Contract No:

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy (DOE) Office of Environmental Management (EM).

Disclaimer:

Product Consistency Test Results for the HFG1 Glasses

M.C. Hsieh

June 2021

SRNL-STI-2021-00148, Revision 0

DISCLAIMER

Printed in the United States of America

Prepared for
U.S. Department of Energy

SRNL-STI-2021-00148
Revision 0

Keywords: *Hanford, WTP, waste glass, durability*

Retention: *Permanent*

Product Consistency Test Results for the HFG1 Glasses

M.C. Hsieh

June 2021

Prepared for the U.S. Department of Energy under contract number DE-AC09-08SR22470.

Savannah River National Laboratory®
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

REVIEWS AND APPROVALS

AUTHORS:

_____
M.C. Hsieh, Applied Materials Research

TECHNICAL REVIEW:

_____
F.C. Johnson, Applied Materials Research, Reviewed per E7 2.60

APPROVAL:

_____
J. Manna, Director, Material Science & Engineering

PREFACE OR ACKNOWLEDGEMENTS

The author would like to thank Meagan Kinard, Kandice Miles, Whitney Riley, Kim Wyszynski, and Anna Stanfield at Savannah River National Laboratory for their skilled assistance with the sample and data analyses described in this report. The author thanks Renee Russell at the Pacific Northwest National Laboratory for helpful discussions and review of these data and the report. Funding from the U.S. Department of Energy Office of River Protection Waste Treatment and Immobilization Plant Project through Inter-Entity Work Order M0SRV00101 as managed by Albert A. Kruger is gratefully acknowledged.

EXECUTIVE SUMMARY

This report provides the results of the Product Consistency Test (PCT) leachates from the High Fluoride Glasses-1, a series of simulated nuclear waste glasses fabricated at the Pacific Northwest National Laboratory (PNNL). The series included quenched (Q) and canister-centerline cooled (CCC) versions of the glasses. These data will be used to validate or identify areas of potential characterization improvements in the current glass property/composition models.

Some of the glass leachates were noted to have significant differences among the triplicate values for certain analytes. Several of these samples were rerun to verify the original measurements and analysis; however, there were no significant differences in the measured values. A review of the PCT data indicated that there was generally little difference between the normalized values based on targeted or measured glass composition. Three of the study glasses have NC_i values that are greater than the EA benchmark NC_B value of 16.695 g/L, NC_{Li} value of 9.565 g/L, and NC_{Na} value of 13.346 g/L. Heat treatment had only a marginal impact on the NC_i values in most cases. Several samples of the Approved Reference Material-1 (ARM-1) reference glass included with each PCT group have concentrations that are outside of the control chart limits. The release rates for B and Na were highly correlated for the study glasses.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

ARM-1	Approved Reference Material-1
BDL	below detection limit
CCC	canister centerline cooled
DOE	U.S. Department of Energy
EA	Environmental Assessment
HFG1	High Fluoride Glasses-1
HLW	high-level waste
ICP-OES	inductively coupled plasma – optical emission spectroscopy
ID	identifier
NC_i	normalized concentration of element "*i*"
ORP	Office of River Protection
PCT	Product Consistency Test
PNNL	Pacific Northwest National Laboratory
Q	quenched
%RSD	percent relative standard deviation
SRNL	Savannah River National Laboratory
TTQAP	Task Technical and Quality Assurance Plan
wt.%	weight percent
WTP	Hanford Tank Waste Treatment and Immobilization Plant

1.0 