality	molality	molality
H2O	55.50868		0.023049	55.50868		0.196061
H2	7.73E-04		0.976951	5.73E-04		0.803939
O2						
NABOH4	0.01501			0.015056		
BOH3	0.002742			0.006667		
ZNOH2	6.71E-06		1	1.47E-05	1	
OHION	9.53E-04			0.002639		
B3O3OH4I	3.40E-04			5.76E-04		
B4O5OH4I	0.002868			6.05E-04		
BOH4ION	0.206501			0.20724		
HION	1.29E-11			6.86E-11		
NAION	0.214353			0.214389		
B2OOH5IC	8.17E-04			0.002676		
ZNION	1.01E-09			8.95E-10		
ZNOH3ION	6.51E-06			4.46E-05		
ZNOH4ION	1.99E-07			1.97E-06		
ZNOHION	2.24E-08			3.71E-07		
NA2B4O7						
NAB5O8						
ZNEL						
NAOH						
NABO2						
NA2B4O7.						
NA2B4O7.						

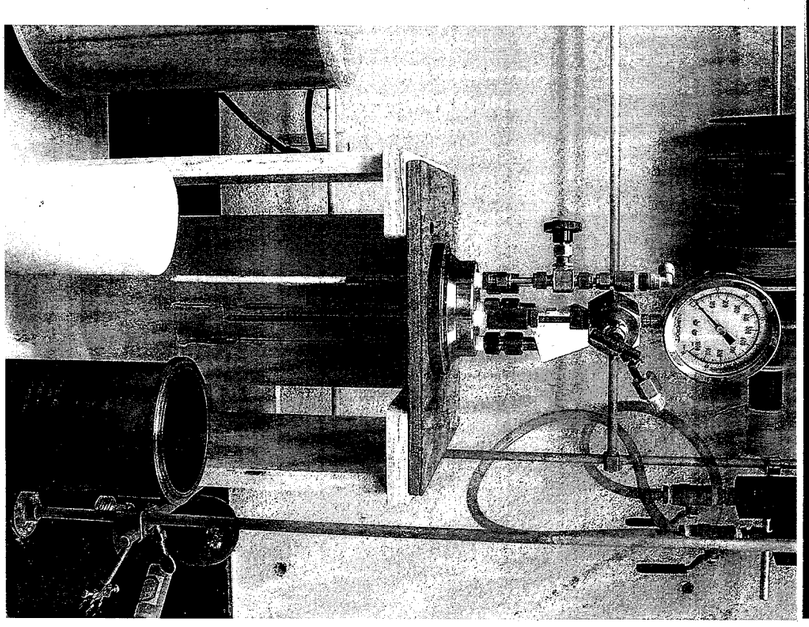
K.T. Chang 4/29/04

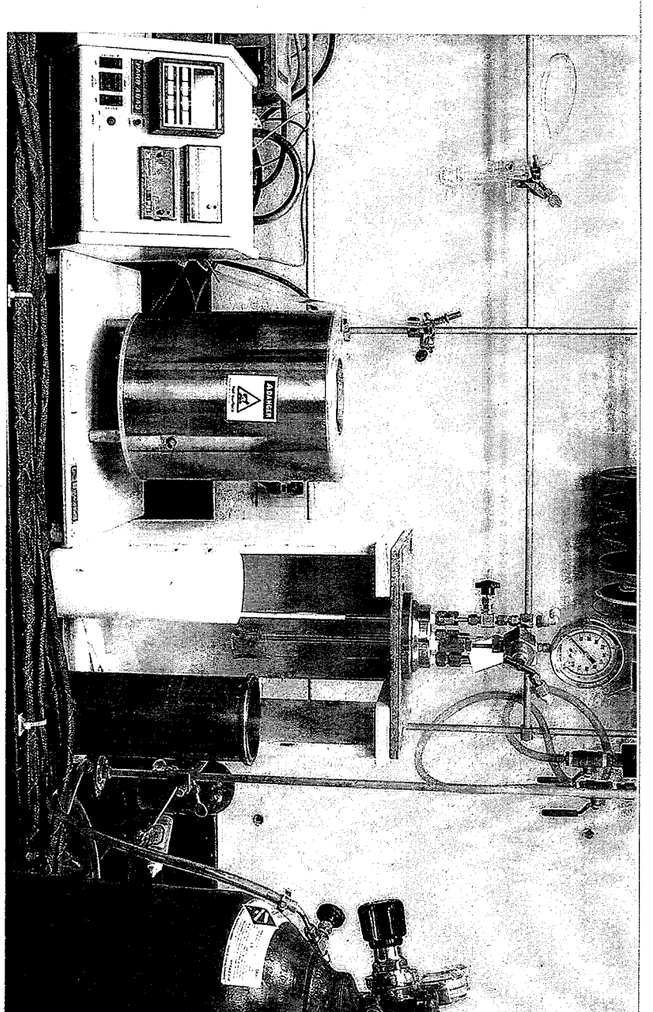
⑥

					NA2B4O7..					
					NAB5O8.5					
					NABO2.0.5					
					NABO2.2H					
					NABO2.4H					
					NAOH.1H2					
					NAH2BO3					
4.0142	0.122869	1013.04	4.68571	0.325461	Total g/hr	1022.01	5.07427	0.122753	1021.82	5.06949	0.323601
	1.23899	1.02406		1.71955	Volume, L/	1.00221		1.23913	1.01796		1.71699
-6113.49	-70.8011	-3.81E+06	-7102.23	-702.014	Enthalpy, c	-3.88E+06	-7727.94	-70.3385	-3.84E+06	-7683.94	-696.005
	0.099169	989.241		0.189271	Density, g/l	1019.76		0.099064	1003.79		0.18847
	1			1	Vapor fract			1			1
1			1		Solid fracti		1			1	
					Organic fra						
		3.26E-05			Osmotic Pr	9.16329			10.3917		
		-0.422315			Redox Pot,	-0.644299			-0.654496		
		0.001276			E-Con, 1/o	0.016526			0.034425		
		3.84326			E-Con, cm	31.9704			105.833		
		0.467606			Abs Visc, c	1.02334			0.476489		
		1.00235			Rel Visc	1.02128			1.02139		
		0.009959			Ionic Stren	0.217221			0.214997		

K.T. Cluing 4/29/04

Component for Auto clave test





K.T. Cluing 4/29/04

Kuang-Tsan Ken Chiang

From: Vijay Jain [vjain@cnwra.swri.edu]
Sent: Friday, May 14, 2004 8:33 AM
To: Ken Chiang
Cc: Lietai Yang
Subject: FW: Validation Plan

I would suggest that we do the following
1) 2,800 ppm B, 0.17 M NaOH, at RT, 60 and 90 C
2) 2,800 ppm B, 0.17 M NaOH, with Zn(OH)2 or ZnCO3 at RT, 60 and 90 C
3) 2,800 ppm B, 0.17 M NaOH, with CaCO3 at RT, 60 and 90 C
4) Speciation of components in one or two solutions. Speciation could be done using Raman or NMR.
5) two autoclave tests.

Measure solubility (or speciation).

Lietai, please provide simulation data for these to Ken for preparing adequate molar concentartions.

Vijay

-----Original Message-----
From: Aladar Csontos [mailto:AAC@nrc.gov]
Sent: Monday, May 10, 2004 10:25 AM
To: vjain@cnwra.swri.edu
Cc: Lietai Yang
Subject: Validation Plan

Hi Vijay,

Here's the proposed validation plan. Please let me know if you don't like anything. Also, do you have a rough cost and time estimate for each benchtop test? I don't want to ask you to do anymore than you guys can handle.

Thanks,
Al

All Tests A= 25°C B= 60°C C= 90°C D= 130°C 7/13/04

2800 ppm H_3BO_3 = 0.259 m = 16.01 g/L

0.17 m NaOH = 6.80 g/L

pH meter Orion EA 940 SN# 2330
cal 7/15/03 Due 7/15/04

pH probe 13-620-296 SN# 4079126 P17 5/25/04

Zinc Carbonate Fisher ≥ 30-500 125.38 Cat # 026003

Cl 0.002%

Fe 0.001%

Pb 0.002%

NO_3 < 0.02%

Boric acid 99.5 % min Cat # C 20 H17

H_3BO_3 61.83

Sodium Hydroxide NaOH Cat # 633572

98.5%

Amonium Hydroxide 0.02%

Cl 0.001%

Heavy metal 0.01%

Fe 0.0003 Mg 0.1 ppm

Ni 0.0001%

N 0.0009%

PO_4 0.0009%

K 0.004%

Na_2CO_3 0.3%

SO_4 0.003%

Test #1 See Matrix pg # 18

#1 H_3BO_3 = 16.030 g/L
$NaOH$ = 6.822 g/L
+ 1000 mls DI
pH: 9.627
Temp = 25°C
Thermometer = C96-816
Cal 12/22/04 Due 7/22/04

#2 H_3BO_3 = 16.021 g/L
$NaOH$ = 6.824 g/L
+ 1000 mls DI
pH = 9.604
Temp = 60°C
Thermometer = H98-149
Cal 12/22/04 Due 7/22/04

#3 H_3BO_3 = 16.617 g/L
$NaOH$ = 6.817 g/L
+ 1000 mls.
Temp = 90°C
Thermometer E98-191
Cal 12/22/04 Due 7/22/04
5/25/04

Zinc Carbonate
Precipitated Powder
Certified

Quantity	Packaging	Cat. No.	Price
500g	Amber Glass	Z30-500	Ea./154.31
			Cs. of 6/712.91

Carbonic Acid Zinc Salt
CAS Reg. 3486-35-9
Color Index No. 77950

ChemAlert® Storage Code: GRAY

Product Specifications
Actual Lot Analysis is reported on label.

Chloride	≤0.003%
Nitrate	≤0.02%
Sulfate	≤0.01%
Lead	≤0.005%
Iron	≤0.002%
Substances Not Precipitated by Ammonium Sulfide (as SO_4)	≤0.40%

1.800.766.7000 **www.fishersci.com** **265C**

Test #2 from Matrix on pg #18

2300 ppm H_3BO_3 Lot# C 20H17 0.259 M = 16.01 g/L

0.17 M NaOH Lot# 033972 = 6.80 g/L

0.25 M $ZnCO_3$ Lot# 026003 = 31.345 g/L

Solution #1

H_3BO_3 = 16.041 g/L

NaOH = 6.826 g/L

$ZnCO_3$ = 31.37 g/L

1000 mls DI water

Temp = 25°C

Thermometer = C96-816

cal 12/22/04 Due 7/22/04

pH @ 25°C was 9.584

pH meter Orion EA940 SN# 2330

cal 7/15/03 Due 7/15/04

pH probe 13-620-296 SN# 4079126 P17

5/25/04

Solution #2

H_3BO_3 = 16.031 g/L

NaOH = 6.817 g/L

$ZnCO_3$ = 31.38 g/L

1000 mls DI water

Temp = 60°C

Thermometer H98-149

cal 12/22/04 Due 7/22/04

pH @ 54°C was 9.636 (See pg #20 for pH Meter and pH probe)

Solution #3

H_3BO_3 = 16.025 g/L

NaOH = 6.828 g/L

$ZnCO_3$ = 31.35 g/L

1000 mls DI water

Temp = 90°C

Thermometer = E 98-191

cal 12/22/04 Due 7/22/04

Solution #4

H_3BO_3 = 16.032 g/L

NaOH = 6.818 g/L

$ZnCO_3$ = 31.35 g/L

1000 mls DI water

Temp = 130°C * Achieves only 108°C In glass will Reco In Autoclave

Thermometer - C98-106

cal 3/10/04 Due 3/10/05

5/25/04

Test # 3 from Matrix on pg #18

2800 ppm H_3BO_3 Lot # C20H17 0.259 m = 16.01 g/L

0.17 m NaOH Lot # 033972 = 6.80 g/L

0.25 m $CaCl_2$ Lot # 025254 = 36.755 g/L

Solution #1

H_3BO_3 = 16.032 g/L

NaOH = 6.804 g/L

$CaCl_2$ = 36.760 g/L

1000 mls DI water

Temp = 25°C

Thermometer SN# C96-816

Cal: 12/22/04 Due 7/22/04

pH @ 25°C was 8.654

pH Meter Orion EA940 SN# 2330 Cal 7/15/03 Due 7/15/04

pH Probe Fisher 13-620-296 SN# 4079126 P17

Solution #2

H_3BO_3 = 16.043

NaOH = 6.824

$CaCl_2$ = 36.763

1000 mls DI water

Temp = 60°C Thermometer H98-149 Cal 12/22/04 Due 7/22/04

pH = 8.601 (Same pH Meter And probe As Above)

5/26/04

Solution #3

H_3BO_3 = 16.035 g/L

NaOH = 6.822 g/L

$CaCl_2$ = 36.761 g/L

1000 mls DI water

Temp = 90°C

Thermometer SN# E98-191 12/22/04 7/22/04

Solution #4

H_3BO_3 = 16.037 g/L

NaOH = 6.823 g/L

$CaCl_2$ = 36.767 g/L

1000 mls DI water

Temp = 130°C * only Achieved 112°C In glass Vessel will Redo In Autoclave

Thermometer SN# C98-106 Cal 3/10/04 Due 3/10/05

** Note: Needed To Use $CaCO_3$ Instead of $CaCl_2$ will Redo All Test #3 Conditions And Submit All Samples for ICP Analysis for - Sodium, Boron, Zinc, Calcium chlorine, Iron, Lead, Nitrate, Nickel, Potassium

5/26/04

Redone Test #3 from Matrix on pg #18

2800 ppm H_3BO_3 Lot# C20H17 : 0.259 m = 16.01 g/L

0.17 m NaOH Lot# 033972 : 6.80 g/L

0.25 m $CaCO_3$ Lot 975703 : 25.02 g/L

Solution #1

H_3BO_3 = 16.034 g/L

NaOH = 6.811 g/L

$CaCO_3$ = 25.037 g/L

1000 mls DI water

Temp = 25°C thermometer SN# C96-816 cal 12/22/04 Due 7/22/05

pH = 9.638

Solution #2

H_3BO_3 = 16.022 g/L

NaOH = 6.816 g/L

$CaCO_3$ = 25.034 g/L

1000 mls DI water

Temp = 60°C thermometer M98-149 cal 12/22/04 Due 7/22/04

pH = 9.625

pH Meter Orion EA940 SN# 2330 cal 7/15/03 Due 7/15/04

pH probe Fisher 13-620-296 SN# 4079126 P17

5/27/04

Solution #3

H_3BO_3 = 16.018 g/L

NaOH = 6.819 g/L

$CaCO_3$ = 25.029 g/L

1000 mls DI water

Temp = 90°C

Thermometer E 98-191 cal 12/22/04 7/22/04

Solution #4

H_3BO_3 = 16.021 g/L

NaOH = 6.817 g/L

$CaCO_3$ = 25.031 g/L

1000 mls DI water

Temp = 130°C

Thermometer C98-106 cal 3/10/04 Due 3/10/05

* Only Achieved 104°C In glass Vessel will Be Redone In Autoclave

Submitted Solution Samples for ICP Analysis for

Sodium, Boron, Zinc, Calcium, Chlorine, Iron

Lead, Nitrate, Nickel And Potassium

5/27/04

FORM FOR REQUESTING WORK FROM OTHER DIVISIONS

A. TO BE COMPLETED BY DIVISION 20 PERSONNEL

Requester: Ken Chiang Request Date: 5/28/04
Project No.: 20.06002.01.081 Phone No.: x 2308
Description of Work Requested:

ICP Analysis for Sodium - Boron - Zinc - Calcium - chloride
Iron - Lead - Nitrate - Nickel - Potassium

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

***QUALITY REQUIREMENTS:** The work requested is governed by the CNWRA Quality Assurance Program which addresses requirements of 10CFR50, Appendix B. Personnel performing this work shall be qualified under the CNWRA QA program or equivalently under the SwRI Nuclear QA program. Test and analysis methods shall be documented by approved procedures or recognized, standard methods. Measuring and test equipment shall be calibrated and controlled according to CNWRA and SwRI Nuclear QA program requirements.*

Sample Identification		Description
1A	H_3BO_3 - $NaOH$ solution	2C H_3BO_3 - $NaOH$ - $ZnCO_3$
1B	" "	2D " "
1C	" "	3A H_3BO_3 - $NaOH$ - $CaCO_3$
2A	H_3BO_3 - $NaOH$ - $ZnCO_3$	3B "
2B	" "	3C " "
		3D " "

B. TO BE COMPLETED BY DIVISION PERFORMING WORK[1]

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

Person Assigned: Signature:
Division: Date:

Make, Model & Serial No. of Equipment Used (*attach list if necessary*):

Software Used (If any):

Standards Used (If any):

Photographic Negative Numbers (If Applicable):

[1] Please sign and date any hardcopy of analysis or list of photographs (The photographs themselves need not be signed). If error occurred during entry, do not erase or overwrite, but strikeout with single line, initial and date, and then reenter correct information.

A = 25°C B = 60°C C = 90°C

Results on pg #28, #29 And #34

5/28/04

SAMPLE LIST/CHAIN OF CUSTODY
Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Requested Turnaround: ☐ 2 Weeks ☐ 3 Weeks ☐ Other:
SwRI Contact: Ken Chiang x2308
Client: Ken Chiang CNWRA Div 20 x 2308
Shipper Name/ Address:
Client Purchase Order/Other ID:
Site/Zone ID:
SwRI Project#: 20.06002.01.081
Therm #:
Temp:
Comments:

Analyses Requested: ICP Analysis for Sodium - Boron - Zinc - Calcium - chloride - Iron - Lead - Nitrate - Nickel - Potassium
* See additional sheet

REMARKS
Preservation
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Cool (4°C±2°C)
f = Other (specify)

Sample ID	Matrix Type	Sample Type	# of Containers	Sample Collection Date (mm/dd/yy)	Sample Collection Time
1A	L		1	5/27/04	2:00
1B	L		1		
1C	L		1		
2A	L		1		
2B	L		1		
2C	L		1		
2D	L		1		
3A	L		1		
3B	L		1		
3C & 3D	L		1		

Matrix Types: A – Air; B – Biota; D - Dust; E – Emission/Stack; L - Liquid; P – Product; Sd - Solid; S – Soil; SED – Sediment; T - Tissue; W - Water; WP - Wipe

Sample Types: D - Duplicate; ER – Equipment Rinsate; ES – Environmental Sample; FB – Field Blank; FD – Field Duplicate; MS – Matrix Spike; MSD – Matrix Spike Dup; TB – Trip Blank

	Date	Time
Relinquished by (Print/Signature)	5/27/04	9:30
Received by (Print/Signature) Brian K. Dadey		
Relinquished by (Print/Signature)		
Received by (Print/Signature)		
Relinquished by (Print/Signature)		
Received by (Print/Signature)		
Relinquished by (Print/Signature)		
Samples Disposed by:		

Received by SwRI Lab: (Signature) Date Time
Samples Disposed: Date Time

Page ___ of ___

Div 01 COC Form 01-01-001, Rev 8/02

Results on pg #28, #29 And #34

5/28/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 1A

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245431

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2582	0.20
Calcium	0.220	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	0.012	0.01
Potassium	1.15	0.500
Sodium	3372	0.500
Zinc	<0.010	0.01

B $\frac{2582 \times 10^{-3}}{10.8} = 0.239$

Na $\frac{3372 \times 10^{-3}}{23} = 0.147$

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID: 1A

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245431

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Chloride	<2	<2	0.00%
Nitrate-N	<2	<2	0.00%
Boron	-----	-----	-----
Calcium	-----	-----	-----
Iron	-----	-----	-----
Lead	-----	-----	-----
Nickel	-----	-----	-----
Potassium	-----	-----	-----
Sodium	-----	-----	-----
Zinc	-----	-----	-----

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: 1A

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245431

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Chloride	<2	39.8	40.0	99.5%
Nitrate-N	<2	14.7	18.1	81.2%
Boron	-----	-----	-----	-----
Calcium	-----	-----	-----	-----
Iron	-----	-----	-----	-----
Lead	-----	-----	-----	-----
Nickel	-----	-----	-----	-----
Potassium	-----	-----	-----	-----
Sodium	-----	-----	-----	-----
Zinc	-----	-----	-----	-----

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 1C

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245433

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2589	0.20
Calcium	0.391	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	0.012	0.01
Potassium	1.08	0.500
Sodium	3381	0.500
Zinc	<0.025	0.025

B $\frac{2589 \times 10^{-3}}{10.8} = 0.240$

Na $\frac{3381 \times 10^{-3}}{23} = 0.147$

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: 1B

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245432

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Chloride	-----	-----	-----	-----
Nitrate-N	-----	-----	-----	-----
Boron	2477	2632	4.00	3875%
Calcium	0.539	34.5	40.0	84.9%
Iron	<0.100	1.82	2.00	91.0%
Lead	<0.050	0.893	1.00	89.3%
Nickel	<0.010	0.850	1.00	85.0%
Potassium	0.995	42.5	40.0	104%
Sodium	3248	3484	40.0	590%
Zinc	<0.010	0.990	1.00	99.0%

B $\frac{2477 \times 10^{-3}}{10.8} = 0.229$

Na $\frac{3248 \times 10^{-3}}{23} = 0.141$

Note: The boron spikes are high due to the sample concentrations being greater than 600 times the spike amounts added.

Note: The sodium spikes are high due to the sample concentrations being greater than 80 times the spike amounts added.

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID: 1B

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245432

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Chloride	-----	-----	-----
Nitrate-N	-----	-----	-----
Boron	2477	2548	2.83%
Calcium	0.539	0.498	7.91%
Iron	<0.100	<0.100	0.00%
Lead	<0.050	<0.050	0.00%
Nickel	<0.010	0.011	200%
Potassium	0.995	1.18	17.0%
Sodium	3248	3342	2.85%
Zinc	<0.010	<0.010	0.00%

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 1B

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245432

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2477	0.20
Calcium	0.539	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	0.995	0.500
Sodium	3248	0.500
Zinc	<0.010	0.01

1A
1B
1C

6/22/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 2A

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245434

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2456	0.20
Calcium	0.697	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.19	0.500
Sodium	3329	0.500
Zinc	1081	0.01

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 2B

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245435

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2540	0.20
Calcium	0.715	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.27	0.500
Sodium	3421	0.500
Zinc	653	0.01

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 2C

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245436

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2529	0.20
Calcium	0.717	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.16	0.500
Sodium	3405	0.500
Zinc	408	0.01

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 2D

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245437

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	3020	0.20
Calcium	6.64	0.20
Iron	0.573	0.10
Lead	0.437	0.05
Nickel	0.042	0.01
Potassium	1.53	0.500
Sodium	3965	0.500
Zinc	23660	0.01

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID: 2D

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245437

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Chloride	-----	-----	-----
Nitrate-N	-----	-----	-----
Boron	3020	3196	5.66%
Calcium	6.64	6.52	1.82%
Iron	0.573	0.595	3.77%
Lead	0.437	0.454	3.82%
Nickel	0.042	0.044	4.65%
Potassium	1.53	1.44	6.06%
Sodium	3965	4173	5.11%
Zinc	23660	24904	5.12%

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: 2D

Lab Name: Southwest Research Institute
Client: Division 20
Lab Code: SwRI
Date Received: 05/28/04
Matrix: Liquid
Project No.: 10542.02.002
Task Order: 040601-6
SRR: 25978
Lab System ID: 245437

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Chloride	-----	-----	-----	-----
Nitrate-N	-----	-----	-----	-----
Boron	3020	3106	4.00	2150%
Calcium	6.64	38.9	40.0	80.7%
Iron	0.573	2.37	2.00	89.9%
Lead	0.437	1.29	1.00	85.3%
Nickel	0.042	0.820	1.00	77.8%
Potassium	1.53	41.3	40.0	99.4%
Sodium	3965	4082	40.0	293%
Zinc	23660	24481	1.00	82100%

Note: The boron spikes are high due to the sample concentrations being greater than 600 times the spike amounts added.

Note: The sodium spikes are high due to the sample concentrations being greater than 80 times the spike amounts added.

Note: The zinc spike is out due to the sample concentration being greater than 23000 times the spike amount added.

2A, 2B, 2C, 2D 0.25M $ZnCO_3$

Auto Clave Tests from Matrix on pg #18

Test # 5

Solution # 5 A

H_3BO_3 Lot # C20H17 = 16.034 g/L

NaOH Lot # 033972 = 6.811 g/L

$CuCO_3$ Lot # 975703 = 25.037 g/L

1000 mls DI water

Temp = 130°C

TC # 330 cal 1/22/04 due 7/22/04

Omega H22 thermometer SN# T94140 cal 4/27/04 due 10/27/04

Temp Achieved 134.2°C then pulled sample for ICP Analysis

Solution # 5 B

H_3BO_3 Lot # C20H17 = 16.019 g/L

NaOH Lot # 033972 = 6.816 g/L

$ZnCO_3$ Lot # 026003 = 31.358 g/L

1000 mls DI water

Temp = 130°C

TC # 330 cal 1/22/04 due 7/22/04

Omega H22 thermometer SN# T94140 cal 4/27/04 due 10/27/04

Temp Achieved 132.6°C then pulled sample for ICP Analysis

* Note: Held and maintained temperatures for 45 min to 1 hr. before samples were pulled for ICP.

[signature] 6/2/04

SAMPLE LIST/CHAIN OF CUSTODY
Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Shipper Name/Address:

Client: Ken Chiang CNWRA D.J20 X 2308

Client Purchase Order/Other ID:

Site/Zone ID:

Requested Turnaround: ☐ 2 Weeks ☐ 3 Weeks ☑ Other: Luke Please Thanks

SwRI Contact: Ken Chiang X 2308

REMARKS
Preservation
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Cool (4°C±2°C)
f = Other (specify)

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time	Matrix Type	Sample Type	# of Containers	ICP Analysis	Iron - Sodium	Boron - Zinc	Calcium	Chlorine - Iron Lead - Nitrate	Nickel - Potassium	* see additional sheet							
5 A	6/2/04	1:30pm	L		1	✓													
5 B	↓	↓	↓		1	✓													

Matrix Types: A – Air, B – Biota, D – Dust, E – Emission/Stack, L – Liquid, P – Product, Sd - Solid, S – Soil, SED – Sediment, T - Tissue, W - Water, WP - Wipe

Sample Types: D - Duplicate, ER – Equipment Rinsate, ES – Environmental Sample, FB – Field Blank, FD – Field Duplicate, MS – Matrix Spike, MSD – Matrix Spike Dup, TB – Trip Blank

Temp:
Therm #:
Comments:

	Date	Time
Relinquished by (Print/Signature): Brian K. Derby / [signature]	6/2/04	3:20
Received by (Print/Signature)	Date	Time
Relinquished by (Print/Signature)	Date	Time
Received by (Print/Signature)	Date	Time
Relinquished by (Print/Signature)	Date	Time

SwRI Project#: 20.06002.01.081
Received by SwRI Lab: (Signature)
Date / Time
Samples Disposed: Date / Time
Samples Disposed by:

Div 01 COC Form 01-01-001, Rev 8/02

Page _____ of _____

Results on pg #33

[signature] 6/2/04

FORM FOR REQUESTING WORK FROM OTHER DIVISIONS

A. TO BE COMPLETED BY DIVISION 20 PERSONNEL

Requester: Ken Chiang **Request Date:** 6/2/04
Project No.: 20.06002.9.001 **Phone No.:** x 2306
Description of Work Requested:

ICP Analysis for - Sodium - Boron - Zinc - Calcium
Chloride - Iron - Lead - Nitrate - Nickel - Potassium

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

QUALITY REQUIREMENTS: The work requested is governed by the CNWRA Quality Assurance Program which addresses requirements of 10CFR50, Appendix B. Personnel performing this work shall be qualified under the CNWRA QA program or equivalently under the SwRI Nuclear QA program. Test and analysis methods shall be documented by approved procedures or recognized, standard methods. Measuring and test equipment shall be calibrated and controlled according to CNWRA and SwRI Nuclear QA program requirements.

Sample Identification	Description
5A - H_3BO_3 - NaOH - $CaCO_3$ ✓	
5B - H_3BO_3 - NaOH - $ZnCO_3$ ✓	

B. TO BE COMPLETED BY DIVISION PERFORMING WORK[1]

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

Person Assigned: **Signature:**
Division: **Date:**

Make, Model & Serial No. of Equipment Used (*attach list if necessary*):

Software Used (If any):

Standards Used (If any):

Photographic Negative Numbers (If Applicable):

[1] Please sign and date any hardcopy of analysis or list of photographs (The photographs themselves need not be signed). If error occurred during entry, do not erase or overwrite, but strikeout with single line, initial and date, and then reenter correct information.

130°C
A= ~~25°C~~ RT 6/2/04 B = 130°C this Test only

Results on pg #33

6/2/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5A

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040603-3
Lab System ID: 245613

Client: Division 20
Date Received: 06/02/04
Project No.: 10542.02.002
SRR: 25997

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	38.3	2
Nitrate-N	<2	2
Boron	2658	0.20
Calcium	231	0.20
Iron	0.766	0.10
Lead	<0.050	0.05
Nickel	0.347	0.01
Potassium	1.45	0.500
Sodium	3448	0.500
Zinc	<0.025	0.025

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5B

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040603-3
Lab System ID: 245614

Client: Division 20
Date Received: 06/02/04
Project No.: 10542.02.002
SRR: 25997

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	2.42	2
Nitrate-N	<2	2
Boron	2895	0.20
Calcium	17.1	0.20
Iron	0.170	0.10
Lead	<0.050	0.05
Nickel	0.053	0.01
Potassium	1.47	0.500
Sodium	3757	0.500
Zinc	5.88	0.025

1st autoclave test @ 130°C 5A 0.25 mole $CaCO_3$

5B 0.25 mole $ZnCO_3$

6/22/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 3A

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040601-6
Lab System ID: 245438

Client: Division 20
Date Received: 05/28/04
Project No.: 10542.02.002
SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2387	0.20
Calcium	110	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.29	0.500
Sodium	3067	0.500
Zinc	<0.025	0.025

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 3B

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040601-6
Lab System ID: 245439

Client: Division 20
Date Received: 05/28/04
Project No.: 10542.02.002
SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2586	0.20
Calcium	130	0.20
Iron	0.151	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.40	0.500
Sodium	3373	0.500
Zinc	<0.025	0.025

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 3C

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040601-6
Lab System ID: 245440

Client: Division 20
Date Received: 05/28/04
Project No.: 10542.02.002
SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2780	0.20
Calcium	2516	0.20
Iron	2.11	0.10
Lead	<0.050	0.05
Nickel	0.020	0.01
Potassium	1.44	0.500
Sodium	3649	0.500
Zinc	0.030	0.025

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 3D

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040601-6
Lab System ID: 245441

Client: Division 20
Date Received: 05/28/04
Project No.: 10542.02.002
SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2866	0.20
Calcium	1119	0.20
Iron	8.96	0.10
Lead	<0.050	0.05
Nickel	0.080	0.01
Potassium	2.33	0.500
Sodium	3890	0.500
Zinc	0.162	0.025

3A 0.25M $CaCO_3$

3B

3C

3D

6/22/04

Autoclave set up for High Temperature Test

6/22/04

FORM FOR REQUESTING WORK FROM OTHER DIVISIONS

A. TO BE COMPLETED BY DIVISION 20 PERSONNEL

Requester: Ken Chiang **Request Date:** 6/16/04
Project No.: 20.10542.02.002 **Phone No.:** x 2308
Description of Work Requested:
ICP Analysis for Sodium, Boron, Zinc, Calcium, Chloride, Iron, Lead, Nitrate, Nickel, Potassium

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

QUALITY REQUIREMENTS: *The work requested is governed by the CNWRA Quality Assurance Program which addresses requirements of 10CFR50, Appendix B. Personnel performing this work shall be qualified under the CNWRA QA program or equivalently under the SwRI Nuclear QA program. Test and analysis methods shall be documented by approved procedures or recognized, standard methods. Measuring and test equipment shall be calibrated and controlled according to CNWRA and SwRI Nuclear QA program requirements.*

Sample Identification	Description
4-2 A	H_3BO_3 + NaOH + $ZnCO_3$
4-2 B	↓
4-2 C	↓
4-2 D	↓

Sample Identification	Description
5-2 A	H_3BO_3 + NaOH + $CaCO_3$ Solids
5-2 B	↓
5-2 C	↓
5-2 D	↓

B. TO BE COMPLETED BY DIVISION PERFORMING WORK[1]

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

Person Assigned: _____ **Signature:** _____
Division: _____ **Date:** _____

Make, Model & Serial No. of Equipment Used (*attach list if necessary*): _____

Software Used (If any): _____

Standards Used (If any): _____

Photographic Negative Numbers (If Applicable): _____

[1] Please sign and date any hardcopy of analysis or list of photographs (The photographs themselves need not be signed). If error occurred during entry, do not erase or overwrite, but strikeout with single line, initial and date, and then reenter correct information.

See pg # 38 for Solutions

A = 25°C B = 60°C C = 90°C D = 130°C

6/22/04

Change to 0.01 M Solid of $ZnCO_3$ and $CaCO_3$

SAMPLE LIST/CHAIN OF CUSTODY
Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Requested Turnaround: ☐ 2 Weeks ☐ 3 Weeks ☐ Other: ASAP

Shipper Name/Address:
Client: Ken Chiang Div 20 GWWEA x 2308

Client Purchase Order/ID: Site/Zone ID:
SwRI Contact: Ken Chiang x2308

Analyses Requested: ICP Analysis See Attached Sheet

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time	Matrix Type	Sample Type	# of Containers	ICP Analysis See Attached Sheet
4-2D ZN130	6/16/04	3:40	L		1	✓
4-2C ZN90	6/16/04	3:40	L		1	✓
4-2B ZN60	6/16/04	3:40	L		1	✓
4-2A ZN25	6/16/04	3:40	L		1	✓
					X	
5-2D CaB0	6/16/04	3:40	L		1	✓
5-2C Ca90	6/16/04	3:40	L		1	✓
5-2B Ca60	6/16/04	3:40	L		1	✓
5-2A Ca25	6/16/04	3:40	L		1	✓
			X			

REMARKS
Preservation
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Cool (4°C±2°C)
f = Other (specify)

Matrix Types: A – Air; B – Biota; D - Dust; E – Emission/Stack; L - Liquid; P – Product; Sd - Solid; S – Soil; SED – Sediment; T - Tissue; W - Water; WP - Wipe

Sample Types: D - Duplicate; ER – Equipment Rinsate; ES – Environmental Sample; FB – Field Blank; FD – Field Duplicate; MS – Matrix Spike; MSD – Matrix Spike Dup; TB – Trip Blank

Temp: Therm #:
Comments:

	Date	Time
Relinquished by (Print/Signature): Brian K Drake /	6/16/04	3:51
Received by (Print/Signature):		
Relinquished by (Print/Signature):		
Received by (Print/Signature):		
Relinquished by (Print/Signature):		

SwRI Project#: 20.10542.02.002
Received by SwRI Lab: (Signature)
Date / Time
Samples Disposed: Date / Time
Samples Disposed by:

Div 01 COC Form 01-01-001, Rev 8/02

Page ____ of ____

See pg # 35 for Solutions

6/22/04

Used Teflon Beaker In Various ovens At Temperatures Below
checked All oven Temperatures with
Omega Microprocessor thermometer Model # HH22 sn# T 94140
cal 4/27/04 Due 10/27/04
Thermal couple # 330 cal Jan/22/04 Due 7/22/04

Test #4

0.259 Mole H_3BO_3 = 32.023 g H_3BO_3 Lot# C20H17
0.17 Mole NaOH = 13.622 g NaOH Lot# 033972
0.01 Mole $ZnCO_3$ = 2.511 g $ZnCO_3$ Lot# 626603
+ 2000 mls DI water

$32.023 \times 0.995 / 61.83 \times 2 = 0.2577$ M
$13.622 * 0.995 / 40 = 0.1677$ M

Test #5

0.259 Mole H_3BO_3 = 32.025 g H_3BO_3 Lot# C20H17
0.17 Mole $NaOH$ = 13.625 g $NaOH$ Lot# 033972
0.01 Mole $CaCO_3$ = 2.002 g $CaCO_3$ Lot# 975703
+ 2000 mls DI water

* made solutions on 6/16/04

Used 250 mls of each solution in teflon beakers
At A= 25°C B= 60°C C= 90°C D= 130°C

6/22/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-2A ZN25 ✓ 25°C

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040617-9
Lab System ID: 246146

Client: Division 20
Date Received: 06/16/04
Project No.: 10542.02.002
SRR: 26058

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	2665	0.20
Calcium	0.413	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.37	0.500
Sodium	3465	0.500
Zinc	0.121	0.01
Chloride	<2	2
Nitrate-N	<2	2

$B: \frac{2665 \times 10^{-3}}{10.8} = 0.24676$

$Na: \frac{3465 \times 10^{-3}}{23} = 0.1507$

$Zn \quad \frac{0.121 \times 10^{-3}}{65.4} = 1.85 \times 10^{-6}$

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID: 4-2A ZN25

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040617-9
Lab System ID: 246146

Client: Division 20
Date Received: 06/16/04
Project No.: 10542.02.002
SRR: 26058

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Boron	2665	2668	0.11%
Calcium	0.413	0.410	0.73%
Iron	<0.200	<0.200	0.00%
Lead	<0.030	<0.030	0.00%
Nickel	<0.020	<0.020	0.00%
Potassium	2.37	2.34	1.27%
Sodium	3465	3454	0.32%
Zinc	0.121	0.120	0.83%
Chloride	<2	<2	0.00%
Nitrate-N	<2	<2	0.00%

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: 4-2A ZN25 ✓

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040617-9
Lab System ID: 246146

Client: Division 20
Date Received: 06/16/04
Project No.: 10542.02.002
SRR: 26058

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Boron	2665	2696	NA	NA
Calcium	0.413	38.5	40.0	95.2%
Iron	<0.200	2.02	2.00	101%
Lead	<0.030	0.969	1.00	96.9%
Nickel	<0.020	0.926	1.00	92.6%
Potassium	2.37	53.0	40.0	127%
Sodium	3465	3470	40.0	12.5%
Zinc	0.121	1.10	1.00	97.9%
Chloride	<2	39.5	40.0	98.8%
Nitrate-N	<2	15.1	18.1	83.4%

Note: Boron was not added to the sample matrix spike.

Note: The sodium spikes are low due to the sample concentrations being greater than 85 times the spike amounts added.

7/9/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-2B ZN60 ✓

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040617-9

Lab System ID: 246147

Client: Division 20

Date Received: 06/16/04

Project No.: 10542.02.002

SRR: 26058

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	3101	0.20
Calcium	1.08	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.26	0.500
Sodium	4006	0.500
Zinc	0.390	0.01
Chloride	<2	2
Nitrate-N	<2	2

Zn $\frac{0.39 \times 10^{-3}}{65.4} = 5.96 \times 10^{-6}$

B $\frac{3101 \times 10^{-3}}{10.8} = .287$

Na $\frac{4006 \times 10^{-3}}{23} = .174$

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-2C ZN90

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040617-9

Lab System ID: 246148

Client: Division 20

Date Received: 06/16/04

Project No.: 10542.02.002

SRR: 26058

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	3741	0.20
Calcium	1.76	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.46	0.500
Sodium	4849	0.500
Zinc	1.00	0.01
Chloride	<2	2
Nitrate-N	<2	2

7/9/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-2D ZN130

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040617-9

Lab System ID: 246149

Client: Division 20

Date Received: 06/16/04

Project No.: 10542.02.002

SRR: 26058

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	4239	0.20
Calcium	0.605	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	3.78	0.500
Sodium	5296	0.500
Zinc	3.13	0.01
Chloride	3.15	2
Nitrate-N	<2	2

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-2A Ca25 ✓

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040617-9

Lab System ID: 246150

Client: Division 20

Date Received: 06/16/04

Project No.: 10542.02.002

SRR: 26058

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	2694	0.20
Calcium	32.1	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.34	0.500
Sodium	3456	0.500
Zinc	0.044	0.01
Chloride	2.35	2
Nitrate-N	<2	2

B: $\frac{2694 \times 10^{-3}}{10.8} = .249$ m

Na: $\frac{3456}{23} \times 10^{-3} = 0.150$ m

Ca = $\frac{32.1 \times 10^{-3}}{40.1} = 8.0 \times 10^{-4}$

7/9/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
5-2B Ca60

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040617-9
Lab System ID: 246151

Client: Division 20
Date Received: 06/16/04
Project No.: 10542.02.002
SRR: 26058

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	3159	0.20
Calcium	33.1	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.50	0.500
Sodium	3892	0.500
Zinc	0.080	0.01
Chloride	2.08	2
Nitrate-N	<2	2

$B\ \frac{3159 \times 10^{-3}}{10.8} = .293$

$Na\ \frac{3892 \times 10^{-3}}{23} = .169$

$Ca\ \frac{33.1 \times 10^{-3}}{40.1} = 8.25 \times 10^{-4}$

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
5-2C Ca90

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040617-9
Lab System ID: 246152

Client: Division 20
Date Received: 06/16/04
Project No.: 10542.02.002
SRR: 26058

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	3729	0.20
Calcium	34.3	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	3.36	0.500
Sodium	4843	0.500
Zinc	0.154	0.01
Chloride	2.28	2
Nitrate-N	<2	2

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
5-2D Ca130

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040617-9
Lab System ID: 246153

Client: Division 20
Date Received: 06/16/04
Project No.: 10542.02.002
SRR: 26058

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	4287	0.20
Calcium	25.9	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	4.30	0.500
Sodium	5310	0.500
Zinc	0.244	0.01
Chloride	2.69	2
Nitrate-N	<2	2

FORM FOR REQUESTING WORK FROM OTHER DIVISIONS

A. TO BE COMPLETED BY DIVISION 20 PERSONNEL

Requester: Ken Chiang **Request Date:** 7/2/04
Project No.: 20.10542.02.002 **Phone No.:** x 2308
Description of Work Requested: Total ICP Analysis of Reagents And Solutio-

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

***QUALITY REQUIREMENTS:** The work requested is governed by the CNWRA Quality Assurance Program which addresses requirements of 10CFR50, Appendix B. Personnel performing this work shall be qualified under the CNWRA QA program or equivalently under the SwRI Nuclear QA program. Test and analysis methods shall be documented by approved procedures or recognized, standard methods. Measuring and test equipment shall be calibrated and controlled according to CNWRA and SwRI Nuclear QA program requirements.*

Sample Identification	Description
Calcium Carbonate	Reagent
Zinc Carbonate	Reagent
Sodium Hydroxide	Reagent
Boric Acid	Reagent
4-3 A	Le with these Reagents. 45µm Filtered Aliquot
5-3 A	"

B. TO BE COMPLETED BY DIVISION PERFORMING WORK[1]

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

Person Assigned: _____ **Signature:** _____
Division: _____ **Date:** _____

Make, Model & Serial No. of Equipment Used (*attach list if necessary*): _____

Software Used (If any): _____

Standards Used (If any): _____

Photographic Negative Numbers (If Applicable): _____

[1] Please sign and date any hardcopy of analysis or list of photographs (The photographs themselves need not be signed). If error occurred during entry, do not erase or overwrite, but strikeout with single line, initial and date, and then reenter correct information.

Calcium Carbonate Lot# 975703 Sodium Hydroxide Lot# 033972
Zinc Carbonate Lot# 026003 Boric Acid Lot# C20H17
7/9/04

SAMPLE LIST/CHAIN OF CUSTODY
Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Shipper Name/Address:
Client: Ken Chiang - CNWRA Div20
Client Purchase Order/Other ID:
Site/Zone ID:

Requested Turnaround:
☐ 2 Weeks
☐ 3 Weeks
☒ Other: Ink ASAP thanks

SwRI Contact: Ken Chiang X 2308

Analyses Requested

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time	Matrix Type	Sample Type	# of Containers	Total ICP								
Calcium Carbonate	7/1/04	2:15	Sd		1	✓								
Zinc Carbonate	7/2/04	2:15	Sd		1	✓								
Sodium Hydroxide	7/2/04	2:15	Sd		1	✓								
Boric Acid	7/2/04	2:15	Sd		1	✓								
4-3 A	7/1/04	2:00	L		1	✓								
5-3 A	7/1/04	2:00	L		1	✓								

REMARKS
Preservation
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Cool (4°C±2°C)
f = Other (specify)

Matrix Types:	*Sample Types:*
A – Air	D - Duplicate
B – Biota	ER – Equipment Rinsate
D - Dust	ES – Environmental Sample
E – Emission/Stack	FB – Field Blank
L - Liquid	FD – Field Duplicate
P – Product	MS – Matrix Spike
Sd - Solid	MSD – Matrix Spike Dup
S – Soil	TB – Trip Blank
SED – Sediment	
T - Tissue	
W - Water	
WP - Wipe	
Temp:	Therm #:
Comments:	

	Date	Time
Relinquished by (Print/Signature): Brian K. Derby	7/2/04	2:25
Received by (Print/Signature):	Date	Time
Relinquished by (Print/Signature):	Date	Time
Received by (Print/Signature):	Date	Time
Relinquished by (Print/Signature):	Date	Time

SwRI Project#: 20.10542.02.002
Received by SwRI Lab: (Signature)
Date Time
Samples Disposed: Date Time
Samples Disposed by:

Div 01 COC Form 01-01-001, Rev 8/02

Page ____ of ____

* Summited Solutions 4-3 A And 5-3 B Same Solution from pg #38 Has Not been Restirred Decanted Le from flasks being Careful Not to stir up Solution And not to get Any Precipitant or Solid from Bottom of Cell 0.45µm filter Used for Solution Also Summited Solid form of All Reagents
7/9/04

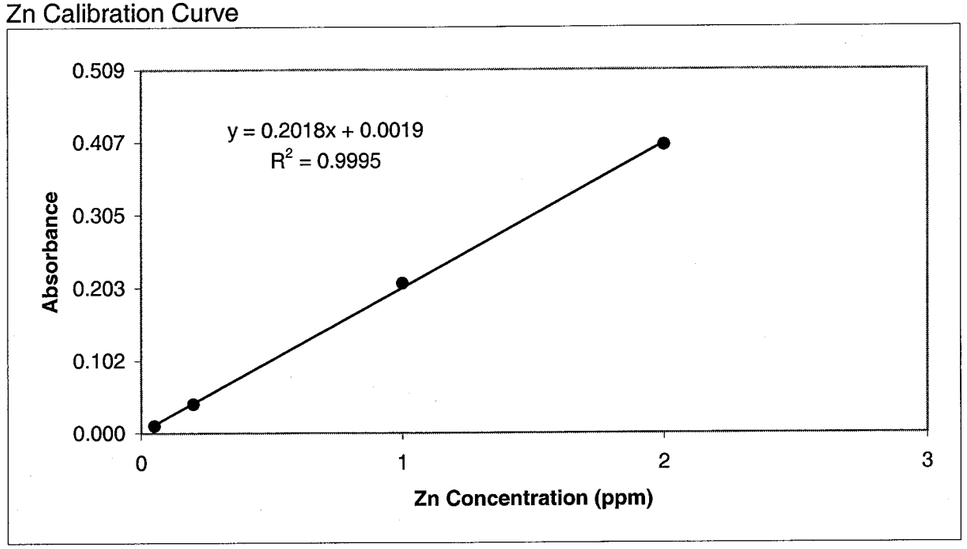
Comparison of AA and ICP analysis

Zinc Concentration in Sample 4-3A Zn 15 days

Zinc Std Data

Zn Std (ppm)	Absorbance Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Absorbance
0.05	0.010	0.011	0.010	0.009	0.012	0.0104
0.2	0.042	0.041	0.041	0.040	0.039	0.0406
1	0.209	0.208	0.210	0.213	0.209	0.2098
2	0.401	0.405	0.404	0.400	0.403	0.4026

Zn Calibration Curve



Zn Sample Data

Solution ID	Absorbance Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Absorbance	Calculated Zn (ppm)
4-3A Zn 15 days	0.067	0.067	0.066	0.069	0.068	0.0674	0.32
0.2 ppm Standard	0.040	0.040	0.041	0.040	0.039	0.0400	0.19

$Zn \quad 0.32\ ppm = \frac{0.32 \times 10^{-3}}{65.4} = 4.89 \times 10^{-6}\ mol$

7/12/04

4-3A ICP Data Sample observed by Institute Quality Assurance

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-3 A

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247108

Client: Division 20

Date Received: 07/02/04

Project No.: 10542.02.002

SRR: 26134

TO: 040706-3

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	0.090	0.01
Barium	<0.01	0.01
Beryllium	<0.01	0.01
Bismuth	0.078	0.02
Boron	2724	0.1
Cadmium	<0.01	0.01
Calcium	0.197	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.03	0.03
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.03	0.03
Phosphorus	<0.05	0.05
Potassium	1.25	0.4
Selenium	<0.02	0.02
Silicon	1.66	0.05
Silver	<0.02	0.02
Sodium	3628	0.4
Strontium	0.012	0.01
Sulfur	<0.1	0.1
Thallium	<0.02	0.02
Thorium	<0.02	0.02
Tin	0.036	0.01
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.301	0.01
Zirconium	<0.01	0.01

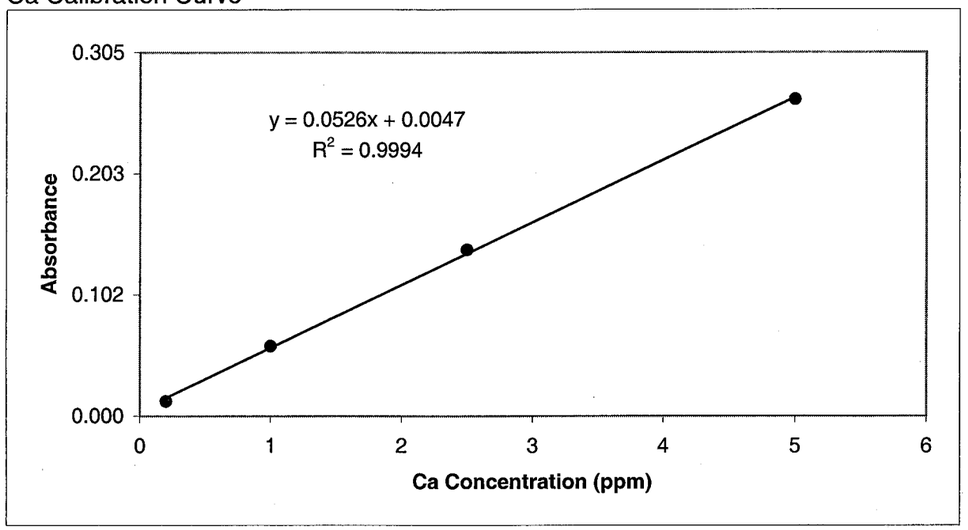
7/12/04

Calcium Concentration in Sample 5-3A 15 days

Ca Std Data

Ca Std (ppm)	Absorbance Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Absorbance
0.2	0.012	0.013	0.013	0.012	0.012	0.0124
1	0.059	0.058	0.059	0.059	0.059	0.0588
2.5	0.142	0.138	0.138	0.141	0.137	0.1392
5	0.265	0.268	0.265	0.266	0.265	0.2658

Ca Calibration Curve



Ca Sample Data

Solution ID	Absorbance Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Absorbance	Calculated CA (ppm)	Conc of Original Soln (ppm)
5-3A 15 days DF10	0.178	0.172	0.174	0.174	0.176	0.1748	3.23	32.3
2.5 ppm Standard	0.141	0.143	0.143	0.140	0.141	0.1416	2.60	na

$32.3\ ppm\ Ca = \frac{32.3 \times 10^{-3}}{40.1} = 8.05 \times 10^{-4}\ mol$

7/12/04

5-3A ICP data

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-3 A

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 07/02/04

Matrix: Liquid

Project No.: 10542.02.002

Lab System ID: 247109

SRR: 26134

TO: 040706-3

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	0.094	0.01
Barium	<0.01	0.01
Beryllium	<0.01	0.01
Bismuth	0.065	0.02
Boron	2689	0.1
Cadmium	<0.01	0.01
Calcium	33.3	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	0.018	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.03	0.03
Lithium	<0.01	0.01
Magnesium	1.09	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.03	0.03
Phosphorus	0.077	0.05
Potassium	1.52	0.4
Selenium	<0.02	0.02
Silicon	2.36	0.05
Silver	<0.02	0.02
Sodium	3596	0.4
Strontium	0.040	0.01
Sulfur	<0.1	0.1
Thallium	<0.02	0.02
Thorium	<0.02	0.02
Tin	0.038	0.01
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	<0.01	0.01
Zirconium	<0.01	0.01

7/12/04

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID: Boric Acid

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Solid

Lab System ID: 247110

Client: Division 20

Date Received: 07/02/04

Project No.: 10542.02.002

SRR: 26134

TO: 040706-3

Analysis	Sample Result (mg/Kg)	Duplicate Result (mg/Kg)	RPD
Aluminum	<2.5	<2.5	0.00%
Antimony	<5	<5	0.00%
Arsenic	<1.5	<1.5	0.00%
Barium	<0.25	<0.25	0.00%
Beryllium	<0.25	<0.25	0.00%
Bismuth	<1.25	<1.25	0.00%
Cadmium	<0.25	<0.25	0.00%
Calcium	4.23	5.47	25.5%
Chromium	<0.5	<0.5	0.00%
Cobalt	<1.25	<1.25	0.00%
Copper	<0.5	<0.5	0.00%
Iron	<5	<5	0.00%
Lanthanum	<0.5	<0.5	0.00%
Lead	<2	<2	0.00%
Lithium	<0.25	<0.25	0.00%
Magnesium	<5	<5	0.00%
Manganese	<0.25	<0.25	0.00%
Molybdenum	<0.5	<0.5	0.00%
Nickel	<0.25	<0.25	0.00%
Palladium	<2	<2	0.00%
Phosphorus	<5	<5	0.00%
Potassium	<5	<5	0.00%
Selenium	<1.5	<1.5	0.00%
Silicon	<2.5	<2.5	0.00%
Silver	<1	<1	0.00%
Sodium	<10	<10	0.00%
Strontium	<0.25	<0.25	0.00%
Sulfur	<10	<10	0.00%
Thallium	<1.25	<1.25	0.00%
Thorium	<1	<1	0.00%
Tin	<0.75	<0.75	0.00%
Titanium	<0.25	<0.25	0.00%
Tungsten	<0.5	<0.5	0.00%
Uranium	<25	<25	0.00%
Vanadium	<0.25	<0.25	0.00%
Yttrium	<0.25	<0.25	0.00%
Zinc	<1.25	<1.25	0.00%
Zirconium	<0.25	<0.25	0.00%

7/13/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: Boric Acid

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Solid

Lab System ID: 247110

Client: Division 20

Date Received: 07/02/04

Project No.: 10542.02.002

SRR: 26134

TO: 040706-3

Analysis	Sample Result (mg/Kg)	Reporting Limit (mg/Kg)
Aluminum	<2.5	2.5
Antimony	<5	5
Arsenic	<1.5	1.5
Barium	<0.25	0.25
Beryllium	<0.25	0.25
Bismuth	<1.25	1.25
Cadmium	<0.25	0.25
Calcium	4.23	2.5
Chromium	<0.5	0.5
Cobalt	<1.25	1.25
Copper	<0.5	0.5
Iron	<5	5
Lanthanum	<0.5	0.5
Lead	<2	2
Lithium	<0.25	0.25
Magnesium	<5	5
Manganese	<0.25	0.25
Molybdenum	<0.5	0.5
Nickel	<0.25	0.25
Palladium	<2	2
Phosphorus	<5	5
Potassium	<5	5
Selenium	<1.5	1.5
Silicon	<2.5	2.5
Silver	<1	1
Sodium	<10	10
Strontium	<0.25	0.25
Sulfur	<10	10
Thallium	<1.25	1.25
Thorium	<1	1
Tin	<0.75	0.75
Titanium	<0.25	0.25
Tungsten	<0.5	0.5
Uranium	<25	25
Vanadium	<0.25	0.25
Yttrium	<0.25	0.25
Zinc	<1.25	1.25
Zirconium	<0.25	0.25

7/13/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
Sodium Hydroxide

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Solid

Lab System ID: 247112

Client: Division 20

Date Received: 07/02/04

Project No.: 10542.02.002

SRR: 26134

TO: 040706-3

Analysis	Sample Result (mg/Kg)	Reporting Limit (mg/Kg)
Aluminum	<2.5	2.5
Antimony	<1.25	1.25
Arsenic	<0.5	0.5
Barium	<0.25	0.25
Beryllium	<0.25	0.25
Bismuth	<0.5	0.5
Boron	<5	5
Cadmium	<0.25	0.25
Calcium	14.2	2.5
Chromium	<0.25	0.25
Cobalt	<0.25	0.25
Copper	<0.75	0.75
Iron	<5	5
Lanthanum	<0.25	0.25
Lead	<0.5	0.5
Lithium	<0.25	0.25
Magnesium	<2.5	2.5
Manganese	<0.25	0.25
Molybdenum	<1	1
Nickel	1.24	0.25
Palladium	<0.5	0.5
Phosphorus	<2.5	2.5
Potassium	561	5
Selenium	<0.5	0.5
Silicon	<20	20
Silver	<0.25	0.25
Strontium	1.21	0.25
Sulfur	<5	5
Thallium	<0.5	0.5
Thorium	<1	1
Tin	<0.25	0.25
Titanium	<0.25	0.25
Tungsten	<2	2
Uranium	<5	5
Vanadium	<0.25	0.25
Yttrium	<0.25	0.25
Zinc	<1.25	1.25
Zirconium	<0.75	0.75

7/13/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
Zinc Carbonate

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Solid

Lab System ID: 247113

Client: Division 20

Date Received: 07/02/04

Project No.: 10542.02.002

SRR: 26134

TO: 040706-3

Analysis	Sample Result (mg/Kg)	Reporting Limit (mg/Kg)
Aluminum	6.82	2.5
Antimony	<2.5	2.5
Arsenic	<2.5	2.5
Barium	7.59	0.25
Beryllium	<0.25	0.25
Bismuth	<4	4
Boron	20.0	5
Cadmium	8.28	0.25
Calcium	189	2.5
Chromium	<0.25	0.25
Cobalt	<2	2
Copper	<1	1
Iron	12.9	5
Lanthanum	<0.25	0.25
Lead	6.65	0.5
Lithium	<0.25	0.25
Magnesium	139	2.5
Manganese	10.1	0.25
Molybdenum	<0.5	0.5
Nickel	0.634	0.25
Palladium	<1	1
Phosphorus	<5	5
Potassium	<5	5
Selenium	<15	15
Silicon	185	5
Silver	<0.75	0.75
Sodium	915	10
Strontium	2.39	0.25
Sulfur	629	5
Thallium	<4	4
Thorium	<2.5	2.5
Tin	<5	5
Titanium	<0.25	0.25
Tungsten	<2550	2550
Uranium	<5	5
Vanadium	<0.5	0.5
Yttrium	<0.25	0.25
Zirconium	<0.25	0.25

7/13/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
Calcium Carbonate

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Solid

Lab System ID: 247111

Client: Division 20

Date Received: 07/02/04

Project No.: 10542.02.002

SRR: 26134

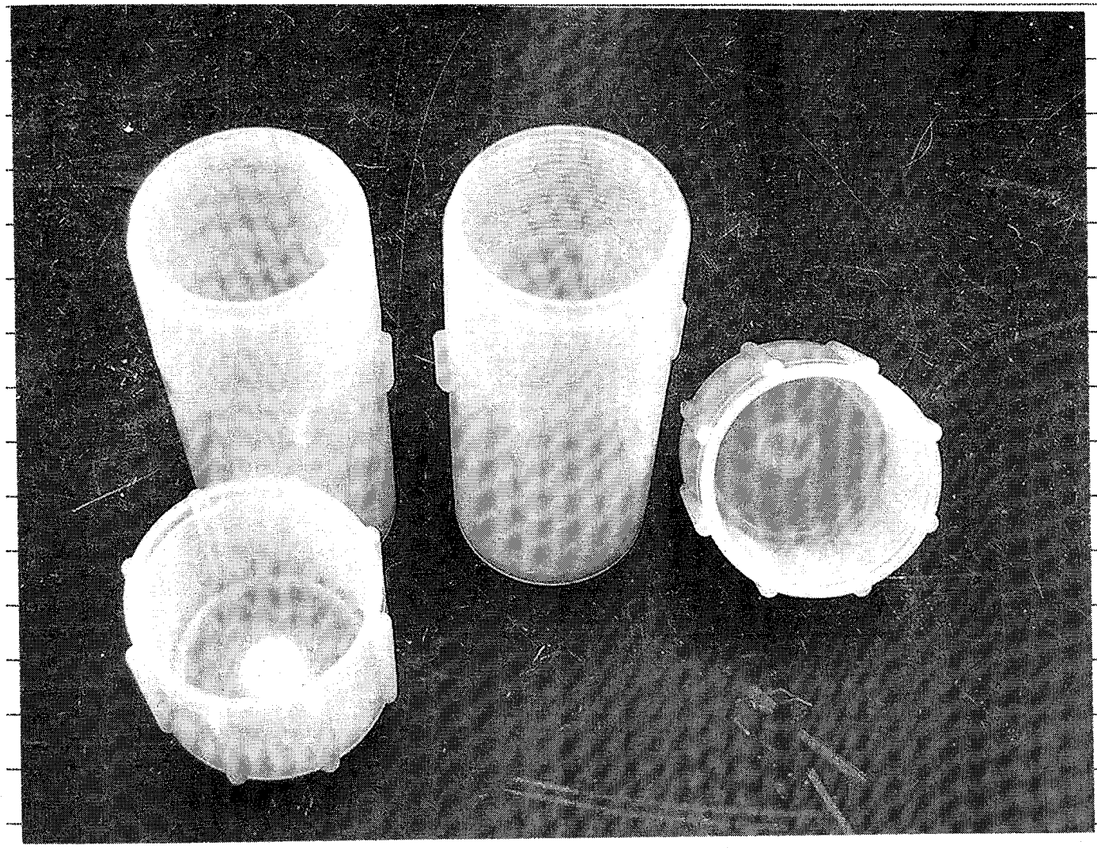
TO: 040706-3

Analysis	Sample Result (mg/Kg)	Reporting Limit (mg/Kg)
Aluminum	66.8	2.5
Antimony	<5	5
Arsenic	<1	1
Barium	3.54	0.25
Beryllium	<0.25	0.25
Bismuth	<1.25	1.25
Boron	<5	5
Cadmium	<0.25	0.25
Chromium	<0.5	0.5
Cobalt	<0.5	0.5
Copper	<1.25	1.25
Iron	327	5
Lanthanum	<1.5	1.5
Lead	<1.25	1.25
Lithium	<0.25	0.25
Magnesium	2032	2.5
Manganese	23.1	0.25
Molybdenum	<0.5	0.5
Nickel	2.29	0.25
Palladium	<0.5	0.5
Phosphorus	56.6	2.5
Potassium	29.1	5
Selenium	<5	5
Silicon	165	2.5
Silver	<0.25	0.25
Sodium	59.5	10
Strontium	199	0.25
Sulfur	210	5
Thallium	<12.5	12.5
Thorium	<2	2
Tin	<12.5	12.5
Titanium	<1	1
Tungsten	<1	1
Uranium	<5	5
Vanadium	5.16	0.25
Yttrium	1.29	0.25
Zinc	10.5	0.5
Zirconium	<2	2

7/12/04

New Test with Sealed Teflon Cell See Pictures Below
Checked All oven Temperatures with
Omega Microprocessor thermometer Model # HH22 SN# T 94140
Cal 4/27/04 Due 10/27/04
Thermal Couple # 330 Cal Jan 22/04 Due 7/22/04

Teflon Cell Held 120 mls of Solution



7/13/04

Solutions

#4

0.259 m H_3BO_3 = 32.031 g H_3BO_3 Lot # C20H17

0.17 m NaOH = 13.652 g NaOH Lot # 033972

0.01 m $ZnCO_3$ = 2.510 g $ZnCO_3$ Lot # 626003

+ DI water To 2000 mls

#5

0.259 m H_3BO_3 = 32.026 g H_3BO_3 Lot # C20H17

0.17 m NaOH = 13.6820 g NaOH Lot # 033972

0.01 m $CaCO_3$ = 2.003 g $CaCO_3$ Lot # 975703

+ DI water To 2000 mls

Placed Solution Into Teflon Cells held @ Temperature for 1 hr. C = 90°C D = ~~120°C~~ 130°C

Checked Internal Temperature with Omega Meter And used DI water As Solution To check duration of Time Before solution reaches set point for Temperature of Testing Condition which was 9 mins for 90°C And 16 mins for 130°C Added this Additional time to test over time - Pulled And Filtered (.45 um) Samples for ICP Analysis

[signature] 7/13/04

FORM FOR REQUESTING WORK FROM OTHER DIVISIONS

A. TO BE COMPLETED BY DIVISION 20 PERSONNEL

Requester: Ken Chiang **Request Date:** 7/12/04
Project No.: 20-10542.02.002 **Phone No.:** X2308
Description of Work Requested:

Total ICP Analysis

All Solutions .45 um filtered Already Thanks

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

QUALITY REQUIREMENTS: The work requested is governed by the CNWRA Quality Assurance Program which addresses requirements of 10CFR50, Appendix B. Personnel performing this work shall be qualified under the CNWRA QA program or equivalently under the SwRI Nuclear QA program. Test and analysis methods shall be documented by approved procedures or recognized, standard methods. Measuring and test equipment shall be calibrated and controlled according to CNWRA and SwRI Nuclear QA program requirements.

Sample Identification		Description
4-4C	H_3BO_3 + NaOH + $ZnCO_3$	
4-4D	" "	
5-4C	H_3BO_3 + NaOH + $CaCO_3$	
5-4D	" "	

B. TO BE COMPLETED BY DIVISION PERFORMING WORK[1]

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

Person Assigned: **Signature:**
Division: **Date:**

Make, Model & Serial No. of Equipment Used (*attach list if necessary*):

Software Used (If any):

Standards Used (If any):

Photographic Negative Numbers (If Applicable):

[1] Please sign and date any hardcopy of analysis or list of photographs (The photographs themselves need not be signed). If error occurred during entry, do not erase or overwrite, but strikeout with single line, initial and date, and then reenter correct information.

C = 90°C D = 130°C

[signature] 7/13/04

SAMPLE LIST/CHAIN OF CUSTODY

Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Shipper Name/Address:

Client: Ken Chiang CNWRA Div20

Client Purchase Order/Other ID:

Site/Zone ID:

Requested Turnaround:
☐ 2 Weeks
☐ 3 Weeks
☒ Other: Link Memo Thanks

SwRI Contact: Ken Chiang x 2305

Analyses Requested

REMARKS

Preservation
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Cool (4°C±2°C)
f = Other (specify)

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time	Matrix Type	Sample Type	# of Containers	ICP Analysis Total ICP
4-4C	7/12/01	2:30	L		1	
4-4D	7/12/01	2:30	L		1	
5-4C	7/12/01	2:30	L		1	
5-4D	7/12/01	2:30	L		1	

Matrix Types:
A – Air
B – Biota
D – Dust
E – Emission/Stack
L - Liquid
P – Product
Sd - Solid
S – Soil
SED – Sediment
T - Tissue
W - Water
WP - Wipe

Sample Types:
D - Duplicate
ER – Equipment Rinsate
ES – Environmental Sample
FB – Field Blank
FD – Field Duplicate
MS – Matrix Spike
MSD – Matrix Spike Dup
TB – Trip Blank

Temp: Therm #:

Comments: All solutions .45µm filtered

	Date	Time
Relinquished by (Print/Signature): Brian K. Dealy /	7/12/04	3:28
Received by (Print/Signature):	Date	Time
Relinquished by (Print/Signature):	Date	Time
Received by (Print/Signature):	Date	Time
Relinquished by (Print/Signature):	Date	Time

SwRI Project#: 20.10542.02.002

Received by SwRI Lab: (Signature) Date Time

Samples Disposed: Date Time

Samples Disposed by:

Div 01 COC Form 01-01-001, Rev 8/02

Page ____ of ____

7/13/04

Sample Analysis monitored by Institute Quality Assurance

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247357

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.422	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2782	10
Cadmium	<0.01	0.01
Calcium	0.329	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.93	0.4
Selenium	<0.02	0.02
Silicon	0.549	0.05
Silver	<0.02	0.02
Sodium	3729	20
Strontium	0.020	0.01
Sulfur	0.227	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.44	0.01
Zirconium	<0.01	0.01

7/26/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

PTFE Bottle 90°C $ZnCO_3$

Sample ID: 4-4D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247358

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.484	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	3072	10
Cadmium	<0.01	0.01
Calcium	0.369	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	0.084	0.08
Potassium	2.41	0.4
Selenium	<0.02	0.02
Silicon	0.872	0.05
Silver	<0.02	0.02
Sodium	4009	20
Strontium	0.021	0.01
Sulfur	0.306	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	2.30	0.01
Zirconium	<0.01	0.01

B 3072

Na 4009

Zinc 2.30

7/26/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

PTFE Bottle $CaCO_3$

Sample ID: 5-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247359

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.103	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.692	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2787	10
Cadmium	<0.01	0.01
Calcium	28.3	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	1.01	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	2.56	0.4
Selenium	<0.02	0.02
Silicon	2.10	0.05
Silver	<0.02	0.02
Sodium	3679	20
Strontium	0.057	0.01
Sulfur	0.527	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.097	0.01
Zirconium	<0.01	0.01

B 2787

Ca 28.3

Na 3679

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

$ZnCO_3$ 130°C Electrochemical Cell KF

Sample ID
5-4D

PTFE bottle

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247360

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)	
Aluminum	<0.1	0.1	
Antimony	<0.05	0.05	
Arsenic	<0.2	0.2	
Barium	0.500	0.01	
Beryllium	<0.01	0.01	
Bismuth	<0.2	0.2	
Boron	3027	10	B 3027
Cadmium	<0.01	0.01	
Calcium	24.4	0.1	Ca 24.4
Chromium	<0.01	0.01	
Cobalt	<0.02	0.02	
Copper	<0.01	0.01	
Iron	<0.1	0.1	
Lanthanum	<0.02	0.02	
Lead	<0.02	0.02	
Lithium	<0.01	0.01	
Magnesium	1.04	0.1	
Manganese	<0.01	0.01	
Molybdenum	<0.01	0.01	
Nickel	<0.01	0.01	
Palladium	<0.02	0.02	
Phosphorus	<0.08	0.08	
Potassium	2.36	0.4	
Selenium	<0.02	0.02	
Silicon	2.59	0.05	
Silver	<0.02	0.02	
Sodium	4046	20	4046
Strontium	0.065	0.01	
Sulfur	0.333	0.1	
Thallium	<0.02	0.02	
Thorium	<0.03	0.03	
Tin	<0.05	0.05	
Titanium	<0.01	0.01	
Tungsten	<0.02	0.02	
Uranium	<0.2	0.2	
Vanadium	<0.01	0.01	
Yttrium	<0.01	0.01	
Zinc	0.131	0.01	
Zirconium	<0.01	0.01	

7/26/04

Used Electrochemical Cell Small Glass Reactor Cell with stir plate - Stirred Solution At 90°C for 4 hrs then placed Cell Into Oven @ 90°C for 4 hrs Longer then Removed Cell And pulled Sample for ICP Analysis

Test # 4-5C

0.259 m H_3BO_3 # C20H17 = 4.004 g

0.17 m NaOH Lot# 033972 = 1.726 g

0.01 m $ZnCO_3$ Lot# 026003 = 0.317 g

+ 250 mls DI water

Test # 5-5C

0.259 m H_3BO_3 # C20H17 = 4.003 g

0.17 m NaOH Lot# 033972 = 1.707 g

0.01 m $CaCO_3$ Lot# 975703 = 0.251 g

+ 250 mls DI water

Sent samples for ICP Analysis - one sample filtered .45 μm filter And the other not filtered

7/26/04

FORM FOR REQUESTING WORK FROM OTHER DIVISIONS

A. TO BE COMPLETED BY DIVISION 20 PERSONNEL

Requester: Ken Chiang **Request Date:** 7/14/04
Project No.: 20.10542.02.002 **Phone No.:** x 2308
Description of Work Requested:

Total ICP Analysis

* Please Do Not Filter Samples that Are Marked Not Filtered thanks

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

QUALITY REQUIREMENTS: *The work requested is governed by the CNWRA Quality Assurance Program which addresses requirements of 10CFR50, Appendix B. Personnel performing this work shall be qualified under the CNWRA QA program or equivalently under the SwRI Nuclear QA program. Test and analysis methods shall be documented by approved procedures or recognized, standard methods. Measuring and test equipment shall be calibrated and controlled according to CNWRA and SwRI Nuclear QA program requirements.*

Sample Identification	Description
4-5 C Filtered	H_3BO_3 - NaOH - $ZnCO_3$
4-5 C Not Filtered	
5-5 C Filtered	H_3BO_3 - NaOH - $CaCO_3$
5-5 C Not Filtered	

B. TO BE COMPLETED BY DIVISION PERFORMING WORK[1]

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

Person Assigned: _____ **Signature:** _____
Division: _____ **Date:** _____

Make, Model & Serial No. of Equipment Used (*attach list if necessary*): _____

Software Used (If any): _____

Standards Used (If any): _____

Photographic Negative Numbers (If Applicable): _____

[1] Please sign and date any hardcopy of analysis or list of photographs (The photographs themselves need not be signed). If error occurred during entry, do not erase or overwrite, but strikeout with single line, initial and date, and then reenter correct information.

7/26/04

SAMPLE LIST/CHAIN OF CUSTODY
Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Shipper Name/Address:
Client: Ken Chiang CNWRA Div20

Client Purchase Order/Other ID | Site/Zone ID

Requested Turnaround:
☐ 2 Weeks
☐ 3 Weeks
☒ Other: ASAP thanks Bam

SwRI Contact: Ken Chiang x 2308

Analyses Requested

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time	Matrix Type	Sample Type	# of Containers	ICP Analysis Total ICP
4-5C Filtered	7/13/04	5:30	L		1	
4-5C Not Filtered			L		1	
5-5C Filtered			L		1	
5-5C Not Filtered			L		1	

REMARKS
Preservation
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Cool (4°C±2°C)
f = Other (specify)

Matrix Types:
A – Air
B – Biota
D - Dust
E – Emission/Stack
L - Liquid
P – Product
Sd - Solid
S – Soil
SED – Sediment
T - Tissue
W - Water
WP - Wipe

Sample Types:
D - Duplicate
ER – Equipment Rinsate
ES – Environmental Sample
FB – Field Blank
FD – Field Duplicate
MS – Matrix Spike
MSD – Matrix Spike Dup
TB – Trip Blank

Temp: Therm #:

Comments: Please Do Not Filter Samples that Are Marked Not Filtered

	Date	Time
Relinquished by (Print/Signature) Brian K Debby / Bi KO	7/14/04	8:20
Received by (Print/Signature)	Date	Time
Relinquished by (Print/Signature)	Date	Time
Received by (Print/Signature)	Date	Time
Relinquished by (Print/Signature)	Date	Time

SwRI Project#: 20.10542.02.002
Received by SwRI Lab: (Signature)
Date Time
Samples Disposed: Date Time
Samples Disposed by:

Div 01 COC Form 01-01-001 Rev 8/02

Page ____ of ____

7/26/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
4-5C Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247433

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.182	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.528	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2776	10
Cadmium	<0.01	0.01
Calcium	1.02	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	2.56	0.4
Selenium	<0.02	0.02
Silicon	6.85	0.05
Silver	<0.02	0.02
Sodium	3695	20
Strontium	0.024	0.01
Sulfur	0.501	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.15	0.01
Zirconium	<0.01	0.01

$\frac{1.15 \times 10^{-3}}{65.4} \approx 1.76 \times 10^{-5}$

B $\frac{2776 \times 10^{-3}}{10.8} = 0.257$

Na $\frac{3695 \times 10^{-3}}{23} \approx 0.161$

7/26/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
4-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247434

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.269	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2678	10
Cadmium	<0.02	0.02
Calcium	0.946	0.4
Chromium	<0.02	0.02
Cobalt	<0.02	0.02
Copper	<0.02	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	<0.2	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	5.94	0.1
Silver	<0.06	0.06
Sodium	3631	20
Strontium	<0.02	0.02
Sulfur	0.348	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	<0.04	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	2.12	0.02
Zirconium	<0.02	0.02

7/26/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-5C Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247435

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.304	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.818	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2810	10
Cadmium	<0.01	0.01
Calcium	21.5	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	1.07	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	3.45	0.4
Selenium	<0.02	0.02
Silicon	20.3	0.05
Silver	<0.02	0.02
Sodium	3677	20
Strontium	0.070	0.01
Sulfur	1.05	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.252	0.01
Zirconium	<0.01	0.01

Ca
$\frac{21.5 \times 10^{-3}}{40.1} = 5.36 \times 10^{-4}$

B
$\frac{2810 \times 10^{-3}}{10.8} = 0.260$

Na
$\frac{3677 \times 10^{-3}}{23} = 1.599 \times 10^{-1}$

7/20/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247436

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.519	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2711	10
Cadmium	<0.02	0.02
Calcium	21.7	0.4
Chromium	<0.02	0.02
Cobalt	<0.02	0.02
Copper	0.024	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	1.06	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	1.34	0.8
Selenium	<0.04	0.04
Silicon	18.1	0.1
Silver	<0.06	0.06
Sodium	3538	20
Strontium	0.053	0.02
Sulfur	0.571	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	<0.04	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	<0.02	0.02
Zirconium	<0.02	0.02

7/20/04

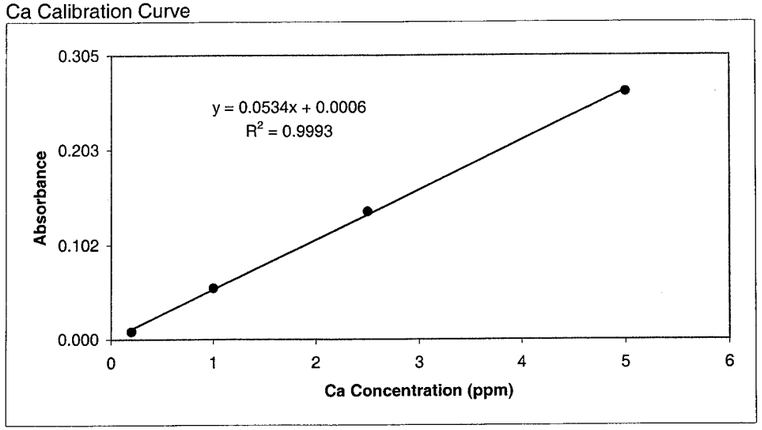
6/17/2004 Test solution from pg # 38

Calcium Concentration in Sample

Ca Std Data

Solution ID	Ca Std (ppm)	Absorbance Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Absorbance
	0.2	0.008	0.009	0.009	0.008	0.008	0.0084
	1	0.055	0.055	0.057	0.055	0.054	0.0552
	2.5	0.137	0.140	0.138	0.137	0.136	0.1376
	5	0.264	0.261	0.271	0.267	0.266	0.2658

Ca Calibration Curve



6/17/2004 Test solution from pg #38

Ca Sample Data

Solution ID	Absorbance Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average Absorbance	Calculated CA (ppm)	Conc of Original Soln (ppm)
130 DF10	0.168	0.167	0.169	0.169	0.170	0.1686	3.15	31.5
60 DF 10	0.179	0.182	0.179	0.182	0.180	0.1804	3.37	33.7
25 DF 10	0.172	0.171	0.171	0.174	0.171	0.1718	3.21	32.1
2.5 ppm Standard	0.137	0.138	0.134	0.139	0.138	0.1372	2.56	

$$32.1 \text{ ppm Ca} = \frac{32.1 \times 10^{-3}}{40.1} = 8.0 \times 10^{-4} \text{ mol}$$

K.T. Chiang 7/26/04

OLI Simulation Result Transferred from V. Jain

Test1,2,3 Results
7/14/04 4:57:23 PM *StreamAnalyzer* Page 1 of 4
OLI Systems, Inc.

Validation with 0.01 M

Calculation Summary

Test1,2,3 Calculation for Work1

Automatic Chemistry Model
Databanks:
Public

Unit Set: Default

Temperature survey:
Range 20.000 to 100.00 °C
Step size 5.0000 °C
No. steps 16
No. points 17

No secondary survey selected

Isothermal Calculation

Calc. elapsed time: 5.838 sec

Stream Inflows

	Input	Final	
H2O	55.508		mol
B(OH)3	0.25900		mol
NaOH	0.17000		mol
CaCO3	0.0100000	0.010000	mol

Survey Inflows

Temp °C	H2O mol	B(OH)3 mol	NaOH mol	CaCO3 mol
20.000	55.508	0.25900	0.17000	0.010000
25.000	55.508	0.25900	0.17000	0.010000
30.000	55.508	0.25900	0.17000	0.010000
35.000	55.508	0.25900	0.17000	0.010000
40.000	55.508	0.25900	0.17000	0.010000
45.000	55.508	0.25900	0.17000	0.010000
50.000	55.508	0.25900	0.17000	0.010000
55.000	55.508	0.25900	0.17000	0.010000
60.000	55.508	0.25900	0.17000	0.010000
65.000	55.508	0.25900	0.17000	0.010000
70.000	55.508	0.25900	0.17000	0.010000
75.000	55.508	0.25900	0.17000	0.010000
80.000	55.508	0.25900	0.17000	0.010000
85.000	55.508	0.25900	0.17000	0.010000

K.T. Chiang 7/26/04

Temp	H2O	B(OH)3	NaOH	CaCO3
°C	mol	mol	mol	mol
90.000	55.508	0.25900	0.17000	0.010000
95.000	55.508	0.25900	0.17000	0.010000
100.00	55.508	0.25900	0.17000	0.010000

Element Balance

Temp	(+3)Inflow su	(+4)Inflow su	(+2)Inflow s	(+1)Inflow su	(+1)Inflow s	(-2)Inflow su
°C	mol	mol	mol	mol	mol	mol
20.000	0.0	0.0	0.0	0.0	0.0	0.0
25.000	0.0	0.0	0.0	0.0	0.0	0.0
30.000	0.0	0.0	0.0	0.0	0.0	0.0
35.000	0.0	0.0	0.0	0.0	0.0	0.0
40.000	0.0	0.0	0.0	0.0	0.0	0.0
45.000	0.0	0.0	0.0	0.0	0.0	0.0
50.000	0.0	0.0	0.0	0.0	0.0	0.0
55.000	0.0	0.0	0.0	0.0	0.0	0.0
60.000	0.0	0.0	0.0	0.0	0.0	0.0
65.000	0.0	0.0	0.0	0.0	0.0	0.0
70.000	0.0	0.0	0.0	0.0	0.0	0.0
75.000	0.0	0.0	0.0	0.0	0.0	0.0
80.000	0.0	0.0	0.0	0.0	0.0	0.0
85.000	0.0	0.0	0.0	0.0	0.0	0.0
90.000	0.0	0.0	0.0	0.0	0.0	0.0
95.000	0.0	0.0	0.0	0.0	0.0	0.0
100.00	0.0	0.0	0.0	0.0	0.0	0.0

Temp	B(+3)Aq sum	C(+4)Aq sum	CA(+2)Aq sum	H(+1)Aq sum	NA(+1)Aq sum	O(-2)Aq sum
°C	mol	mol	mol	mol	mol	mol
20.000	0.25900	5.2105e-4	5.2105e-4	111.96	0.17000	56.457
25.000	0.25900	5.1748e-4	5.1748e-4	111.96	0.17000	56.457
30.000	0.25900	5.1185e-4	5.1185e-4	111.96	0.17000	56.457
35.000	0.25900	5.0430e-4	5.0430e-4	111.96	0.17000	56.457
40.000	0.25900	4.9514e-4	4.9514e-4	111.96	0.17000	56.456
45.000	0.25900	4.8467e-4	4.8467e-4	111.96	0.17000	56.456
50.000	0.25900	4.7322e-4	4.7322e-4	111.96	0.17000	56.456
55.000	0.25900	4.6107e-4	4.6107e-4	111.96	0.17000	56.456
60.000	0.25900	4.4847e-4	4.4847e-4	111.96	0.17000	56.456
65.000	0.25900	4.3562e-4	4.3562e-4	111.96	0.17000	56.456
70.000	0.25900	4.2268e-4	4.2268e-4	111.96	0.17000	56.456
75.000	0.25900	4.0978e-4	4.0978e-4	111.96	0.17000	56.456
80.000	0.25900	3.9703e-4	3.9703e-4	111.96	0.17000	56.456
85.000	0.25900	3.8450e-4	3.8450e-4	111.96	0.17000	56.456
90.000	0.25900	3.7226e-4	3.7226e-4	111.96	0.17000	56.456
95.000	0.25900	3.6035e-4	3.6035e-4	111.96	0.17000	56.456
100.00	0.25900	3.4879e-4	3.4879e-4	111.96	0.17000	56.456

K.T. Chua
7/26/04

Temp	B(+3)Vap sum	C(+4)Vap sum	CA(+2)Vap sum	H(+1)Vap sum	NA(+1)Vap sum	O(-2)Vap sum
°C	mol	mol	mol	mol	mol	mol
20.000	0.0	0.0	0.0	0.0	0.0	0.0
25.000	0.0	0.0	0.0	0.0	0.0	0.0
30.000	0.0	0.0	0.0	0.0	0.0	0.0
35.000	0.0	0.0	0.0	0.0	0.0	0.0
40.000	0.0	0.0	0.0	0.0	0.0	0.0
45.000	0.0	0.0	0.0	0.0	0.0	0.0
50.000	0.0	0.0	0.0	0.0	0.0	0.0
55.000	0.0	0.0	0.0	0.0	0.0	0.0
60.000	0.0	0.0	0.0	0.0	0.0	0.0
65.000	0.0	0.0	0.0	0.0	0.0	0.0
70.000	0.0	0.0	0.0	0.0	0.0	0.0
75.000	0.0	0.0	0.0	0.0	0.0	0.0
80.000	0.0	0.0	0.0	0.0	0.0	0.0
85.000	0.0	0.0	0.0	0.0	0.0	0.0
90.000	0.0	0.0	0.0	0.0	0.0	0.0
95.000	0.0	0.0	0.0	0.0	0.0	0.0
100.00	0.0	0.0	0.0	0.0	0.0	0.0

Temp	B(+3)Sol sum	C(+4)Sol sum	CA(+2)Sol sum	H(+1)Sol sum	NA(+1)Sol sum	O(-2)Sol sum
°C	mol	mol	mol	mol	mol	mol
20.000	0.0	9.4790e-3	9.4790e-3	0.0	0.0	0.028437
25.000	0.0	9.4825e-3	9.4825e-3	0.0	0.0	0.028448
30.000	0.0	9.4882e-3	9.4882e-3	0.0	0.0	0.028464
35.000	0.0	9.4957e-3	9.4957e-3	0.0	0.0	0.028487
40.000	0.0	9.5049e-3	9.5049e-3	0.0	0.0	0.028515
45.000	0.0	9.5153e-3	9.5153e-3	0.0	0.0	0.028546
50.000	0.0	9.5268e-3	9.5268e-3	0.0	0.0	0.028580
55.000	0.0	9.5389e-3	9.5389e-3	0.0	0.0	0.028617
60.000	0.0	9.5515e-3	9.5515e-3	0.0	0.0	0.028655
65.000	0.0	9.5644e-3	9.5644e-3	0.0	0.0	0.028693
70.000	0.0	9.5773e-3	9.5773e-3	0.0	0.0	0.028732
75.000	0.0	9.5902e-3	9.5902e-3	0.0	0.0	0.028771
80.000	0.0	9.6030e-3	9.6030e-3	0.0	0.0	0.028809
85.000	0.0	9.6155e-3	9.6155e-3	0.0	0.0	0.028847
90.000	0.0	9.6277e-3	9.6277e-3	0.0	0.0	0.028883
95.000	0.0	9.6397e-3	9.6397e-3	0.0	0.0	0.028919
100.00	0.0	9.6512e-3	9.6512e-3	0.0	0.0	0.028954

Temp	(+3)2ndLiq su	(+4)2ndLiq su	(+2)2ndLiq s	(+1)2ndLiq su	(+1)2ndLiq s	(-2)2ndLiq su
°C	n/a	n/a	n/a	n/a	n/a	n/a
20.000	0.0	0.0	0.0	0.0	0.0	0.0
25.000	0.0	0.0	0.0	0.0	0.0	0.0
30.000	0.0	0.0	0.0	0.0	0.0	0.0
35.000	0.0	0.0	0.0	0.0	0.0	0.0
40.000	0.0	0.0	0.0	0.0	0.0	0.0
45.000	0.0	0.0	0.0	0.0	0.0	0.0

K.T. Chua
7/26/04

Temp	(+3)2ndLiq su	(+4)2ndLiq su	(+2)2ndLiq s	(+1)2ndLiq su	(+1)2ndLiq s	(-2)2ndLiq su
°C	n/a	n/a	n/a	n/a	n/a	n/a
50.000	0.0	0.0	0.0	0.0	0.0	0.0
55.000	0.0	0.0	0.0	0.0	0.0	0.0
60.000	0.0	0.0	0.0	0.0	0.0	0.0
65.000	0.0	0.0	0.0	0.0	0.0	0.0
70.000	0.0	0.0	0.0	0.0	0.0	0.0
75.000	0.0	0.0	0.0	0.0	0.0	0.0
80.000	0.0	0.0	0.0	0.0	0.0	0.0
85.000	0.0	0.0	0.0	0.0	0.0	0.0
90.000	0.0	0.0	0.0	0.0	0.0	0.0
95.000	0.0	0.0	0.0	0.0	0.0	0.0
100.00	0.0	0.0	0.0	0.0	0.0	0.0

K.T. Chiang
7/26/04

Calculation Summary

SinglePoint1,2,3 Calculation for Work1

Automatic Chemistry Model
Databanks:
Public

Unit Set: Default

Isothermal Calculation
Temperature 130.00 °C
Pressure 3.0000 atm

Stream Inflows

H2O	55.508	mol
NaOH	0.17000	mol
B(OH)3	0.25900	mol
CaCO3	0.0100000	mol

Speciation Summary

Total number of species: **72**

User Inflows	Related Inflows	Aqueous Species	Vapor Species	Solid Species	Second Liquid Species
H2O	(CaHCO3)2CO3	H2O	H2O - Vap	B(OH)3	
NaOH	Ca(HCO3)2	B(OH)3 - Aq	CO2 - Vap	Ca(OH)2	
B(OH)3	Ca(HCO3)OH	B(OH)4-1		Ca3(BO3)2	
CaCO3	Ca(OH)2	B2O(OH)5-1		CaCO3	
	Ca3(BO3)2	B3O3(OH)4-1		Na2B4O7	
	CaHCO3HCO3	B4O5(OH)4-2		Na2B4O7.10H2O	
	CO2	Ca+2		Na2B4O7.4H2O	
	H2CO3	CaCO3 - Aq		Na2B4O7.5H2O	
	Na2B4O7	CaH2BO3+1		Na2CO3	
	Na2B4O7.10H2O	CaHCO3+1		Na2CO3.10H2O	
	Na2B4O7.4H2O	CaOH+1		Na2CO3.1H2O	
	Na2B4O7.5H2O	CO2 - Aq		Na2CO3.7H2O	
	Na2CO3	CO3-2		NaB5O8.5H2O	
	Na2CO3.10H2O	H+1		NaBO2	
	Na2CO3.1H2O	HCO3-1		NaBO2.0.5H2O	
	Na2CO3.7H2O	Na+1		NABO2.2H2O	
	NaB(OH)4	NaB(OH)4 - Aq		NaBO2.4H2O	
	NaB5O8	NaCO3-1		NaHCO3	
	NaB5O8.5H2O	NaHCO3 - Aq		NaOH	
	NaBO2	OH-1		NaOH.1H2O	
	NaBO2.0.5H2O				
	NABO2.2H2O				
	NaBO2.4H2O				
	NaH2BO3				
	NaHCO3				
	NaOH.1H2O				

K.T. Chiang
7/26/04

Stream Parameters

Stream Amt	55.947	mol
Temperature	130.00	°C
Pressure	3.0000	atm
pH	8.9349	pH
Ionic Strength	0.16389	mol/kg H2O
Osmotic Pressure	9.4278	atm
H2OActivity	0.99454	Activity
Electrical Cond, specific	0.053670	1/ohm
Electrical Cond, molar	131.37	cm2/ohm-mol
Viscosity, absolute	0.21634	cP
Viscosity, relative	1.0162	cP/cP H2O

	Total	Aqueous	Vapor	Solid	2nd Liquid
	--	g/ml	g/ml	g/ml	g/ml
Density	--	0.95189	0.0	2.7102	0.0

	Total	Aqueous	Vapor	Solid	2nd Liquid
	cal	cal	cal	cal	cal
Enthalpy	-3.7763e6	-3.7735e6	0.0	-2775.1	0.0

Total and Phase Flows (Amounts)

	Total	Aqueous	Vapor	Solid	2nd Liquid
	mol	mol	mol	mol	mol
Mole	55.951	55.941	0.0	9.7120e-3	0.0

	Total	Aqueous	Vapor	Solid	2nd Liquid
	g	g	g	g	g
Mass	1023.8	1022.8	0.0	0.97205	0.0

	Total	Aqueous	Vapor	Solid	2nd Liquid
	L	L	L	L	L
Volume	1.0749	1.0745	0.0	3.5866e-4	0.0

Scaling Tendencies

solids within temperature range		Temperature Range		
CaCO3	1.0000	data valid through range		inside range
B(OH)3	4.7906e-3	0.0	160.00 °C	inside range
Ca(OH)2	1.8838e-4	data valid through range		inside range
NaHCO3	2.0642e-5	0.0	200.00 °C	inside range
Na2B4O7.4H2O	1.9497e-6	58.500	140.00 °C	inside range
Ca3(BO3)2	1.0925e-6	data valid through range		inside range
Na2CO3	1.0041e-7	109.00	200.00 °C	inside range

K. J. Chung
7/26/04

Species Output (True Species)

0.01 – 9.7120×10⁻³ =

	Total	Aqueous	Vapor	Solid	2nd Liquid
	mol	mol	mol	mol	n/a
H2O	55.555	55.555	0.0	0.0	0.0
B(OH)3	0.055519	0.055519	0.0	0.0	0.0
CaCO3	9.7155e-3	3.4606e-6	0.0	9.7120e-3	0.0
CO2	5.4990e-7	5.4990e-7	0.0	0.0	0.0
NaB(OH)4	7.8866e-3	7.8866e-3	0.0	0.0	0.0
NaHCO3	4.9912e-5	4.9912e-5	0.0	0.0	0.0
B(OH)4-1	0.13231	0.13231	0.0	0.0	0.0
B2O(OH)5-1	0.017896	0.017896	0.0	0.0	0.0
B3O3(OH)4-1	7.0601e-3	7.0601e-3	0.0	0.0	0.0
B4O5(OH)4-2	1.5233e-3	1.5233e-3	0.0	0.0	0.0
Ca+2	5.7720e-5	5.7720e-5	0.0	0.0	0.0
CaH2BO3+1	2.2276e-4	2.2276e-4	0.0	0.0	0.0
CaHCO3+1	1.3212e-7	1.3212e-7	0.0	0.0	0.0
CaOH+1	3.9184e-6	3.9184e-6	0.0	0.0	0.0
CO3-2	3.9569e-5	3.9569e-5	0.0	0.0	0.0
H+1	1.6989e-9	1.6989e-9	0.0	0.0	0.0
HCO3-1	1.9287e-4	1.9287e-4	0.0	0.0	0.0
Na+1	0.16206	0.16206	0.0	0.0	0.0
NaCO3-1	1.5028e-6	1.5028e-6	0.0	0.0	0.0
OH-1	1.8212e-3	1.8212e-3	0.0	0.0	0.0

Molecular Output (Apparent Species)

	Total	Aqueous	Vapor	Solid	2nd Liquid
	mol	mol	mol	mol	n/a
H2O	55.982	55.982	0.0	0.0	0.0
CaCO3	9.7120e-3	0.0	0.0	9.7120e-3	0.0
Ca3(BO3)2	9.5997e-5	9.5997e-5	0.0	0.0	0.0
CO2	2.8799e-4	2.8799e-4	0.0	0.0	0.0
NaB5O8	0.022202	0.022202	0.0	0.0	0.0
NaBO2	0.14780	0.14780	0.0	0.0	0.0

Element Balance

K. J. Chung
7/26/04

	Total	Aqueous	Vapor	Solid	2nd Liquid
	mol	mol	mol	mol	n/a
B(+3)	0.0	0.25900	0.0	0.0	0.0
C(+4)	0.0	2.8799e-4	0.0	9.7120e-3	0.0
CA(+2)	0.0	2.8799e-4	0.0	9.7120e-3	0.0
H(+1)	0.0	111.96	0.0	0.0	0.0
NA(+1)	0.0	0.17000	0.0	0.0	0.0
O(-2)	0.0	56.456	0.0	0.029136	0.0

K.T. Chiang
7/26/04

Calculation Summary

Test1,2 Calculation for Work1

Automatic Chemistry Model
Databanks:
Public

Unit Set: Default

Temperature survey:
Range 20.000 to 100.00 °C
Step size 5.0000 °C
No. steps 16
No. points 17

No secondary survey selected

Isothermal Calculation

Calc. elapsed time: 12.739 sec

Stream Inflows

	Input	Final	
H2O	55.508		mol
B(OH)3	0.25900		mol
NaOH	0.17000		mol
ZnCO3	0.0100000	0.010000	mol

Survey Inflows

Temp	H2O	B(OH)3	NaOH	ZnCO3
°C	mol	mol	mol	mol
20.000	55.508	0.25900	0.17000	0.010000
25.000	55.508	0.25900	0.17000	0.010000
30.000	55.508	0.25900	0.17000	0.010000
35.000	55.508	0.25900	0.17000	0.010000
40.000	55.508	0.25900	0.17000	0.010000
45.000	55.508	0.25900	0.17000	0.010000
50.000	55.508	0.25900	0.17000	0.010000
55.000	55.508	0.25900	0.17000	0.010000
60.000	55.508	0.25900	0.17000	0.010000
65.000	55.508	0.25900	0.17000	0.010000
70.000	55.508	0.25900	0.17000	0.010000
75.000	55.508	0.25900	0.17000	0.010000
80.000	55.508	0.25900	0.17000	0.010000
85.000	55.508	0.25900	0.17000	0.010000

K.T. Chiang
7/26/04

Temp	H2O	B(OH)3	NaOH	ZnCO3
°C	mol	mol	mol	mol
90.000	55.508	0.25900	0.17000	0.010000
95.000	55.508	0.25900	0.17000	0.010000
100.00	55.508	0.25900	0.17000	0.010000

Survey Parameters

Temp	Stream Amt	Pres	pH	onic Strengt	ORP	OsPres
°C	mol	atm	pH	mol/kg H2O	V (SHE)	atm
20.000	55.947	1.0000	9.6889	0.19690	0.0	4.2442
25.000	55.947	1.0000	9.6064	0.19279	0.0	4.6555
30.000	55.947	1.0000	9.5321	0.18886	0.0	5.0688
35.000	55.947	1.0000	9.4646	0.18523	0.0	5.4744
40.000	55.947	1.0000	9.4030	0.18197	0.0	5.8643
45.000	55.947	1.0000	9.3463	0.17911	0.0	6.2322
50.000	55.947	1.0000	9.2941	0.17665	0.0	6.5746
55.000	55.947	1.0000	9.2457	0.17457	0.0	6.8900
60.000	55.947	1.0000	9.2010	0.17281	0.0	7.1787
65.000	55.947	1.0000	9.1595	0.17134	0.0	7.4421
70.000	55.947	1.0000	9.1211	0.17010	0.0	7.6823
75.000	55.947	1.0000	9.0855	0.16905	0.0	7.9016
80.000	55.947	1.0000	9.0526	0.16816	0.0	8.1023
85.000	55.947	1.0000	9.0222	0.16740	0.0	8.2864
90.000	55.947	1.0000	8.9941	0.16674	0.0	8.4558
95.000	55.947	1.0000	8.9682	0.16617	0.0	8.6121
100.00	55.947	1.0000	8.9443	0.16567	0.0	8.7566

Temp	H2O	ECond, sp	ECond, mol	Visc, abs	Visc, rel
°C	Activity	1/ohm	cm2/ohm-mol	cP	cP/cP H2O
20.000	0.99683	0.012116	27.785	1.0229	1.0209
25.000	0.99658	0.013654	31.353	0.90928	1.0208
30.000	0.99633	0.015249	35.066	0.81467	1.0208
35.000	0.99610	0.016904	38.936	0.73497	1.0207
40.000	0.99588	0.018612	42.947	0.66714	1.0207
45.000	0.99568	0.020363	47.080	0.60889	1.0207
50.000	0.99550	0.022147	51.316	0.55850	1.0206
55.000	0.99535	0.023955	55.635	0.51458	1.0206
60.000	0.99522	0.025833	60.145	0.47609	1.0205
65.000	0.99510	0.027695	64.650	0.44216	1.0205
70.000	0.99500	0.029575	69.233	0.41209	1.0205
75.000	0.99492	0.031474	73.896	0.38533	1.0204
80.000	0.99485	0.033392	78.642	0.36141	1.0204
85.000	0.99479	0.035324	83.465	0.33995	1.0204
90.000	0.99474	0.037266	88.354	0.32061	1.0203
95.000	0.99469	0.039212	93.298	0.30314	1.0203
100.00	0.99466	0.041155	98.284	0.28729	1.0203

K.-T. Chiang
7/26/04

Temp	DensityAq	DensityVap	DensitySolid	Density2ndLiq
°C	g/ml	g/ml	g/ml	g/ml
20.000	1.0162	0.0	0.0	0.0
25.000	1.0149	0.0	0.0	0.0
30.000	1.0134	0.0	0.0	0.0
35.000	1.0118	0.0	0.0	0.0
40.000	1.0099	0.0	0.0	0.0
45.000	1.0079	0.0	0.0	0.0
50.000	1.0058	0.0	0.0	0.0
55.000	1.0034	0.0	0.0	0.0
60.000	1.0010	0.0	0.0	0.0
65.000	0.99832	0.0	0.0	0.0
70.000	0.99553	0.0	0.0	0.0
75.000	0.99259	0.0	0.0	0.0
80.000	0.98952	0.0	0.0	0.0
85.000	0.98630	0.0	0.0	0.0
90.000	0.98295	0.0	0.0	0.0
95.000	0.97946	0.0	0.0	0.0
100.00	0.97585	0.0	0.0	0.0

Temp	Enthalpy	EnthAq	EnthVap	EnthSolid	Enth2ndLiq
°C	cal	cal	cal	cal	cal
20.000	-3.8866e6	-3.8850e6	0.0	-1512.7	0.0
25.000	-3.8815e6	-3.8800e6	0.0	-1511.5	0.0
30.000	-3.8765e6	-3.8749e6	0.0	-1510.4	0.0
35.000	-3.8714e6	-3.8699e6	0.0	-1509.2	0.0
40.000	-3.8663e6	-3.8648e6	0.0	-1508.0	0.0
45.000	-3.8613e6	-3.8598e6	0.0	-1506.8	0.0
50.000	-3.8562e6	-3.8547e6	0.0	-1505.6	0.0
55.000	-3.8512e6	-3.8497e6	0.0	-1504.4	0.0
60.000	-3.8462e6	-3.8446e6	0.0	-1503.2	0.0
65.000	-3.8411e6	-3.8396e6	0.0	-1502.1	0.0
70.000	-3.8361e6	-3.8346e6	0.0	-1500.9	0.0
75.000	-3.8310e6	-3.8295e6	0.0	-1499.8	0.0
80.000	-3.8260e6	-3.8245e6	0.0	-1498.7	0.0
85.000	-3.8209e6	-3.8194e6	0.0	-1497.7	0.0
90.000	-3.8159e6	-3.8144e6	0.0	-1496.7	0.0
95.000	-3.8108e6	-3.8093e6	0.0	-1495.7	0.0
100.00	-3.8057e6	-3.8042e6	0.0	-1494.8	0.0

Element Balance

K.-T. Chiang
7/26/04

Temp	(+3)Inflow su	(+4)Inflow su	(+1)Inflow su	(+1)Inflow s	(-2)Inflow su	(+2)Inflow s
°C	mol	mol	mol	mol	mol	mol
20.000	0.0	0.0	0.0	0.0	0.0	0.0
25.000	0.0	0.0	0.0	0.0	0.0	0.0
30.000	0.0	0.0	0.0	0.0	0.0	0.0
35.000	0.0	0.0	0.0	0.0	0.0	0.0
40.000	0.0	0.0	0.0	0.0	0.0	0.0
45.000	0.0	0.0	0.0	0.0	0.0	0.0
50.000	0.0	0.0	0.0	0.0	0.0	0.0
55.000	0.0	0.0	0.0	0.0	0.0	0.0
60.000	0.0	0.0	0.0	0.0	0.0	0.0
65.000	0.0	0.0	0.0	0.0	0.0	0.0
70.000	0.0	0.0	0.0	0.0	0.0	0.0
75.000	0.0	0.0	0.0	0.0	0.0	0.0
80.000	0.0	0.0	0.0	0.0	0.0	0.0
85.000	0.0	0.0	0.0	0.0	0.0	0.0
90.000	0.0	0.0	0.0	0.0	0.0	0.0
95.000	0.0	0.0	0.0	0.0	0.0	0.0
100.00	0.0	0.0	0.0	0.0	0.0	0.0

Temp	B(+3)Aq sum	C(+4)Aq sum	H(+1)Aq sum	NA(+1)Aq sum	O(-2)Aq sum	ZN(+2)Aq sum
°C	mol	mol	mol	mol	mol	mol
20.000	0.25900	0.010000	111.94	0.17000	56.465	7.9981e-6
25.000	0.25900	0.010000	111.94	0.17000	56.465	9.6147e-6
30.000	0.25900	0.010000	111.94	0.17000	56.465	1.1362e-5
35.000	0.25900	0.010000	111.94	0.17000	56.465	1.3218e-5
40.000	0.25900	0.010000	111.94	0.17000	56.465	1.5153e-5
45.000	0.25900	0.010000	111.94	0.17000	56.465	1.7134e-5
50.000	0.25900	0.010000	111.94	0.17000	56.465	1.9123e-5
55.000	0.25900	0.010000	111.94	0.17000	56.465	2.1081e-5
60.000	0.25900	0.010000	111.94	0.17000	56.465	2.2969e-5
65.000	0.25900	0.010000	111.94	0.17000	56.465	2.4747e-5
70.000	0.25900	0.010000	111.94	0.17000	56.465	2.6375e-5
75.000	0.25900	0.010000	111.94	0.17000	56.465	2.7815e-5
80.000	0.25900	0.010000	111.94	0.17000	56.465	2.9033e-5
85.000	0.25900	0.010000	111.94	0.17000	56.465	2.9997e-5
90.000	0.25900	0.010000	111.94	0.17000	56.465	3.0681e-5
95.000	0.25900	0.010000	111.94	0.17000	56.465	3.1067e-5
100.00	0.25900	0.010000	111.94	0.17000	56.465	3.1141e-5

Temp	B(+3)Vap sum	C(+4)Vap sum	H(+1)Vap sum	NA(+1)Vap sum	O(-2)Vap sum	ZN(+2)Vap sum
°C	mol	mol	mol	mol	mol	mol
20.000	0.0	0.0	0.0	0.0	0.0	0.0
25.000	0.0	0.0	0.0	0.0	0.0	0.0
30.000	0.0	0.0	0.0	0.0	0.0	0.0
35.000	0.0	0.0	0.0	0.0	0.0	0.0
40.000	0.0	0.0	0.0	0.0	0.0	0.0
45.000	0.0	0.0	0.0	0.0	0.0	0.0

K.T. Chung
7/26/04

Temp	B(+3)Vap sum	C(+4)Vap sum	H(+1)Vap sum	NA(+1)Vap sum	O(-2)Vap sum	ZN(+2)Vap sum
°C	mol	mol	mol	mol	mol	mol
50.000	0.0	0.0	0.0	0.0	0.0	0.0
55.000	0.0	0.0	0.0	0.0	0.0	0.0
60.000	0.0	0.0	0.0	0.0	0.0	0.0
65.000	0.0	0.0	0.0	0.0	0.0	0.0
70.000	0.0	0.0	0.0	0.0	0.0	0.0
75.000	0.0	0.0	0.0	0.0	0.0	0.0
80.000	0.0	0.0	0.0	0.0	0.0	0.0
85.000	0.0	0.0	0.0	0.0	0.0	0.0
90.000	0.0	0.0	0.0	0.0	0.0	0.0
95.000	0.0	0.0	0.0	0.0	0.0	0.0
100.00	0.0	0.0	0.0	0.0	0.0	0.0

Temp	B(+3)Sol sum	C(+4)Sol sum	H(+1)Sol sum	NA(+1)Sol sum	O(-2)Sol sum	ZN(+2)Sol sum
°C	mol	mol	mol	mol	mol	mol
20.000	0.0	0.0	0.019984	0.0	0.019984	9.9920e-3
25.000	0.0	0.0	0.019981	0.0	0.019981	9.9904e-3
30.000	0.0	0.0	0.019977	0.0	0.019977	9.9886e-3
35.000	0.0	0.0	0.019974	0.0	0.019974	9.9868e-3
40.000	0.0	0.0	0.019970	0.0	0.019970	9.9848e-3
45.000	0.0	0.0	0.019966	0.0	0.019966	9.9829e-3
50.000	0.0	0.0	0.019962	0.0	0.019962	9.9809e-3
55.000	0.0	0.0	0.019958	0.0	0.019958	9.9789e-3
60.000	0.0	0.0	0.019954	0.0	0.019954	9.9770e-3
65.000	0.0	0.0	0.019951	0.0	0.019951	9.9753e-3
70.000	0.0	0.0	0.019947	0.0	0.019947	9.9736e-3
75.000	0.0	0.0	0.019944	0.0	0.019944	9.9722e-3
80.000	0.0	0.0	0.019942	0.0	0.019942	9.9710e-3
85.000	0.0	0.0	0.019940	0.0	0.019940	9.9700e-3
90.000	0.0	0.0	0.019939	0.0	0.019939	9.9693e-3
95.000	0.0	0.0	0.019938	0.0	0.019938	9.9689e-3
100.00	0.0	0.0	0.019938	0.0	0.019938	9.9689e-3

Temp	(+3)2ndLiq su	(+4)2ndLiq su	(+1)2ndLiq su	(+1)2ndLiq s	(-2)2ndLiq su	(+2)2ndLiq s
°C	n/a	n/a	n/a	n/a	n/a	n/a
20.000	0.0	0.0	0.0	0.0	0.0	0.0
25.000	0.0	0.0	0.0	0.0	0.0	0.0
30.000	0.0	0.0	0.0	0.0	0.0	0.0
35.000	0.0	0.0	0.0	0.0	0.0	0.0
40.000	0.0	0.0	0.0	0.0	0.0	0.0
45.000	0.0	0.0	0.0	0.0	0.0	0.0
50.000	0.0	0.0	0.0	0.0	0.0	0.0
55.000	0.0	0.0	0.0	0.0	0.0	0.0
60.000	0.0	0.0	0.0	0.0	0.0	0.0
65.000	0.0	0.0	0.0	0.0	0.0	0.0
70.000	0.0	0.0	0.0	0.0	0.0	0.0
75.000	0.0	0.0	0.0	0.0	0.0	0.0

K.T. Chung
7/26/04

Temp	(+3)2ndLiq su	(+4)2ndLiq su	(+1)2ndLiq su	(+1)2ndLiq s	(-2)2ndLiq su	(+2)2ndLiq s
°C	n/a	n/a	n/a	n/a	n/a	n/a
80.000	0.0	0.0	0.0	0.0	0.0	0.0
85.000	0.0	0.0	0.0	0.0	0.0	0.0
90.000	0.0	0.0	0.0	0.0	0.0	0.0
95.000	0.0	0.0	0.0	0.0	0.0	0.0
100.00	0.0	0.0	0.0	0.0	0.0	0.0

K. T. Chang
7/26/04

Calculation Summary

SinglePoint1,2 Calculation for Work1

Automatic Chemistry Model
Databanks:
Public

Unit Set: Default

Isothermal Calculation
Temperature 130.00 °C
Pressure 3.0000 atm

Stream Inflows

H2O	55.508	mol
NaOH	0.17000	mol
B(OH)3	0.25900	mol
ZnCO3	0.0100000	mol

Speciation Summary

Total number of species: **68**

User Inflows	Related Inflows	Aqueous Species	Vapor Species	Solid Species	Second Liquid Species
H2O	CO2	H2O	H2O - Vap	B(OH)3	
NaOH	H2CO3	B(OH)3 - Aq	CO2 - Vap	Na2B4O7	
B(OH)3	Na2B4O7	B(OH)4-1		Na2B4O7.10H2O	
ZnCO3	Na2B4O7.10H2O	B2O(OH)5-1		Na2B4O7.4H2O	
	Na2B4O7.4H2O	B3O3(OH)4-1		Na2B4O7.5H2O	
	Na2B4O7.5H2O	B4O5(OH)4-2		Na2CO3	
	Na2CO3	CO2 - Aq		Na2CO3.10H2O	
	Na2CO3.10H2O	CO3-2		Na2CO3.1H2O	
	Na2CO3.1H2O	H+1		Na2CO3.7H2O	
	Na2CO3.7H2O	HCO3-1		NaB5O8.5H2O	
	NaB(OH)4	Na+1		NaBO2	
	NaB5O8	NaB(OH)4 - Aq		NaBO2.0.5H2O	
	NaB5O8.5H2O	NaCO3-1		NABO2.2H2O	
	NaBO2	NaHCO3 - Aq		NaBO2.4H2O	
	NaBO2.0.5H2O	OH-1		NaHCO3	
	NABO2.2H2O	Zn(OH)2 - Aq		NaOH	
	NaBO2.4H2O	Zn(OH)3-1		NaOH.1H2O	
	NaH2BO3	Zn(OH)4-2		Zn(OH)2	
	NaHCO3	Zn+2		ZnCO3	
	NaOH.1H2O	ZnHCO3+1			
	Zn(HCO3)2	ZnOH+1			
	Zn(OH)2				

Stream Parameters

Stream Amt	55.947	mol

K. T. Chang
7/26/04

Temperature	130.00	°C
Pressure	3.0000	atm
pH	8.8848	pH
Ionic Strength	0.16510	mol/kg H2O
Osmotic Pressure	9.4585	atm
H2OActivity	0.99452	Activity
Electrical Cond, specific	0.053212	1/ohm
Electrical Cond, molar	130.27	cm2/ohm-mol
Viscosity, absolute	0.21719	cP
Viscosity, relative	1.0202	cP/cP H2O

	Total	Aqueous	Vapor	Solid	2nd Liquid
	--	g/ml	g/ml	g/ml	g/ml
Density	--	0.95221	0.0	4.4350	0.0

	Total	Aqueous	Vapor	Solid	2nd Liquid
	cal	cal	cal	cal	cal
Enthalpy	-3.7753e6	-3.7742e6	0.0	-1112.5	0.0

Total and Phase Flows (Amounts)

	Total	Aqueous	Vapor	Solid	2nd Liquid
	mol	mol	mol	mol	mol
Mole	55.952	55.946	0.0	5.7922e-3	0.0

	Total	Aqueous	Vapor	Solid	2nd Liquid
	g	g	g	g	g
Mass	1024.1	1023.3	0.0	0.72634	0.0

	Total	Aqueous	Vapor	Solid	2nd Liquid
	L	L	L	L	L
Volume	1.0749	1.0747	0.0	1.6378e-4	0.0

Scaling Tendencies

solids within temperature range		**Temperature Range**		
ZnCO3	1.0000	data valid through range		inside range
B(OH)3	5.1229e-3	0.0	160.00 °C	inside range
NaHCO3	3.0886e-4	0.0	200.00 °C	inside range
Na2B4O7.4H2O	2.0214e-6	58.500	140.00 °C	inside range
Na2CO3	1.3324e-6	109.00	200.00 °C	inside range

Species Output (True Species)

K.T. Chang
7/26/04

	Total	Aqueous	Vapor	Solid	2nd Liquid
	mol	mol	mol	mol	n/a
H2O	55.554	55.554	0.0	0.0	0.0
B(OH)3	0.059349	0.059349	0.0	0.0	0.0
ZnCO3	5.7922e-3	0.0	0.0	5.7922e-3	0.0
CO2	9.2650e-6	9.2650e-6	0.0	0.0	0.0
NaB(OH)4	7.4854e-3	7.4854e-3	0.0	0.0	0.0
NaHCO3	7.4675e-4	7.4675e-4	0.0	0.0	0.0
Zn(OH)2	7.8521e-4	7.8521e-4	0.0	0.0	0.0
B(OH)4-1	0.12623	0.12623	0.0	0.0	0.0
B2O(OH)5-1	0.018249	0.018249	0.0	0.0	0.0
B3O3(OH)4-1	7.6977e-3	7.6977e-3	0.0	0.0	0.0
B4O5(OH)4-2	1.5876e-3	1.5876e-3	0.0	0.0	0.0
CO3-2	5.3197e-4	5.3197e-4	0.0	0.0	0.0
H+1	1.9071e-9	1.9071e-9	0.0	0.0	0.0
HCO3-1	2.8998e-3	2.8998e-3	0.0	0.0	0.0
Na+1	0.16175	0.16175	0.0	0.0	0.0
NaCO3-1	2.0054e-5	2.0054e-5	0.0	0.0	0.0
OH-1	1.6242e-3	1.6242e-3	0.0	0.0	0.0
Zn(OH)3-1	2.0566e-3	2.0566e-3	0.0	0.0	0.0
Zn(OH)4-2	3.4145e-5	3.4145e-5	0.0	0.0	0.0
Zn+2	2.2405e-7	2.2405e-7	0.0	0.0	0.0
ZnHCO3+1	2.7431e-9	2.7431e-9	0.0	0.0	0.0
ZnOH+1	1.3317e-3	1.3317e-3	0.0	0.0	0.0

Molecular Output (Apparent Species)

	Total	Aqueous	Vapor	Solid	2nd Liquid
	mol	mol	mol	mol	n/a
H2O	55.977	55.977	0.0	0.0	0.0
ZnCO3	5.7922e-3	0.0	0.0	5.7922e-3	0.0
CO2	4.2078e-3	4.2078e-3	0.0	0.0	0.0
NaB5O8	0.022250	0.022250	0.0	0.0	0.0
NaBO2	0.14775	0.14775	0.0	0.0	0.0
Zn(OH)2	4.2078e-3	4.2078e-3	0.0	0.0	0.0

Element Balance

K.T. Chang
7/26/04

	Total	Aqueous	Vapor	Solid	2nd Liquid
	mol	mol	mol	mol	n/a
B(+3)	0.0	0.25900	0.0	0.0	0.0
C(+4)	0.0	4.2078e-3	0.0	5.7922e-3	0.0
H(+1)	0.0	111.96	0.0	0.0	0.0
NA(+1)	0.0	0.17000	0.0	0.0	0.0
O(-2)	0.0	56.468	0.0	0.017377	0.0
ZN(+2)	0.0	4.2078e-3	0.0	5.7922e-3	0.0

K.T. Chiang 7/26/04

FORM FOR REQUESTING WORK FROM OTHER DIVISIONS

A. TO BE COMPLETED BY DIVISION 20 PERSONNEL

Requester: Ken Chiang Request Date: 7/20/04
Project No.: 20.10542.02.002 Phone No.: x2808
Description of Work Requested:

Total ICP Analysis

2 Solutions Filtered .45μm - Please Do Not Filter the Other Two

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

QUALITY REQUIREMENTS: The work requested is governed by the CNWRA Quality Assurance Program which addresses requirements of 10CFR50, Appendix B. Personnel performing this work shall be qualified under the CNWRA QA program or equivalently under the SwRI Nuclear QA program. Test and analysis methods shall be documented by approved procedures or recognized, standard methods. Measuring and test equipment shall be calibrated and controlled according to CNWRA and SwRI Nuclear QA program requirements.

Sample Identification	Description
4-6 D	$H_3BO_3 + NaOH + ZnCO_3$
4-6 D Filtered	
5-6 D	$H_3BO_3 + NaOH + CaCl_2$
5-6 D Filtered	

B. TO BE COMPLETED BY DIVISION PERFORMING WORK[1]

☐ Optical Microscopy ☐ SEM ☐ Hardness ☐ Profilometer ☐ Auger ☐ Other

Person Assigned: Signature:
Division: Date:

Make, Model & Serial No. of Equipment Used (*attach list if necessary*):

Software Used (If any):

Standards Used (If any):

Photographic Negative Numbers (If Applicable):

[1] Please sign and date any hardcopy of analysis or list of photographs (The photographs themselves need not be signed). If error occurred during entry, do not erase or overwrite, but strikeout with single line, initial and date, and then reenter correct information.

7/27/04

SAMPLE LIST/CHAIN OF CUSTODY

Southwest Research Institute
Chemistry and Chemical Engineering Division
6220 Culebra Road
San Antonio, Texas 78238-5166

Client Purchase Order/Other ID

Site/Zone ID

Requested Turnaround:
☐ 2 Weeks
☐ 3 Weeks
☐ Other: ASAP Thurs 5pm

SwRI Contact
Ken Chiang
x 2308

Analyses Requested

REMARKS
Preservation
a = HCl to pH <2
b = HNO_3 to pH <2
c = H_2SO_4 to pH <2
d = NaOH to pH >12
e = Cool (4°C±2°C)
f = Other (specify)

ICP Analysis Total ICP

Sample ID	Sample Collection Date (mm/dd/yy)	Sample Collection Time	Matrix Type	Sample Type	# of Containers
4-6 D	7/20	2:30 pm	L		1
4-6 D Filtered			L		1
5-6 D			L		1
5-6 D Filtered			L		1

Client: Ken Chiang CNWRA Div 20
Shipper Name/ Address:

Matrix Types:
A – Air
B – Biota
D - Dust
E – Emission/Stack
L - Liquid
P – Product
Sd - Solid
S – Soil
SED – Sediment
T - Tissue
W - Water
WP - Wipe

Sample Types:
D - Duplicate
ER – Equipment Rinsate
ES – Environmental Sample
FB – Field Blank
FD – Field Duplicate
MS – Matrix Spike
MSD – Matrix Spike Dup
TB – Trip Blank

Temp:
Therm #:
Comments: Please do not Filter samples that are marked as Filtered

Relinquished by (Print/Signature)	Date 7/20/04	Time 3:25 pm	SwRI Project#: 20.10342.002
Received by (Print/Signature)	Date	Time	Received by SwRI Lab: (Signature)
Relinquished by (Print/Signature)	Date	Time	Date / Time
Received by (Print/Signature)	Date	Time	Samples Disposed: Date / Time
Relinquished by (Print/Signature)	Date	Time	Samples Disposed by:

Page ___ of ___

Div 01 COC Form 01-01-001, Rev 8/02

These test were conducted In the Autoclave
(see pg #17 And #35) Temperature of 130°C
Thermocouple #331 cal 5/5/04 11/5/04 Due date
Omega Microprocesson thermometer SN# T 941140 cal 4/27/04 Due 10/27/04

Test ID #4-6D Solution
0.259 m H_3BO_3 = 16.015g Lot# C20H17
0.17 m $NaOH$ = 6.804g Lot# 033972
0.01 m $ZnCl_2$ = 1.264g Lot# 026803
+ DI water 1000 mls

We stirred the Autoclave once It Reach Temperature
Reached temp @ 6:42 A.M Temp = 134.6°C
Removed stirred for 8 min Returned To heat @ 128.9°C

Removed Aro stirred Again @ 7:38 A.m for 5 min Temp = 134.2°C
After Stirred 5 min Returned to heat @ 130.2°C

Removed Aro stirred Again @ 8:45 A.M for 5 min Temp = 133.6 C
After Stirred 5 min Returned To heat @ 130.1°C

Removed Aro stirred Again @ 9:50 for 5 min Temp = 135.6°C
After stirred 5 min Returned To heat @ 131.2°C

maintained 130°C for 4 hrs pulled Sample
@ 2:40 pm for ICP Analysis see pg #89 & #90 7/27/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-6 D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248204

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.284	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2394	10
Cadmium	<0.02	0.02
Calcium	1.21	0.4
Chromium	0.052	0.02
Cobalt	<0.02	0.02
Copper	0.085	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	<0.2	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	0.225	0.1
Silver	<0.06	0.06
Sodium	3189	20
Strontium	<0.02	0.02
Sulfur	<0.2	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	0.110	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	14.6	0.02
Zirconium	<0.02	0.02

7/27/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-6 D Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248205

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.188	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.056	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2448	10
Cadmium	<0.01	0.01
Calcium	1.02	0.1
Chromium	0.057	0.01
Cobalt	<0.02	0.02
Copper	0.040	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	0.101	0.1
Manganese	<0.01	0.01
Molybdenum	0.057	0.01
Nickel	0.015	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.50	0.4
Selenium	<0.02	0.02
Silicon	0.442	0.05
Silver	<0.02	0.02
Sodium	3228	20
Strontium	0.013	0.01
Sulfur	0.159	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	0.032	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.66	0.01
Zirconium	<0.01	0.01

7/27/04

this test was conducted In the Autoclave
(See pg #17 And #35) Temperature of 130°C
thermocouple #331 cal 5/5/04 due 11/5/04
Omega Microprocesson thermometer sn# T94140 cal 4/27/04 due 10/27/04

Test ID # 5-6 D

0.259 m H_3BO_3 = 16.019g Lot# C20H17
0.17 m $NaOH$ = 6.830g Lot# 033572
0.01 m $CaCO_3$ = 1.017g Lot# 026003
+ DI water 1000 mls

We stirred the Autoclave one It Reached Temperature
Reached Temp @ 6:50 A.m Temp. 133.9°C
Removed stirrer for 5 min Returned to heat @ 129.8°C

Removed And stirred Again @ 8:07 A.m for 8 min Temp = 137.1°C
After stirring 8 min Returned To heat @ 131.0°C

Removed And stirred Again @ 9:15 A.m for 5 min Temp = 133.5°C
After stirring 5 min Returned To heat @ 129.6°C

Removed And stirred Again @ 10:42 A.m for 5 min Temp = 134.7°C
After stirring 5 min Returned to heat @ 131.2°C

Maintained 130°C for 4 hrs then pulled samples @ 2:45 pm
for ICP Analysis See pg # 89 & #90

7/27/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-6 D not filtered

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Lab System ID: 248206

Client: Division 20
Date Received: 07/20/04
Project No.: 10542.02.002
SRR: 26225
TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.236	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2484	10
Cadmium	<0.02	0.02
Calcium	20.4	0.4
Chromium	0.094	0.02
Cobalt	<0.02	0.02
Copper	0.043	0.02
Iron	0.255	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	0.289	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	0.034	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	0.652	0.1
Silver	<0.06	0.06
Sodium	3307	20
Strontium	0.078	0.02
Sulfur	0.305	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	0.056	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	1.95	0.02
Zirconium	<0.02	0.02

7/27/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
5-6 D Filtered ✓

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248207

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.133	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.107	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2607	10
Cadmium	<0.01	0.01
Calcium	13.4	0.1
Chromium	0.040	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	0.251	0.1
Manganese	<0.01	0.01
Molybdenum	0.013	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.55	0.4
Selenium	<0.02	0.02
Silicon	1.11	0.05
Silver	<0.02	0.02
Sodium	3410	20
Strontium	0.079	0.01
Sulfur	0.277	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.26	0.01
Zirconium	<0.01	0.01

Ca
13.4 / 40.1 = 3.34 x 10^-4

B
2607 x 10^-3 / 10.8 = 0.241

Na
3410 / 23 x 10^-3 = 0.1483

7/27/04

Final Report on ICP Analysis, Sample submitted June 16, 2004

MEMORANDUM

TO: **Kuang-Tsan Chiang**
Division 20 Bldg. 57

FROM: **Mike Dammann**

RE: **Project No.: 10542.02.002**
Task Order: 040617-9
SRR: 26058
Samples Received: June 16, 2004

Analysis of liquid samples by ICP and IC.

Raw data and nuclear safety documentation for this project are archived in Division 20 records control and Division 01 QA.

DATE: **July 26, 2004**

Enclosed, please find the sample results for the analyses referenced above.

The analyses performed comply with the SwRI Program Quality Plan, Document No. PQP-Nuclear Rev. 1, 10CFR 50 Appendix B, 10CFR 21, and 01-QPP-015 Revision 4.

If there are any questions, please feel free to contact me by voice mail at 522-5428 or by fax at 522-3649. I look forward to our continued analytical support of your projects.

Mike Dammann

Manager, Inorganic Group

for **Jo Ann Boyd**

Manager, Div. 01 Quality Assurance

K. T. Chiang 7/28/04

010001

SOUTHWEST RESEARCH INSTITUTE
NUCLEAR PROJECT
CLIENT: Division 20
TASK ORDER: 040617-9
SRR: 26058
SDG: 246146
CASE: CNWRA
VTSR: June 16, 2004
PROJECT#: 10542.02.002

FINAL REPORT

K. J. Chiang
7/28/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010002

Sample ID
4-2A ZN25

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246146

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	2665	0.20
Calcium	0.413	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.37	0.500
Sodium	3465	0.500
Zinc	0.121	0.01
Chloride	<2	2
Nitrate-N	<2	2

K. J. Chiang
7/28/04

SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY 010003

Sample ID
4-2A ZN25

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246146

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Boron	2665	2668	0.11%
Calcium	0.413	0.410	0.73%
Iron	<0.200	<0.200	0.00%
Lead	<0.030	<0.030	0.00%
Nickel	<0.020	<0.020	0.00%
Potassium	2.37	2.34	1.27%
Sodium	3465	3454	0.32%
Zinc	0.121	0.120	0.83%
Chloride	<2	<2	0.00%
Nitrate-N	<2	<2	0.00%

K.J. Chiang
7/28/04

SOUTHWEST RESEARCH INSTITUTE

MATRIX SPIKE SUMMARY 010004

Sample ID
4-2A ZN25

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246146

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Boron	2665	2696	NA	NA
Calcium	0.413	38.5	40.0	95.2%
Iron	<0.200	2.02	2.00	101%
Lead	<0.030	0.969	1.00	96.9%
Nickel	<0.020	0.926	1.00	92.6%
Potassium	2.37	53.0	40.0	127%
Sodium	3465	3470	40.0	12.5%
Zinc	0.121	1.10	1.00	97.9%
Chloride	<2	39.5	40.0	98.8%
Nitrate-N	<2	15.1	18.1	83.4%

Note: Boron was not added to the sample matrix spike.

Note: The sodium spikes are low due to the sample concentrations being greater than 85 times the spike amounts added.

K.J. Chiang
7/28/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

010005
Sample ID
4-2B ZN60

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246147

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	3101	0.20
Calcium	1.08	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.26	0.500
Sodium	4006	0.500
Zinc	0.390	0.01
Chloride	<2	2
Nitrate-N	<2	2

K. T. Chiang
7/28/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

010006
Sample ID
4-2C ZN90

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246148

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	3741	0.20
Calcium	1.76	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.46	0.500
Sodium	4849	0.500
Zinc	1.00	0.01
Chloride	<2	2
Nitrate-N	<2	2

K. T. Chiang
7/28/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010007

Sample ID
4-2D ZN130

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246149

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	4239	0.20
Calcium	0.605	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	3.78	0.500
Sodium	5296	0.500
Zinc	3.13	0.01
Chloride	3.15	2
Nitrate-N	<2	2

K. J. Chiang
7/28/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010008

Sample ID
5-2A Ca25

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246150

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	2694	0.20
Calcium	32.1	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.34	0.500
Sodium	3456	0.500
Zinc	0.044	0.01
Chloride	2.35	2
Nitrate-N	<2	2

K. J. Chiang
7/28/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

010009

Sample ID
5-2B Ca60

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246151

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	3159	0.20
Calcium	33.1	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	2.50	0.500
Sodium	3892	0.500
Zinc	0.080	0.01
Chloride	2.08	2
Nitrate-N	<2	2

K. J. Chung
7/28/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

010010

Sample ID
5-2C Ca90

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246152

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	3729	0.20
Calcium	34.3	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	3.36	0.500
Sodium	4843	0.500
Zinc	0.154	0.01
Chloride	2.28	2
Nitrate-N	<2	2

K. J. Chung
7/28/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010011

Sample ID
5-2D Ca130

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 06/16/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: 246153

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	4287	0.20
Calcium	25.9	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	4.30	0.500
Sodium	5310	0.500
Zinc	0.244	0.01
Chloride	2.69	2
Nitrate-N	<2	2

K. J. Chung
7/28/04

SOUTHWEST RESEARCH INSTITUTE

LABORATORY CONTROL SAMPLE

010012
Sample ID
LCSW

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: NA

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: NA

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Boron	4.78	5.00	95.6%
Calcium	39.7	40.0	99.3%
Iron	2.29	2.00	115%
Lead	0.984	1.00	98.4%
Nickel	0.988	1.00	98.8%
Potassium	38.4	40.0	96.0%
Sodium	38.6	40.0	96.5%
Zinc	0.983	1.00	98.3%
Chloride	205	200	103%
Nitrate-N	84.5	90.4	93.5%

NA- Not Applicable.

K. J. Chung
7/28/04

SOUTHWEST RESEARCH INSTITUTE

BLANK SUMMARY

010013

Sample ID
PBW

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: NA

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040617-9

SRR: 26058

Lab System ID: NA

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Boron	<0.200	0.20
Calcium	<0.200	0.20
Iron	<0.200	0.20
Lead	<0.030	0.03
Nickel	<0.020	0.02
Potassium	<0.500	0.500
Sodium	<0.500	0.500
Zinc	<0.010	0.01
Chloride	<0.1	0.1
Nitrate-N	<0.1	0.1

NA- Not Applicable.

K. T. Chuang
7/28/04

Final Report

A.3 Experimental Validation Tests and Analyses

Three sets of experiments were performed to support validation of the OLI Systems, Inc. software for borated water. The validation tests involved determination of solubility of compounds by mixing 0.259 mol H_3BO_3, 0.17 mol NaOH, and 0.01 mol $ZnCO_3$ or $CaCO_3$ in 1,000 mL water. The validation test matrix is shown in Table A–6.

A.3.1 Validation Test Method

The 25 and 60 °C [77 and 140 °F] tests were performed in open polytetrafluoroethylene beakers. The 90 °C [194 °F] tests were performed in a sealed glass cell to avoid excessive evaporation. The water–solid mixtures were stirred for 4 hours and held for another 4 hours to allow the solid to settle at the bottom of the polytetrafluoroethylene beakers or the glass cell. At the end of the 4-hour hold, samples were taken from the upper section of the beaker or glass cell using a syringe through a 0.45-µm [1.77 × 10^{-5}-in] filter to prevent the suspended solid particles from entering the sample. Because of the high water pressure of the solid–water mixture, the 130 °C [266 °F] tests were conducted in a polytetrafluoroethylene-lined autoclave composed of a nickel-based alloy that allowed the mixing by a polytetrafluoroethylene-sheathed magnetic stir bar. At the end of the 4-hour hold, approximately 80 mL [2.7 oz] of liquid were siphoned from the upper section of the autoclave to a beaker through a 3.18-mm [0.125-in]-diameter stainless steel tubing. The tubing was slightly cooled so that the liquid temperature exiting the tubing was lower than 100 °C [212 °F] to avoid evaporation. A syringe was used to take the sample from the beaker, while the liquid was still hot, through a 0.45-µm [1.77 × 10^{-5}-in] filter to prevent the suspended solid particle from entering the sample.

Two types of analyses were performed in supporting validation of the OLI Systems, Inc. software for borated water. The primary method was inductively coupled plasma emission spectrophotometry analysis, and the second method was atomic absorption spectrophotometry analysis. Brief descriptions of the analysis methods are given in the following paragraphs.

The inductively coupled plasma spectrophotometer utilizes plasma to excite elemental electrons that produce photons unique to each element (Vela, et al.,1993; Winge, 1985). Advantages of using inductively coupled plasma include its ability to identify and quantify all metallic and

Table A–6. Validation Test Matrix

	Solution	Temperature (°C) [°F]			
		25 [77]	60 [140]	90 [194]	130 [266]
Test 1	1,000 mL H_2O, 0.259 mol H_3BO_3, 0.17 mol NaOH	X	X	X	—
Test 2	1,000 mL H_2O, 0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $ZnCO_3$	X	X	X	X
Test 3	1,000 mL H_2O, 0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $CaCO_3$	X	X	X	X

K. T. Chuang
7/29/04

nonmetallic elements in an aqueous solution with the exception of argon. In this method, elements entering the hot plasma are vaporized and excited, resulting in the emission of characteristic wavelengths of the element. The intensity of that emission can be used to quantify the amount of the element. Two inductively coupled plasmas were utilized, a Thermo Jarrell Ash Inductively Coupled Plasma Spectrometer Model ICAP 61 Trace Analyzer and a Spectro Inductively Coupled Plasma Spectrometer Model FME–05. The instruments were calibrated daily using traceable standards from the National Institute of Standards and Technology. The detection limit by inductively coupled plasma is 2.5×10^{-6} mol [0.1 ppm] for calcium and 1.5×10^{-6} mol [0.01 ppm] for zinc.

Atomic-absorption spectroscopy was employed on selected samples to verify the zinc and calcium results from inductively coupled plasma. The method uses the absorption of light to measure the concentration of gas-phase atoms in a sample solution (Elwell and Gidley, 1966; Perkin-Elmer Corporation, 1971). Concentrations are determined from a working curve after calibrating the instrument with standards of known concentrations. The calcium and zinc contents of the 25 °C [77 °F] samples were analyzed using a Perkin-Elmer Model 3100 Atomic Absorption Spectrophotometer. Calcium and zinc elements were analyzed independently. Calcium analyses were performed with a copper-iron-manganese-zinc hollow cathode lamp at a 422.7-nm [16.64×10^{-6}-in] wavelength using an air-acetylene flame. The detection limits are 5.0×10^{-6} mol [0.2 ppm] for calcium and 7.6×10^{-7} mol [0.05 ppm] for zinc. Zinc analyses were performed using a calcium-magnesium hollow cathode lamp at 213.9-nm [8.42×10^{-6}-in] wavelength, using an air-acetylene flame. Five absorbency measurements were recorded for each sample, and the average values were reported.

Table A–7 compares the measured values from inductively coupled plasma and atomic absorption analyses on two calcium-containing solutions and one zinc-containing solution. For the calcium-containing solutions, samples were taken after 4 hours and after 360 hours hold times. Identical solutions were submitted for atomic absorption and inductively coupled plasma analysis for comparison. For the 4-hour samples, the atomic absorption and inductively coupled plasma measurements yield an identical value of 8.03×10^{-4} mol. For the 360-hour samples, the

Table A–7. Comparison of Atomic Absorption and Inductively Coupled Plasma Measurements

Test Solution in 1,000 mL Water at 25 °C [77 °F]	Component	Atomic Absorption Measurement (mol)	Inductively Coupled Plasma Measurement (mol)	Percent Difference (%)
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $CaCO_3$	Calcium	8.03×10^{-4}*	8.03×10^{-4}*	0
		8.33×10^{-4}†	8.08×10^{-4}†	3.0
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $ZnCO_3$	Zinc	4.89×10^{-6}†	4.6×10^{-6}†	5.9

*Samples taken after 4 hours.
†Samples taken after 360 hours.

K.J. Chiang
7/29/04

inductively coupled plasma measurement yields 8.08×10^{-4} mol while the atomic absorption measurement yields 8.33×10^{-4} mol, a difference of approximately 3 percent. For the zinc-containing solution, samples were taken after the solution was settled for 360 hours. The inductively coupled plasma measurement yields a zinc content of 4.6×10^{-6} mol, while the atomic absorption yields a measurement of 4.89×10^{-6} mol. The measurement difference from the two methods is approximately 6 percent. The results show that the zinc and calcium measurements by inductively coupled plasma and atomic absorption are consistent.

A.3.2 Comparison of OLI Systems, Inc. Simulation with Experimental Results

Inductively coupled plasma analyses were performed on all solutions listed in Table A–6 to support validation of the OLI Systems, Inc. software. The OLI simulation results for the soluble and insoluble phases for sodium and boron in zinc- and calcium-containing solutions are presented in Tables A–8, A–9, A–10, and A–11 for 25, 60, 90, and 130°C [77, 140, 194, and 266 °F] tests. The inductively coupled plasma analysis results are also shown in the corresponding tables for comparisons. In the tables, the amount of solid phase for calcium and zinc was obtained as a difference between the amount added to the solution and its soluble component.

The results show good agreement between OLI Systems, Inc. simulations and experimental data for sodium and boron in borated water containing zinc or calcium. Except for 130 °C [266 °F], the results also show a good agreement for the insoluble phases of $CaCO_3$ and $ZnCO_3$. The amount of insoluble phase was estimated by subtracting the amount of soluble phase from the total amount added to the test solution. However, significant variance was observed between OLI Systems, Inc. simulations and experimental data for the soluble phases of $CaCO_3$ and $ZnCO_3$. The variance observed for the soluble phases of $CaCO_3$ is attributed to the large degree of variation in the published solubility data used in the OLI database. For example, the solubility of $CaCO_3$ in water at about 16 °C [60 °F] was 0.9991×10^{-4} mol/kg-water from one published source and 1.449×10^{-4} mol/kg-water from another published source.[2] The variance observed for the soluble $ZnCO_3$ is probably also due to the variations in the published data used in the OLI database. The calculated results for the soluble phases of $CaCO_3$ and $ZnCO_3$ are approximately the same orders of magnitude as the measured results except for $ZnCO_3$ at 130 °C [266 °F]. At 130 °C [266 °F], the measured amount of soluble $ZnCO_3$ was two orders of magnitude lower than that predicted by the OLI Systems, Inc simulation. Detailed analysis of the simulation indicated that the insoluble phase was present as $Zn(OH)_2$ below 105 °C [221 °F] and as $ZnCO_3$ above105 °C [221 °F]. This discrepancy may be due to error(s) in the $ZnCO_3$ database or the uncertainty of the $ZnCO_3$ thermodynamic data at temperatures above 105 °C [221 °F]. The results also show that the calculated trends for the dependence of the solubilities of both $CaCO_3$ and $ZnCO_3$ on temperature are the same as the measured trends.

It should be noted, however, that the estimation of insoluble phases by the subtraction of the soluble phases from added amounts of $CaCO_3$ and $ZnCO_3$ shows a good agreement between OLI Systems, Inc simulation and experimental data. This indicates that despite large variance in the soluble phase, both $CaCO_3$ and $ZnCO_3$ are expected to have low solubility.

[2]Personal communication with Andre Anderko, OLI Systems, Inc., July 2004.

K.J. Chiang
7/29/04

A.4 Summary

Computational thermodynamics simulation calculations were conducted using Environmental Simulation Program (ESP) Version 6.6® (OLI Systems, Inc., 2002a) and StreamAnalyzer Version 1.2® (OLI Systems, Inc., 2002b). OLI Systems, Inc. software was validated by comparing simulation results with data on borated water published in the literature and with results of solubility type experiments using borated water containing $CaCO_3$ or $ZnCO_3$ in the temperature range of 25°C [77°F] to 130°C [266°F]. Data showed a good agreement between published literature and OLI Systems, Inc. simulation. Except for $ZnCO_3$ at 130°C [266°F], the experimentally measured solubility data agreed with the OLI Systems, Inc. simulation results for the dominant solid or soluble phases, including aqueous H_3BO_3, aqueous NaOH, and solid $CaCO_3$ or solid $ZnCO_3$. A large variation was observed for soluble phases of zinc and calcium and was attributed to variation and uncertainty in published data used in OLI Systems, Inc. software database.

A.5 References

Elwell, W.T. and J.A.F. Gidley. *Atomic Absorption Spectrophotometry*. 2nd Edition. New York City, New York: Pergamon Press. 1966.

Perkin-Elmer Corporation. "Analytical Method for Atomic Absorption Spectrophotometry." Norwalk, Connecticut: Perkin-Elmer Corporation. 1971.

Vela, N.P., L.K. Olson, and J.A. Caruso. "Elemental Speciation with Plasma Mass Spectrometry." Analytical Chemistry. Vol. 65, No. 13. pp. 584A–597A. 1993.

Winge, R.K. *Inductively Coupled Plasma-Emission Spectroscopy: An Atlas of Spectral Information*. New York City, New York: John Wiley and Sons. 1985.

K.T. Chiang
7/29/04

Table A–8. Distribution of Soluble and Insoluble Phases in Boric Acid and Sodium Hydroxide Solutions Containing Zinc and Calcium at 25 °C [77 °F]

Test Solution in 1,000 mL Water at 25 °C [77 °F]	Element	Amount (mol)	OLI Systems, Inc. Simulation (mol)		Inductively Coupled Plasma Analyses (mol)		Percent Difference	
			Soluble Phase	Insoluble Phase	Soluble Phase	Insoluble Phase*	Soluble Phase	Insoluble Phase
0.259 mol H_3BO_3, 0.17 mol NaOH	Boron	0.259	0.259	0	0.239	—	7.7	—
	Sodium	0.17	0.17	0	0.147	—	13.5	—
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $ZnCO_3$	Boron	0.259	0.259	0	0.247	—	4.6	—
	Sodium	0.17	0.17	0	0.151	—	11.2	—
	Zinc	0.01	9.8×10^{-6}	9.99×10^{-3}	1.85×10^{-6}†	9.99×10^{-3}	81.1	0
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $CaCO_3$	Boron	0.259	0.259	0	0.249	—	3.9	—
	Sodium	0.17	0.17	0	0.15	—	11.8	—
	Calcium	0.01	5.2×10^{-4}	9.48×10^{-3}	8.0×10^{-4}	9.2×10^{-3}	−53.8	−3

*Estimated from the analysis of soluble species.
†Number close to detection limit, indicating extremely low solubility.

K.T. Chiang
7/29/04

Table A–9. Distribution of Soluble and Insoluble Phases in Boric Acid and Sodium Hydroxide Solutions Containing Zinc and Calcium at 60 °C [140 °F]

Test Solution in 1,000 mL Water at 60 °C [140 °F]	Element	Amount (mol)	OLI Systems, Inc. Simulation (mol)		Inductively Coupled Plasma Analyses (mol)		Percent Difference	
			Soluble Phase	Insoluble Phase	Soluble Phase	Insoluble Phase*	Soluble Phase	Insoluble Phase
0.259 mol H_3BO_3, 0.17 mol NaOH	Boron	0.259	0.259	0	0.229	—	11.6	—
	Sodium	0.17	0.17	0	0.141	—	17.1	—
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $ZnCO_3$	Boron	0.259	0.259	0	0.287	—	-10.8	—
	Sodium	0.17	0.17	0	0.174	—	-2.4	—
	Zinc	0.01	2.4×10^{-5}	9.98×10^{-3}	6.0×10^{-6}†	9.99×10^{-3}	-74.0	-0.1
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $CaCO_3$	Boron	0.259	0.259	0	0.292	—	-12.7	—
	Sodium	0.17	0.17	0	0.169	—	0.6	—
	Calcium	0.01	4.5×10^{-4}	9.55×10^{-3}	8.3×10^{-4}	9.2×10^{-3}	-84.4	4.0

*Estimated from the analysis of soluble species.
†Number close to detection limit, indicating extremely low solubility.

K.J. Chang 7/29/05

Table A–10. Distribution of Soluble and Insoluble Phases in Boric Acid and Sodium Hydroxide Solutions Containing Zinc and Calcium at 90 °C [194 °F]

Test Solution in 1,000 mL Water at 90 °C [194 °F]	Element	Amount (mol)	OLI Systems, Inc. Simulation (mol)		Inductively Coupled Plasma Analyses (mol)		Percent Difference	
			Soluble Phase	Insoluble Phase	Soluble Phase	Insoluble Phase*	Soluble Phase	Insoluble Phase
0.259 mol H_3BO_3, 0.17 mol NaOH	Boron	0.259	0.259	0	0.240	—	7.3	—
	Sodium	0.17	0.17	0	0.147	—	13.5	—
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $ZnCO_3$	Boron	0.259	0.259	0	0.257	—	0.8	—
	Sodium	0.17	0.17	0	0.161	—	5.3	—
	Zinc	0.01	3.07×10^{-5}	9.97×10^{-3}	1.76×10^{-5}	9.98×10^{-3}	43.7	-0.1
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $CaCO_3$	Boron	0.259	0.259	0	0.259	—	0	—
	Sodium	0.17	0.17	0	0.16	—	5.9	—
	Calcium	0.01	3.72×10^{-4}	9.63×10^{-3}	5.36×10^{-4}	9.46×10^{-3}	-44.1	1.8

*Estimated from the analysis of soluble species.

K.J. Chang 7/29/05

Table A–11. Distribution of Soluble and Insoluble Phases in Boric Acid and Sodium Hydroxide Solutions Containing Zinc and Calcium at 130 °C [266 °F]

Test Solution in 1,000 mL Water at 130 °C [266 °F]	Element	Amount (mol)	OLI Systems, Inc. Simulation (mol)		Inductively Coupled Plasma Analyses (mol)		Percent Difference	
			Soluble Phase	Insoluble Phase	Soluble Phase	Insoluble Phase*	Soluble Phase	Insoluble Phase
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $ZnCO_3$	Boron	0.259	0.259	0	0.226	—	12.7	—
	Sodium	0.17	0.17	0	0.14	—	17.6	—
	Zinc	0.01	4.21×10^{-3}	5.79×10^{-3}	2.54×10^{-5}	9.97×10^{-3}	99.4	72.2
0.259 mol H_3BO_3, 0.17 mol NaOH, 0.01 mol $CaCO_3$	Boron	0.259	0.259	0	0.241	—	6.9	—
	Sodium	0.17	0.17	0	0.148	—	12.9	—
	Calcium	0.01	2.88×10^{-4}	9.71×10^{-3}	3.34×10^{-4}	9.67×10^{-3}	−16.0	0.4

*Estimated from the analysis of soluble species.

K.J. Chiang
7/29/04

REVISION
Institute Quality Assurance Surveillance Report

Project Number: 20-10542	**Report Number:** 2004-SR-0193	**Page 1 of** 1

Surveillance Scope: Monitor the Tests for Trace Metal Analysis by ICP in Division 01. The client is NRC High Level Waste Program. This is a QA Nuclear surveillance.

Reference Documents: Documentation test packages for Task Orders 040706-3, 040713-4, 040714-12, and 040720-10

Starting Date: 2004-07-10 **Ending Date:** 2004-07-29

Institute QA Representative: Mark R. Ehnstrom

Person(s) Conducting Test/Exam/Procedure: D. Harris

Satisfactory Findings: The test activities were performed on samples provided by Division 20 personnel. Laboratory Task Order Numbers were issued and the samples were given a system ID number. Two samples, 247108 and 247357 were observed in the laboratory. Both were marked with the system ID and Division 20 sample number along with a sticker clearly identifying it as a nuclear sample. The location of the samples was tracked through the Sample Log In System. The Laboratory Task Order sheet made reference to 10CFR 50, Appendix B and to 10CFR Part 21. A "Form for Requesting Work From Other Divisions" was used to inform Division 01 of the types of tests to be performed. A "Sample List/Chain of Custody" form was also used to assure positive control and responsibility for the samples.

Data package review found:

- Test results for the samples to be clear and appropriately identified
- Calibration data on the specific instrumentation used during the testing
- Certificates of Analysis, Reports of Certificates, and Certificates of Reference Materials used to calibrate test instrumentation and/or used during the test.

When appropriate, test documentation referenced traceability back to the National Institute of Standards and Technology. Test results had been reviewed by Division 01 supervisory personnel.

Unsatisfactory Findings: N/A

Nonconformance Report Number: N/A **CAR/SCAR Number:** N/A

Attachments: None

Recommendations/Actions: N/A

Equipment Calibration: None

Approved: "/s/ R. Weber"
Institute Quality Assurance

Date: 7/30/04

Distribution: Original – IQS Records
cc: M.R.Ehnstrom (30)
PM – K. Chiang (20)
J. Boyd (01)

SwRI® Form QA-125-3

K.J. Chiang
7/30/04

MEMORANDUM

TO: Kuang-Tsan Chiang
Division 20 Bldg. 57

FROM: Mike Dammann

RE: Project No.: 10542.02.002
Task Order: 040706-3
SRR: 26134
Samples Received: July 02, 2004

Analysis of solid & liquid samples by ICP.

Raw data and nuclear safety documentation for this project are archived in Division 20 records control and Division 01 QA.

DATE: August 03, 2004

Enclosed, please find the sample results for the analyses referenced above.

The analyses performed comply with the SwRI Program Quality Plan, Document No. PQP-Nuclear Rev. 1, 10CFR 50 Appendix B, 10CFR 21, and 01-QPP-015 Revision 4.

If there are any questions, please feel free to contact me by voice mail at 522-5428 or by fax at 522-3649. I look forward to our continued analytical support of your projects.

Mike Dammann
D Spies
Manager, Inorganic Group

for Jo Ann Boyd
Jeanette H. Garcia
Manager, Div. 01 Quality Assurance

K.T. Chiang
8/3/04

SOUTHWEST RESEARCH INSTITUTE
NUCLEAR PROJECT
CLIENT: Division 20
TASK ORDER: 040706-3
SRR: 26134
SDG: 247108
CASE: CNWRA
VTSR: July 02, 2004
PROJECT#: 10542.02.002

FINAL REPORT

K.T. Chiang
8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247357

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.422	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2782	10
Cadmium	<0.01	0.01
Calcium	0.329	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.93	0.4
Selenium	<0.02	0.02
Silicon	0.549	0.05
Silver	<0.02	0.02
Sodium	3729	20
Strontium	0.020	0.01
Sulfur	0.227	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.44	0.01
Zirconium	<0.01	0.01

K. J. Chiang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID: 4-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247357

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Aluminum	<0.1	<0.1	0.00%
Antimony	<0.05	<0.05	0.00%
Arsenic	<0.2	<0.2	0.00%
Barium	0.422	0.421	0.15%
Beryllium	<0.01	<0.01	0.00%
Bismuth	<0.2	<0.2	0.00%
Boron	2782	2783	0.02%
Cadmium	<0.01	<0.01	0.00%
Calcium	0.329	0.319	2.91%
Chromium	<0.01	<0.01	0.00%
Cobalt	<0.02	<0.02	0.00%
Copper	<0.01	<0.01	0.00%
Iron	<0.1	<0.1	0.00%
Lanthanum	<0.02	<0.02	0.00%
Lead	<0.02	<0.02	0.00%
Lithium	<0.01	<0.01	0.00%
Magnesium	<0.1	<0.1	0.00%
Manganese	<0.01	<0.01	0.00%
Molybdenum	<0.01	<0.01	0.00%
Nickel	<0.01	<0.01	0.00%
Palladium	<0.02	<0.02	0.00%
Phosphorus	<0.08	<0.08	0.00%
Potassium	1.93	2.03	4.92%
Selenium	<0.02	<0.02	0.00%
Silicon	0.549	0.534	2.62%
Silver	<0.02	<0.02	0.00%
Sodium	3729	3709	0.54%
Strontium	0.020	0.020	0.61%
Sulfur	0.227	0.203	10.9%
Thallium	<0.02	<0.02	0.00%
Thorium	<0.03	<0.03	0.00%
Tin	<0.05	<0.05	0.00%
Titanium	<0.01	<0.01	0.00%
Tungsten	<0.02	<0.02	0.00%
Uranium	<0.2	<0.2	0.00%
Vanadium	<0.01	<0.01	0.00%
Yttrium	<0.01	<0.01	0.00%
Zinc	1.44	1.43	0.86%
Zirconium	<0.01	<0.01	0.00%

K. J. Chiang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: 4-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247357

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Aluminum	<0.1	4.42	4.00	110.4%
Antimony	<0.05	1.01	1.00	100.6%
Arsenic	<0.2	4.45	4.00	111.1%
Barium	0.422	4.32	4.00	97.6%
Beryllium	<0.01	0.095	0.100	94.6%
Bismuth	NA	NA	NA	NA
Boron	2782	3222	400	109.9%
Cadmium	<0.01	0.100	0.100	99.7%
Calcium	0.329	41.0	40.0	101.7%
Chromium	<0.01	0.414	0.400	103.6%
Cobalt	<0.02	0.995	1.00	99.5%
Copper	<0.01	0.553	0.500	110.6%
Iron	<0.1	2.07	2.00	103.5%
Lanthanum	NA	NA	NA	NA
Lead	<0.02	1.04	1.00	104.0%
Lithium	NA	NA	NA	NA
Magnesium	<0.1	39.2	40.0	98.0%
Manganese	<0.01	1.02	1.00	102.2%
Molybdenum	NA	NA	NA	NA
Nickel	<0.01	0.986	1.00	98.6%
Palladium	NA	NA	NA	NA
Phosphorus	NA	NA	NA	NA
Potassium	1.93	52.6	40.0	126.6%
Selenium	<0.02	4.23	4.00	105.8%
Silicon	NA	NA	NA	NA
Silver	<0.02	0.094	0.100	93.9%
Sodium	3729	5752	2000	101.1%
Strontium	NA	NA	NA	NA
Sulfur	NA	NA	NA	NA
Thallium	<0.02	4.45	4.00	111.4%
Thorium	NA	NA	NA	NA
Tin	NA	NA	NA	NA
Titanium	NA	NA	NA	NA
Tungsten	NA	NA	NA	NA
Uranium	NA	NA	NA	NA
Vanadium	<0.01	0.999	1.00	99.9%
Yttrium	NA	NA	NA	NA
Zinc	1.44	2.46	1.00	101.4%
Zirconium	NA	NA	NA	NA

NA- Not Applicable.

K.T. Chiang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-4D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247358

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.484	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	3072	10
Cadmium	<0.01	0.01
Calcium	0.369	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	0.084	0.08
Potassium	2.41	0.4
Selenium	<0.02	0.02
Silicon	0.872	0.05
Silver	<0.02	0.02
Sodium	4009	20
Strontium	0.021	0.01
Sulfur	0.306	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	2.30	0.01
Zirconium	<0.01	0.01

K.T. Chiang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247359

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.103	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.692	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2787	10
Cadmium	<0.01	0.01
Calcium	28.3	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	1.01	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	2.56	0.4
Selenium	<0.02	0.02
Silicon	2.10	0.05
Silver	<0.02	0.02
Sodium	3679	20
Strontium	0.057	0.01
Sulfur	0.527	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.097	0.01
Zirconium	<0.01	0.01

K. T. Chiang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-4D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247360

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.500	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	3027	10
Cadmium	<0.01	0.01
Calcium	24.4	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	1.04	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	2.36	0.4
Selenium	<0.02	0.02
Silicon	2.59	0.05
Silver	<0.02	0.02
Sodium	4046	20
Strontium	0.065	0.01
Sulfur	0.333	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.131	0.01
Zirconium	<0.01	0.01

K. T. Chiang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-5C Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247433

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.182	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.528	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2776	10
Cadmium	<0.01	0.01
Calcium	1.02	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	2.56	0.4
Selenium	<0.02	0.02
Silicon	6.85	0.05
Silver	<0.02	0.02
Sodium	3695	20
Strontium	0.024	0.01
Sulfur	0.501	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.15	0.01
Zirconium	<0.01	0.01

K. T. Chuang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247434

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.269	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2678	10
Cadmium	<0.02	0.02
Calcium	0.946	0.4
Chromium	<0.02	0.02
Cobalt	<0.02	0.02
Copper	<0.02	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	<0.2	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	5.94	0.1
Silver	<0.06	0.06
Sodium	3631	20
Strontium	<0.02	0.02
Sulfur	0.348	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	<0.04	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	2.12	0.02
Zirconium	<0.02	0.02

K. T. Chuang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID
4-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247434

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Aluminum	0.269	0.291	8.04%
Antimony	<0.1	<0.1	0.00%
Arsenic	<0.2	<0.2	0.00%
Barium	<0.02	<0.02	0.00%
Beryllium	<0.02	<0.02	0.00%
Bismuth	<0.2	<0.2	0.00%
Boron	2678	2652	0.99%
Cadmium	<0.02	<0.02	0.00%
Calcium	0.946	0.930	1.66%
Chromium	<0.02	<0.02	0.00%
Cobalt	<0.02	<0.02	0.00%
Copper	<0.02	<0.02	0.00%
Iron	<0.2	<0.2	0.00%
Lanthanum	<0.02	<0.02	0.00%
Lead	<0.04	<0.04	0.00%
Lithium	<0.02	<0.02	0.00%
Magnesium	<0.2	<0.2	0.00%
Manganese	<0.02	<0.02	0.00%
Molybdenum	<0.02	<0.02	0.00%
Nickel	<0.02	<0.02	0.00%
Palladium	<0.04	<0.04	0.00%
Phosphorus	<0.16	<0.16	0.00%
Potassium	<0.8	1.05	200%
Selenium	<0.04	<0.04	0.00%
Silicon	5.94	5.98	0.62%
Silver	<0.06	<0.06	0.00%
Sodium	3631	3605	0.73%
Strontium	<0.02	<0.02	0.00%
Sulfur	0.348	0.294	16.6%
Thallium	<0.04	<0.04	0.00%
Thorium	<0.06	<0.06	0.00%
Tin	<0.1	<0.1	0.00%
Titanium	<0.02	<0.02	0.00%
Tungsten	<0.04	<0.04	0.00%
Uranium	<0.4	<0.4	0.00%
Vanadium	<0.02	<0.02	0.00%
Yttrium	<0.02	<0.02	0.00%
Zinc	2.12	2.16	1.58%
Zirconium	<0.02	<0.02	0.00%

K. J. Chuing
8/3/04

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID
4-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247434

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Aluminum	0.269	4.29	4.00	100.6%
Antimony	<0.1	0.917	1.00	91.7%
Arsenic	<0.2	4.08	4.00	101.9%
Barium	<0.02	3.80	4.00	94.9%
Beryllium	<0.02	0.091	0.100	91.4%
Bismuth	NA	NA	NA	NA
Boron	2678	2669	4.00	-225.4%
Cadmium	<0.02	0.094	0.100	94.4%
Calcium	0.946	39.6	40.0	96.6%
Chromium	<0.02	0.393	0.400	98.3%
Cobalt	<0.02	0.951	1.00	95.1%
Copper	<0.02	0.522	0.500	104.4%
Iron	<0.2	1.96	2.00	97.9%
Lanthanum	NA	NA	NA	NA
Lead	<0.04	1.01	1.00	101.4%
Lithium	NA	NA	NA	NA
Magnesium	<0.2	37.3	40.0	93.4%
Manganese	<0.02	0.979	1.00	97.9%
Molybdenum	NA	NA	NA	NA
Nickel	<0.02	0.934	1.00	93.4%
Palladium	NA	NA	NA	NA
Phosphorus	NA	NA	NA	NA
Potassium	<0.8	46.2	40.0	115.5%
Selenium	<0.04	3.86	4.00	96.6%
Silicon	NA	NA	NA	NA
Silver	<0.06	0.080	0.100	79.8%
Sodium	3631	3636	40.0	11.0%
Strontium	NA	NA	NA	NA
Sulfur	NA	NA	NA	NA
Thallium	<0.04	4.19	4.00	104.7%
Thorium	NA	NA	NA	NA
Tin	NA	NA	NA	NA
Titanium	NA	NA	NA	NA
Tungsten	NA	NA	NA	NA
Uranium	NA	NA	NA	NA
Vanadium	<0.02	0.960	1.00	96.0%
Yttrium	NA	NA	NA	NA
Zinc	2.12	3.19	1.00	106.5%
Zirconium	NA	NA	NA	NA

NA- Not Applicable.

The sodium and boron matrix spike recoveries for system id 247434 are low due to the sample concentrations being greater than 90 times the spike amounts added.

K. J. Chuing
8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-5C Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247435

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.304	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.818	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2810	10
Cadmium	<0.01	0.01
Calcium	21.5	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	1.07	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	3.45	0.4
Selenium	<0.02	0.02
Silicon	20.3	0.05
Silver	<0.02	0.02
Sodium	3677	20
Strontium	0.070	0.01
Sulfur	1.05	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.252	0.01
Zirconium	<0.01	0.01

K. J. Cluing 8/8/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247436

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.519	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2711	10
Cadmium	<0.02	0.02
Calcium	21.7	0.4
Chromium	<0.02	0.02
Cobalt	<0.02	0.02
Copper	0.024	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	1.06	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	1.34	0.8
Selenium	<0.04	0.04
Silicon	18.1	0.1
Silver	<0.06	0.06
Sodium	3538	20
Strontium	0.053	0.02
Sulfur	0.571	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	<0.04	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	<0.02	0.02
Zirconium	<0.02	0.02

K. J. Cluing 8/8/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-6 D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248204

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.284	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2394	10
Cadmium	<0.02	0.02
Calcium	1.21	0.4
Chromium	0.052	0.02
Cobalt	<0.02	0.02
Copper	0.085	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	<0.2	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	0.225	0.1
Silver	<0.06	0.06
Sodium	3189	20
Strontium	<0.02	0.02
Sulfur	<0.2	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	0.110	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	14.6	0.02
Zirconium	<0.02	0.02

K. J. Chrisp 8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-6 D Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248205

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.188	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.056	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2448	10
Cadmium	<0.01	0.01
Calcium	1.02	0.1
Chromium	0.057	0.01
Cobalt	<0.02	0.02
Copper	0.040	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	0.101	0.1
Manganese	<0.01	0.01
Molybdenum	0.057	0.01
Nickel	0.015	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.50	0.4
Selenium	<0.02	0.02
Silicon	0.442	0.05
Silver	<0.02	0.02
Sodium	3228	20
Strontium	0.013	0.01
Sulfur	0.159	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	0.032	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.66	0.01
Zirconium	<0.01	0.01

K. J. Chrisp 8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-6 D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248206

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.236	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2484	10
Cadmium	<0.02	0.02
Calcium	20.4	0.4
Chromium	0.094	0.02
Cobalt	<0.02	0.02
Copper	0.043	0.02
Iron	0.255	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	0.289	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	0.034	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	0.652	0.1
Silver	<0.06	0.06
Sodium	3307	20
Strontium	0.078	0.02
Sulfur	0.305	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	0.056	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	1.95	0.02
Zirconium	<0.02	0.02

K. J. Chiang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-6 D Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248207

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.133	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.107	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2607	10
Cadmium	<0.01	0.01
Calcium	13.4	0.1
Chromium	0.040	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	0.251	0.1
Manganese	<0.01	0.01
Molybdenum	0.013	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.55	0.4
Selenium	<0.02	0.02
Silicon	1.11	0.05
Silver	<0.02	0.02
Sodium	3410	20
Strontium	0.079	0.01
Sulfur	0.277	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.26	0.01
Zirconium	<0.01	0.01

K. J. Chiang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
LABORATORY CONTROL SAMPLE

Sample ID: LCSW - G22W1 / G22W2

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: NA

Matrix: Liquid

Project No.: 10542.02.002

Lab System ID: NA

SRR: 26167, 26177, 26225

TO: 040713-4, 040714-12, 040720-1

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Aluminum	3.93	4.00	98.2%
Antimony	0.986	1.00	98.6%
Arsenic	4.08	4.00	101.9%
Barium	4.05	4.00	101.1%
Beryllium	0.099	0.100	98.6%
Bismuth	NA	NA	NA
Boron	8.15	8.00	101.8%
Cadmium	0.099	0.100	99.2%
Calcium	41.1	40.0	102.7%
Chromium	0.401	0.400	100.2%
Cobalt	0.989	1.00	98.9%
Copper	0.506	0.500	101.2%
Iron	2.16	2.00	107.8%
Lanthanum	NA	NA	NA
Lead	1.01	1.00	101.1%
Lithium	NA	NA	NA
Magnesium	40.8	40.0	102.1%
Manganese	1.01	1.00	100.8%
Molybdenum	NA	NA	NA
Nickel	0.984	1.00	98.4%
Palladium	NA	NA	NA
Phosphorus	NA	NA	NA
Potassium	39.8	40.0	99.5%
Selenium	4.18	4.00	104.5%
Silicon	NA	NA	NA
Silver	0.100	0.100	100.3%
Sodium	40.4	40.0	100.9%
Strontium	NA	NA	NA
Sulfur	NA	NA	NA
Thallium	4.21	4.00	105.3%
Thorium	NA	NA	NA
Tin	NA	NA	NA
Titanium	NA	NA	NA
Tungsten	NA	NA	NA
Uranium	NA	NA	NA
Vanadium	0.991	1.00	99.1%
Yttrium	NA	NA	NA
Zinc	0.984	1.00	98.4%
Zirconium	NA	NA	NA

NA- Not Applicable.

K. J. Chuang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
LABORATORY CONTROL SAMPLE

Sample ID: LCSW - G22W3

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: NA

Matrix: Liquid

Project No.: 10542.02.002

Lab System ID: NA

SRR: 26167, 26177, 26225

TO: 040713-4, 040714-12, 040720-1

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Aluminum	3.70	4.00	92.6%
Antimony	0.932	1.00	93.2%
Arsenic	3.74	4.00	93.4%
Barium	3.90	4.00	97.6%
Beryllium	0.090	0.100	89.8%
Bismuth	NA	NA	NA
Boron	3.77	4.00	94.1%
Cadmium	0.094	0.100	93.9%
Calcium	38.6	40.0	96.4%
Chromium	0.384	0.400	96.0%
Cobalt	0.938	1.00	93.8%
Copper	0.476	0.500	95.3%
Iron	2.11	2.00	105.5%
Lanthanum	NA	NA	NA
Lead	0.974	1.00	97.4%
Lithium	NA	NA	NA
Magnesium	37.9	40.0	94.9%
Manganese	0.964	1.00	96.4%
Molybdenum	NA	NA	NA
Nickel	0.936	1.00	93.6%
Palladium	NA	NA	NA
Phosphorus	NA	NA	NA
Potassium	37.9	40.0	94.8%
Selenium	3.53	4.00	88.1%
Silicon	NA	NA	NA
Silver	0.096	0.100	96.3%
Sodium	38.4	40.0	95.9%
Strontium	NA	NA	NA
Sulfur	NA	NA	NA
Thallium	3.97	4.00	99.3%
Thorium	NA	NA	NA
Tin	NA	NA	NA
Titanium	NA	NA	NA
Tungsten	NA	NA	NA
Uranium	NA	NA	NA
Vanadium	0.96	1.00	95.6%
Yttrium	NA	NA	NA
Zinc	0.936	1.00	93.6%
Zirconium	NA	NA	NA

NA- Not Applicable.

K. J. Chuang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
BLANK SUMMARY

Sample ID: PBW - G22W1 / G22W2

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: NA

Client: Division 20

Date Received: NA

Project No.: 10542.02.002

SRR: 26167, 26177, 26225

TO: 040713-4, 040714-12, 040720-1

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	<0.01	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	<0.2	0.2
Cadmium	<0.01	0.01
Calcium	<0.1	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	<0.4	0.4
Selenium	<0.02	0.02
Silicon	<0.05	0.05
Silver	<0.02	0.02
Sodium	<0.4	0.4
Strontium	<0.01	0.01
Sulfur	<0.1	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	<0.01	0.01
Zirconium	<0.01	0.01

NA- Not Applicable.

K. J. Chuang 8/3/04

SOUTHWEST RESEARCH INSTITUTE
BLANK SUMMARY

Sample ID: PBW - G22W3

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: NA

Client: Division 20

Date Received: NA

Project No.: 10542.02.002

SRR: 26167, 26177, 26225

TO: 040713-4, 040714-12, 040720-1

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.2	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	<0.4	0.4
Cadmium	<0.02	0.02
Calcium	<0.4	0.4
Chromium	<0.02	0.02
Cobalt	<0.02	0.02
Copper	<0.02	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	<0.2	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	<0.1	0.1
Silver	<0.06	0.06
Sodium	<0.8	0.8
Strontium	<0.02	0.02
Sulfur	<0.2	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	<0.04	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	<0.02	0.02
Zirconium	<0.02	0.02

NA- Not Applicable.

K. J. Chuang 8/3/04

MEMORANDUM

TO: Kuang-Tsan Chiang
Division 20 Bldg. 57

FROM: Mike Dammann

RE: Project No.: 10542.02.002
Task Order: 040713-4, 040714-12, 040720-10
SRR: 26167, 26177, 26225
Samples Received: July 12, 14, 20, 2004

Analysis of liquid samples by ICP.

Raw data and nuclear safety documentation for this project are archived in Division 20 records control and Division 01 QA.

DATE: August 02, 2004

Enclosed, please find the sample results for the analyses referenced above.

The analyses performed comply with the SwRI Program Quality Plan, Document No. PQP-Nuclear Rev. 1, 10CFR 50 Appendix B, 10CFR 21, and 01-QPP-015 Revision 4.

If there are any questions, please feel free to contact me by voice mail at 522-5428 or by fax at 522-3649. I look forward to our continued analytical support of your projects.

Mike Dammann
Manager, Inorganic Group

Jo Ann Boyd
for Jennifer Garcia
Manager, Div. 01 Quality Assurance

K. T. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-4C

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Lab System ID: 247357

Client: Division 20
Date Received: 07/12/04
Project No.: 10542.02.002
SRR: 26167
TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.422	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2782	10
Cadmium	<0.01	0.01
Calcium	0.329	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.93	0.4
Selenium	<0.02	0.02
Silicon	0.549	0.05
Silver	<0.02	0.02
Sodium	3729	20
Strontium	0.020	0.01
Sulfur	0.227	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.44	0.01
Zirconium	<0.01	0.01

K. T. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID: 4-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247357

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Aluminum	<0.1	<0.1	0.00%
Antimony	<0.05	<0.05	0.00%
Arsenic	<0.2	<0.2	0.00%
Barium	0.422	0.421	0.15%
Beryllium	<0.01	<0.01	0.00%
Bismuth	<0.2	<0.2	0.00%
Boron	2782	2783	0.02%
Cadmium	<0.01	<0.01	0.00%
Calcium	0.329	0.319	2.91%
Chromium	<0.01	<0.01	0.00%
Cobalt	<0.02	<0.02	0.00%
Copper	<0.01	<0.01	0.00%
Iron	<0.1	<0.1	0.00%
Lanthanum	<0.02	<0.02	0.00%
Lead	<0.02	<0.02	0.00%
Lithium	<0.01	<0.01	0.00%
Magnesium	<0.1	<0.1	0.00%
Manganese	<0.01	<0.01	0.00%
Molybdenum	<0.01	<0.01	0.00%
Nickel	<0.01	<0.01	0.00%
Palladium	<0.02	<0.02	0.00%
Phosphorus	<0.08	<0.08	0.00%
Potassium	1.93	2.03	4.92%
Selenium	<0.02	<0.02	0.00%
Silicon	0.549	0.534	2.62%
Silver	<0.02	<0.02	0.00%
Sodium	3729	3709	0.54%
Strontium	0.020	0.020	0.61%
Sulfur	0.227	0.203	10.9%
Thallium	<0.02	<0.02	0.00%
Thorium	<0.03	<0.03	0.00%
Tin	<0.05	<0.05	0.00%
Titanium	<0.01	<0.01	0.00%
Tungsten	<0.02	<0.02	0.00%
Uranium	<0.2	<0.2	0.00%
Vanadium	<0.01	<0.01	0.00%
Yttrium	<0.01	<0.01	0.00%
Zinc	1.44	1.43	0.86%
Zirconium	<0.01	<0.01	0.00%

K. J. Chung
8/10/04

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: 4-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247357

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Aluminum	<0.1	4.42	4.00	110.4%
Antimony	<0.05	1.01	1.00	100.6%
Arsenic	<0.2	4.45	4.00	111.1%
Barium	0.422	4.32	4.00	97.6%
Beryllium	<0.01	0.095	0.100	94.6%
Bismuth	NA	NA	NA	NA
Boron	2782	3222	400	109.9%
Cadmium	<0.01	0.100	0.100	99.7%
Calcium	0.329	41.0	40.0	101.7%
Chromium	<0.01	0.414	0.400	103.6%
Cobalt	<0.02	0.995	1.00	99.5%
Copper	<0.01	0.553	0.500	110.6%
Iron	<0.1	2.07	2.00	103.5%
Lanthanum	NA	NA	NA	NA
Lead	<0.02	1.04	1.00	104.0%
Lithium	NA	NA	NA	NA
Magnesium	<0.1	39.2	40.0	98.0%
Manganese	<0.01	1.02	1.00	102.2%
Molybdenum	NA	NA	NA	NA
Nickel	<0.01	0.986	1.00	98.6%
Palladium	NA	NA	NA	NA
Phosphorus	NA	NA	NA	NA
Potassium	1.93	52.6	40.0	126.6%
Selenium	<0.02	4.23	4.00	105.8%
Silicon	NA	NA	NA	NA
Silver	<0.02	0.094	0.100	93.9%
Sodium	3729	5752	2000	101.1%
Strontium	NA	NA	NA	NA
Sulfur	NA	NA	NA	NA
Thallium	<0.02	4.45	4.00	111.4%
Thorium	NA	NA	NA	NA
Tin	NA	NA	NA	NA
Titanium	NA	NA	NA	NA
Tungsten	NA	NA	NA	NA
Uranium	NA	NA	NA	NA
Vanadium	<0.01	0.999	1.00	99.9%
Yttrium	NA	NA	NA	NA
Zinc	1.44	2.46	1.00	101.4%
Zirconium	NA	NA	NA	NA

NA- Not Applicable.

K. J. Chung
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-4D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247358

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.484	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	3072	10
Cadmium	<0.01	0.01
Calcium	0.369	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	0.084	0.08
Potassium	2.41	0.4
Selenium	<0.02	0.02
Silicon	0.872	0.05
Silver	<0.02	0.02
Sodium	4009	20
Strontium	0.021	0.01
Sulfur	0.306	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	2.30	0.01
Zirconium	<0.01	0.01

K. J. Chin
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-4C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247359

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.103	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.692	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2787	10
Cadmium	<0.01	0.01
Calcium	28.3	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	1.01	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	2.56	0.4
Selenium	<0.02	0.02
Silicon	2.10	0.05
Silver	<0.02	0.02
Sodium	3679	20
Strontium	0.057	0.01
Sulfur	0.527	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.097	0.01
Zirconium	<0.01	0.01

K. J. Chin
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-4D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247360

Client: Division 20

Date Received: 07/12/04

Project No.: 10542.02.002

SRR: 26167

TO: 040713-4

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.500	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	3027	10
Cadmium	<0.01	0.01
Calcium	24.4	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	1.04	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	2.36	0.4
Selenium	<0.02	0.02
Silicon	2.59	0.05
Silver	<0.02	0.02
Sodium	4046	20
Strontium	0.065	0.01
Sulfur	0.333	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.131	0.01
Zirconium	<0.01	0.01

K.J. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-5C Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247433

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.182	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.528	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2776	10
Cadmium	<0.01	0.01
Calcium	1.02	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	2.56	0.4
Selenium	<0.02	0.02
Silicon	6.85	0.05
Silver	<0.02	0.02
Sodium	3695	20
Strontium	0.024	0.01
Sulfur	0.501	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.15	0.01
Zirconium	<0.01	0.01

K.J. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID
4-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247434

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.269	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2678	10
Cadmium	<0.02	0.02
Calcium	0.946	0.4
Chromium	<0.02	0.02
Cobalt	<0.02	0.02
Copper	<0.02	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	<0.2	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	5.94	0.1
Silver	<0.06	0.06
Sodium	3631	20
Strontium	<0.02	0.02
Sulfur	0.348	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	<0.04	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	2.12	0.02
Zirconium	<0.02	0.02

K. J. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
DUPLICATE SUMMARY

Sample ID
4-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247434

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Aluminum	0.269	0.291	8.04%
Antimony	<0.1	<0.1	0.00%
Arsenic	<0.2	<0.2	0.00%
Barium	<0.02	<0.02	0.00%
Beryllium	<0.02	<0.02	0.00%
Bismuth	<0.2	<0.2	0.00%
Boron	2678	2652	0.99%
Cadmium	<0.02	<0.02	0.00%
Calcium	0.946	0.930	1.66%
Chromium	<0.02	<0.02	0.00%
Cobalt	<0.02	<0.02	0.00%
Copper	<0.02	<0.02	0.00%
Iron	<0.2	<0.2	0.00%
Lanthanum	<0.02	<0.02	0.00%
Lead	<0.04	<0.04	0.00%
Lithium	<0.02	<0.02	0.00%
Magnesium	<0.2	<0.2	0.00%
Manganese	<0.02	<0.02	0.00%
Molybdenum	<0.02	<0.02	0.00%
Nickel	<0.02	<0.02	0.00%
Palladium	<0.04	<0.04	0.00%
Phosphorus	<0.16	<0.16	0.00%
Potassium	<0.8	1.05	200%
Selenium	<0.04	<0.04	0.00%
Silicon	5.94	5.98	0.62%
Silver	<0.06	<0.06	0.00%
Sodium	3631	3605	0.73%
Strontium	<0.02	<0.02	0.00%
Sulfur	0.348	0.294	16.6%
Thallium	<0.04	<0.04	0.00%
Thorium	<0.06	<0.06	0.00%
Tin	<0.1	<0.1	0.00%
Titanium	<0.02	<0.02	0.00%
Tungsten	<0.04	<0.04	0.00%
Uranium	<0.4	<0.4	0.00%
Vanadium	<0.02	<0.02	0.00%
Yttrium	<0.02	<0.02	0.00%
Zinc	2.12	2.16	1.58%
Zirconium	<0.02	<0.02	0.00%

K. J. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
MATRIX SPIKE SUMMARY

Sample ID: 4-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247434

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Aluminum	0.269	4.29	4.00	100.6%
Antimony	<0.1	0.917	1.00	91.7%
Arsenic	<0.2	4.08	4.00	101.9%
Barium	<0.02	3.80	4.00	94.9%
Beryllium	<0.02	0.091	0.100	91.4%
Bismuth	NA	NA	NA	NA
Boron	2678	2669	4.00	-225.4%
Cadmium	<0.02	0.094	0.100	94.4%
Calcium	0.946	39.6	40.0	96.6%
Chromium	<0.02	0.393	0.400	98.3%
Cobalt	<0.02	0.951	1.00	95.1%
Copper	<0.02	0.522	0.500	104.4%
Iron	<0.2	1.96	2.00	97.9%
Lanthanum	NA	NA	NA	NA
Lead	<0.04	1.01	1.00	101.4%
Lithium	NA	NA	NA	NA
Magnesium	<0.2	37.3	40.0	93.4%
Manganese	<0.02	0.979	1.00	97.9%
Molybdenum	NA	NA	NA	NA
Nickel	<0.02	0.934	1.00	93.4%
Palladium	NA	NA	NA	NA
Phosphorus	NA	NA	NA	NA
Potassium	<0.8	46.2	40.0	115.5%
Selenium	<0.04	3.86	4.00	96.6%
Silicon	NA	NA	NA	NA
Silver	<0.06	0.080	0.100	79.8%
Sodium	3631	3636	40.0	11.0%
Strontium	NA	NA	NA	NA
Sulfur	NA	NA	NA	NA
Thallium	<0.04	4.19	4.00	104.7%
Thorium	NA	NA	NA	NA
Tin	NA	NA	NA	NA
Titanium	NA	NA	NA	NA
Tungsten	NA	NA	NA	NA
Uranium	NA	NA	NA	NA
Vanadium	<0.02	0.960	1.00	96.0%
Yttrium	NA	NA	NA	NA
Zinc	2.12	3.19	1.00	106.5%
Zirconium	NA	NA	NA	NA

NA- Not Applicable.

The sodium and boron matrix spike recoveries for system id 247434 are low due to the sample concentrations being greater than 90 times the spike amounts added.

K.J. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-5C Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247435

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.304	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.818	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2810	10
Cadmium	<0.01	0.01
Calcium	21.5	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	1.07	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	3.45	0.4
Selenium	<0.02	0.02
Silicon	20.3	0.05
Silver	<0.02	0.02
Sodium	3677	20
Strontium	0.070	0.01
Sulfur	1.05	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	0.252	0.01
Zirconium	<0.01	0.01

K.J. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-5C Not Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 247436

Client: Division 20

Date Received: 07/14/04

Project No.: 10542.02.002

SRR: 26177

TO: 040714-12

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.519	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2711	10
Cadmium	<0.02	0.02
Calcium	21.7	0.4
Chromium	<0.02	0.02
Cobalt	<0.02	0.02
Copper	0.024	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	1.06	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	1.34	0.8
Selenium	<0.04	0.04
Silicon	18.1	0.1
Silver	<0.06	0.06
Sodium	3538	20
Strontium	0.053	0.02
Sulfur	0.571	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	<0.04	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	<0.02	0.02
Zirconium	<0.02	0.02

K.T. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-6 D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248204

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.284	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2394	10
Cadmium	<0.02	0.02
Calcium	1.21	0.4
Chromium	0.052	0.02
Cobalt	<0.02	0.02
Copper	0.085	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	<0.2	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	0.225	0.1
Silver	<0.06	0.06
Sodium	3189	20
Strontium	<0.02	0.02
Sulfur	<0.2	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	0.110	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	14.6	0.02
Zirconium	<0.02	0.02

K.T. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 4-6 D Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248205

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.188	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.056	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2448	10
Cadmium	<0.01	0.01
Calcium	1.02	0.1
Chromium	0.057	0.01
Cobalt	<0.02	0.02
Copper	0.040	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	0.101	0.1
Manganese	<0.01	0.01
Molybdenum	0.057	0.01
Nickel	0.015	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.50	0.4
Selenium	<0.02	0.02
Silicon	0.442	0.05
Silver	<0.02	0.02
Sodium	3228	20
Strontium	0.013	0.01
Sulfur	0.159	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	0.032	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.66	0.01
Zirconium	<0.01	0.01

K. J. Chiang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-6 D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248206

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.236	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	2484	10
Cadmium	<0.02	0.02
Calcium	20.4	0.4
Chromium	0.094	0.02
Cobalt	<0.02	0.02
Copper	0.043	0.02
Iron	0.255	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	0.289	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	0.034	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	0.652	0.1
Silver	<0.06	0.06
Sodium	3307	20
Strontium	0.078	0.02
Sulfur	0.305	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	0.056	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	1.95	0.02
Zirconium	<0.02	0.02

K. J. Chiang 8/10/04

SOUTHWEST RESEARCH INSTITUTE
SAMPLE ANALYSIS DATA SHEET

Sample ID: 5-6 D Filtered

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: 248207

Client: Division 20

Date Received: 07/20/04

Project No.: 10542.02.002

SRR: 26225

TO: 040720-10

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	0.133	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	0.107	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	2607	10
Cadmium	<0.01	0.01
Calcium	13.4	0.1
Chromium	0.040	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	0.251	0.1
Manganese	<0.01	0.01
Molybdenum	0.013	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	1.55	0.4
Selenium	<0.02	0.02
Silicon	1.11	0.05
Silver	<0.02	0.02
Sodium	3410	20
Strontium	0.079	0.01
Sulfur	0.277	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	1.26	0.01
Zirconium	<0.01	0.01

K. T. Chuang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
LABORATORY CONTROL SAMPLE

Sample ID: LCSW - G22W1 / G22W2

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: NA

Client: Division 20

Date Received: NA

Project No.: 10542.02.002

SRR: 26167, 26177, 26225

TO: 040713-4, 040714-12, 040720-1

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Aluminum	3.93	4.00	98.2%
Antimony	0.986	1.00	98.6%
Arsenic	4.08	4.00	101.9%
Barium	4.05	4.00	101.1%
Beryllium	0.099	0.100	98.6%
Bismuth	NA	NA	NA
Boron	8.15	8.00	101.8%
Cadmium	0.099	0.100	99.2%
Calcium	41.1	40.0	102.7%
Chromium	0.401	0.400	100.2%
Cobalt	0.989	1.00	98.9%
Copper	0.506	0.500	101.2%
Iron	2.16	2.00	107.8%
Lanthanum	NA	NA	NA
Lead	1.01	1.00	101.1%
Lithium	NA	NA	NA
Magnesium	40.8	40.0	102.1%
Manganese	1.01	1.00	100.8%
Molybdenum	NA	NA	NA
Nickel	0.984	1.00	98.4%
Palladium	NA	NA	NA
Phosphorus	NA	NA	NA
Potassium	39.8	40.0	99.5%
Selenium	4.18	4.00	104.5%
Silicon	NA	NA	NA
Silver	0.100	0.100	100.3%
Sodium	40.4	40.0	100.9%
Strontium	NA	NA	NA
Sulfur	NA	NA	NA
Thallium	4.21	4.00	105.3%
Thorium	NA	NA	NA
Tin	NA	NA	NA
Titanium	NA	NA	NA
Tungsten	NA	NA	NA
Uranium	NA	NA	NA
Vanadium	0.991	1.00	99.1%
Yttrium	NA	NA	NA
Zinc	0.984	1.00	98.4%
Zirconium	NA	NA	NA

NA- Not Applicable.

K. T. Chuang
8/10/04

SOUTHWEST RESEARCH INSTITUTE
LABORATORY CONTROL SAMPLE

Sample ID: LCSW - G22W3

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: NA

Client: Division 20

Date Received: NA

Project No.: 10542.02.002

SRR: 26167, 26177, 26225

TO: 040713-4, 040714-12, 040720-1

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Aluminum	3.70	4.00	92.6%
Antimony	0.932	1.00	93.2%
Arsenic	3.74	4.00	93.4%
Barium	3.90	4.00	97.6%
Beryllium	0.090	0.100	89.8%
Bismuth	NA	NA	NA
Boron	3.77	4.00	94.1%
Cadmium	0.094	0.100	93.9%
Calcium	38.6	40.0	96.4%
Chromium	0.384	0.400	96.0%
Cobalt	0.938	1.00	93.8%
Copper	0.476	0.500	95.3%
Iron	2.11	2.00	105.5%
Lanthanum	NA	NA	NA
Lead	0.974	1.00	97.4%
Lithium	NA	NA	NA
Magnesium	37.9	40.0	94.9%
Manganese	0.964	1.00	96.4%
Molybdenum	NA	NA	NA
Nickel	0.936	1.00	93.6%
Palladium	NA	NA	NA
Phosphorus	NA	NA	NA
Potassium	37.9	40.0	94.8%
Selenium	3.53	4.00	88.1%
Silicon	NA	NA	NA
Silver	0.096	0.100	96.3%
Sodium	38.4	40.0	95.9%
Strontium	NA	NA	NA
Sulfur	NA	NA	NA
Thallium	3.97	4.00	99.3%
Thorium	NA	NA	NA
Tin	NA	NA	NA
Titanium	NA	NA	NA
Tungsten	NA	NA	NA
Uranium	NA	NA	NA
Vanadium	0.96	1.00	95.6%
Yttrium	NA	NA	NA
Zinc	0.936	1.00	93.6%
Zirconium	NA	NA	NA

NA- Not Applicable.

K. T. Chiang 8/10/04

SOUTHWEST RESEARCH INSTITUTE
BLANK SUMMARY

Sample ID: PBW - G22W1 / G22W2

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Lab System ID: NA

Client: Division 20

Date Received: NA

Project No.: 10542.02.002

SRR: 26167, 26177, 26225

TO: 040713-4, 040714-12, 040720-1

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.1	0.1
Antimony	<0.05	0.05
Arsenic	<0.2	0.2
Barium	<0.01	0.01
Beryllium	<0.01	0.01
Bismuth	<0.2	0.2
Boron	<0.2	0.2
Cadmium	<0.01	0.01
Calcium	<0.1	0.1
Chromium	<0.01	0.01
Cobalt	<0.02	0.02
Copper	<0.01	0.01
Iron	<0.1	0.1
Lanthanum	<0.02	0.02
Lead	<0.02	0.02
Lithium	<0.01	0.01
Magnesium	<0.1	0.1
Manganese	<0.01	0.01
Molybdenum	<0.01	0.01
Nickel	<0.01	0.01
Palladium	<0.02	0.02
Phosphorus	<0.08	0.08
Potassium	<0.4	0.4
Selenium	<0.02	0.02
Silicon	<0.05	0.05
Silver	<0.02	0.02
Sodium	<0.4	0.4
Strontium	<0.01	0.01
Sulfur	<0.1	0.1
Thallium	<0.02	0.02
Thorium	<0.03	0.03
Tin	<0.05	0.05
Titanium	<0.01	0.01
Tungsten	<0.02	0.02
Uranium	<0.2	0.2
Vanadium	<0.01	0.01
Yttrium	<0.01	0.01
Zinc	<0.01	0.01
Zirconium	<0.01	0.01

NA- Not Applicable.

K. T. Chiang 8/10/04

SOUTHWEST RESEARCH INSTITUTE

BLANK SUMMARY

Sample ID
PBW - G22W3

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: NA

Matrix: Liquid

Project No.: 10542.02.002

Lab System ID: NA

SRR: 26167, 26177, 26225

TO: 040713-4, 040714-12, 040720-1

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Aluminum	<0.2	0.2
Antimony	<0.1	0.1
Arsenic	<0.2	0.2
Barium	<0.02	0.02
Beryllium	<0.02	0.02
Bismuth	<0.2	0.2
Boron	<0.4	0.4
Cadmium	<0.02	0.02
Calcium	<0.4	0.4
Chromium	<0.02	0.02
Cobalt	<0.02	0.02
Copper	<0.02	0.02
Iron	<0.2	0.2
Lanthanum	<0.02	0.02
Lead	<0.04	0.04
Lithium	<0.02	0.02
Magnesium	<0.2	0.2
Manganese	<0.02	0.02
Molybdenum	<0.02	0.02
Nickel	<0.02	0.02
Palladium	<0.04	0.04
Phosphorus	<0.16	0.16
Potassium	<0.8	0.8
Selenium	<0.04	0.04
Silicon	<0.1	0.1
Silver	<0.06	0.06
Sodium	<0.8	0.8
Strontium	<0.02	0.02
Sulfur	<0.2	0.2
Thallium	<0.04	0.04
Thorium	<0.06	0.06
Tin	<0.1	0.1
Titanium	<0.02	0.02
Tungsten	<0.04	0.04
Uranium	<0.4	0.4
Vanadium	<0.02	0.02
Yttrium	<0.02	0.02
Zinc	<0.02	0.02
Zirconium	<0.02	0.02

NA- Not Applicable.

K.T. Chiang 8/10/04

MEMORANDUM

TO: **Kuang-Tsan Chiang**
Division 20 Bldg. 57

FROM: **Mike Dammann**

RE: **Project No.: 10542.02.002**
Task Order: 040601-6, 040603-3
SRR: 25978, 25997
Samples Received: May 28, June 02, 2004

Analysis of liquid samples by ICP and IC.

Raw data and nuclear safety documentation for this project are archived in Division 20 records control and Division 01 QA.

DATE: **September 16, 2004**

Enclosed, please find the sample results for the analyses referenced above.

The analyses performed comply with the SwRI Program Quality Plan, Document No. PQP-Nuclear Rev. 1, 10CFR 50 Appendix B, 10CFR 21, and 01-QPP-015 Revision 4.

If there are any questions, please feel free to contact me by voice mail at 522-5428 or by fax at 522-3649. I look forward to our continued analytical support of your projects.

Mike Dammann

Manager, Inorganic Group

Jo Ann Boyd

Manager, Div. 01 Quality Assurance

K.T. Chiang 9/20/04

010001

SOUTHWEST RESEARCH INSTITUTE
NUCLEAR PROJECT
CLIENT: Division 20
TASK ORDER: 040601-6, 040603-3
SRR: 25978, 25997
SDG: 245431, 245613
CASE: CNWRA
VTSR: May 28, June 02, 2004
PROJECT#: 10542.02.002

FINAL REPORT

K.J. Chiang 9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010002

Sample ID: 1A

Lab Name: Southwest Research Institute
Lab Code: SwRI
Matrix: Liquid
Task Order: 040601-6
Lab System ID: 245431

Client: Division 20
Date Received: 05/28/04
Project No.: 10542.02.002
SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2582	0.20
Calcium	0.220	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	0.012	0.01
Potassium	1.15	0.500
Sodium	3372	0.500
Zinc	<0.010	0.01

K. J. Chiang
9/20/04

SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY

010003

Sample ID
1A

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245431

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Chloride	<2	<2	0.00%
Nitrate-N	<2	<2	0.00%
Boron	-----	-----	-----
Calcium	-----	-----	-----
Iron	-----	-----	-----
Lead	-----	-----	-----
Nickel	-----	-----	-----
Potassium	-----	-----	-----
Sodium	-----	-----	-----
Zinc	-----	-----	-----

K. J. Chiang 9/20/04

SOUTHWEST RESEARCH INSTITUTE

MATRIX SPIKE SUMMARY

010004

Sample ID
1A

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245431

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Chloride	<2	39.8	40.0	99.5%
Nitrate-N	<2	14.7	18.1	81.2%
Boron	-----	-----	-----	-----
Calcium	-----	-----	-----	-----
Iron	-----	-----	-----	-----
Lead	-----	-----	-----	-----
Nickel	-----	-----	-----	-----
Potassium	-----	-----	-----	-----
Sodium	-----	-----	-----	-----
Zinc	-----	-----	-----	-----

K. J. Chiang
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010005

Sample ID
1B

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245432

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2477	0.20
Calcium	0.539	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	0.995	0.500
Sodium	3248	0.500
Zinc	<0.010	0.01

K. J. Chiang
9/20/04

SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY 010006

Sample ID
1B

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245432

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Chloride	-----	-----	-----
Nitrate-N	-----	-----	-----
Boron	2477	2548	2.83%
Calcium	0.539	0.498	7.91%
Iron	<0.100	<0.100	0.00%
Lead	<0.050	<0.050	0.00%
Nickel	<0.010	0.011	200%
Potassium	0.995	1.18	17.0%
Sodium	3248	3342	2.85%
Zinc	<0.010	<0.010	0.00%

K. J. Chiang
9/20/04

SOUTHWEST RESEARCH INSTITUTE

MATRIX SPIKE SUMMARY

010007

Sample ID
1B

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245432

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Chloride	-----	-----	-----	-----
Nitrate-N	-----	-----	-----	-----
Boron	2477	2632	4.00	3875%
Calcium	0.539	34.5	40.0	84.9%
Iron	<0.100	1.82	2.00	91.0%
Lead	<0.050	0.893	1.00	89.3%
Nickel	<0.010	0.850	1.00	85.0%
Potassium	0.995	42.5	40.0	104%
Sodium	3248	3484	40.0	590%
Zinc	<0.010	0.990	1.00	99.0%

Note: The boron spikes are high due to the sample concentrations being greater than 600 times the spike amounts added.

Note: The sodium spikes are high due to the sample concentrations being greater than 80 times the spike amounts added.

K.J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

010008

Sample ID
1C

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245433

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2589	0.20
Calcium	0.391	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	0.012	0.01
Potassium	1.08	0.500
Sodium	3381	0.500
Zinc	<0.025	0.025

K.J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

010009

Sample ID
2A

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245434

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2456	0.20
Calcium	0.697	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.19	0.500
Sodium	3329	0.500
Zinc	1081	0.01

K. J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET

010010

Sample ID
2B

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245435

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2540	0.20
Calcium	0.715	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.27	0.500
Sodium	3421	0.500
Zinc	653	0.01

K. J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010011

Sample ID: 2C

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245436

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2529	0.20
Calcium	0.717	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.16	0.500
Sodium	3405	0.500
Zinc	408	0.01

K. T. Chuang
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010012

Sample ID: 2D

Lab Name: Southwest Research Institute

Client: Division 20

Lab Code: SwRI

Date Received: 05/28/04

Matrix: Liquid

Project No.: 10542.02.002

Task Order: 040601-6

SRR: 25978

Lab System ID: 245437

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	3020	0.20
Calcium	6.64	0.20
Iron	0.573	0.10
Lead	0.437	0.05
Nickel	0.042	0.01
Potassium	1.53	0.500
Sodium	3965	0.500
Zinc	23660	0.01

K. T. Chuang
9/20/04

SOUTHWEST RESEARCH INSTITUTE

DUPLICATE SUMMARY 010013

Sample ID: 2D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040601-6

Lab System ID: 245437

Client: Division 20

Date Received: 05/28/04

Project No.: 10542.02.002

SRR: 25978

Analysis	Sample Result (mg/L)	Duplicate Result (mg/L)	RPD
Chloride	-----	-----	-----
Nitrate-N	-----	-----	-----
Boron	3020	3196	5.66%
Calcium	6.64	6.52	1.82%
Iron	0.573	0.595	3.77%
Lead	0.437	0.454	3.82%
Nickel	0.042	0.044	4.65%
Potassium	1.53	1.44	6.06%
Sodium	3965	4173	5.11%
Zinc	23660	24904	5.12%

K. T. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

MATRIX SPIKE SUMMARY 010014

Sample ID: 2D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040601-6

Lab System ID: 245437

Client: Division 20

Date Received: 05/28/04

Project No.: 10542.02.002

SRR: 25978

Analysis	Sample Result (mg/L)	Spike Result (mg/L)	Spike Added (mg/L)	Recovery
Chloride	-----	-----	-----	-----
Nitrate-N	-----	-----	-----	-----
Boron	3020	3106	4.00	2150%
Calcium	6.64	38.9	40.0	80.7%
Iron	0.573	2.37	2.00	89.9%
Lead	0.437	1.29	1.00	85.3%
Nickel	0.042	0.820	1.00	77.8%
Potassium	1.53	41.3	40.0	99.4%
Sodium	3965	4082	40.0	293%
Zinc	23660	24481	1.00	82100%

Note: The boron spikes are high due to the sample concentrations being greater than 600 times the spike amounts added.

Note: The sodium spikes are high due to the sample concentrations being greater than 80 times the spike amounts added.

Note: The zinc spike is out due to the sample concentration being greater than 23000 times the spike amount added.

K. T. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010015

Sample ID: 3A

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040601-6

Lab System ID: 245438

Client: Division 20

Date Received: 05/28/04

Project No.: 10542.02.002

SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2387	0.20
Calcium	110	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.29	0.500
Sodium	3067	0.500
Zinc	<0.025	0.025

K. J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010016

Sample ID: 3B

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040601-6

Lab System ID: 245439

Client: Division 20

Date Received: 05/28/04

Project No.: 10542.02.002

SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2586	0.20
Calcium	130	0.20
Iron	0.151	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	1.40	0.500
Sodium	3373	0.500
Zinc	<0.025	0.025

K. J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010017

Sample ID: 3C

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040601-6

Lab System ID: 245440

Client: Division 20

Date Received: 05/28/04

Project No.: 10542.02.002

SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2780	0.20
Calcium	2516	0.20
Iron	2.11	0.10
Lead	<0.050	0.05
Nickel	0.020	0.01
Potassium	1.44	0.500
Sodium	3649	0.500
Zinc	0.030	0.025

K. J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010018

Sample ID: 3D

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040601-6

Lab System ID: 245441

Client: Division 20

Date Received: 05/28/04

Project No.: 10542.02.002

SRR: 25978

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<2	2
Nitrate-N	<2	2
Boron	2866	0.20
Calcium	11195	0.20
Iron	8.96	0.10
Lead	<0.050	0.05
Nickel	0.080	0.01
Potassium	2.33	0.500
Sodium	3890	0.500
Zinc	0.162	0.025

K. J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010019

Sample ID: 5A

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040603-3

Lab System ID: 245613

Client: Division 20

Date Received: 06/02/04

Project No.: 10542.02.002

SRR: 25997

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	38.3	2
Nitrate-N	<2	2
Boron	2658	0.20
Calcium	231	0.20
Iron	0.766	0.10
Lead	<0.050	0.05
Nickel	0.347	0.01
Potassium	1.45	0.500
Sodium	3448	0.500
Zinc	<0.025	0.025

K. J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

SAMPLE ANALYSIS DATA SHEET 010020

Sample ID: 5B

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040603-3

Lab System ID: 245614

Client: Division 20

Date Received: 06/02/04

Project No.: 10542.02.002

SRR: 25997

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	2.42	2
Nitrate-N	<2	2
Boron	2895	0.20
Calcium	17.1	0.20
Iron	0.170	0.10
Lead	<0.050	0.05
Nickel	0.053	0.01
Potassium	1.47	0.500
Sodium	3757	0.500
Zinc	5.88	0.025

K. J. Chung
9/20/04

SOUTHWEST RESEARCH INSTITUTE

LABORATORY CONTROL SAMPLE 010021

Sample ID: LCSW

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040601-6, 040603-3

Lab System ID: NA

Client: Division 20

Date Received: NA

Project No.: 10542.02.002

SRR: 25978, 25997

Analysis	Sample Result (mg/L)	True Value (mg/L)	Recovery
Chloride	197	200	98.5%
Nitrate-N	82.5	90.4	91.3%
Boron	3.01	4.00	75.3%
Calcium	34.2	40.0	85.5%
Iron	1.93	2.00	96.5%
Lead	0.874	1.00	87.4%
Nickel	0.859	1.00	85.9%
Potassium	32.0	40.0	80.0%
Sodium	32.0	40.0	80.0%
Zinc	0.874	1.00	87.4%

NA- Not Applicable.

K. J. Chmiel
9/20/04

SOUTHWEST RESEARCH INSTITUTE

BLANK SUMMARY 010022

Sample ID: PBW

Lab Name: Southwest Research Institute

Lab Code: SwRI

Matrix: Liquid

Task Order: 040601-6, 040603-3

Lab System ID: NA

Client: Division 20

Date Received: NA

Project No.: 10542.02.002

SRR: 25978, 25997

Analysis	Sample Result (mg/L)	Reporting Limit (mg/L)
Chloride	<0.1	0.1
Nitrate-N	<0.1	0.1
Boron	<0.200	0.20
Calcium	<0.200	0.20
Iron	<0.100	0.10
Lead	<0.050	0.05
Nickel	<0.010	0.01
Potassium	<0.500	0.500
Sodium	<0.500	0.500
Zinc	<0.010	0.01

NA- Not Applicable.

K. J. Chmiel
9/20/04

I have reviewed this scientific notebook and find it in compliance with QAP-001. There is sufficient information regarding procedures used for conducting tests, acquiring and analyzing data so that another qualified individual could repeat the activity.

9/27/2004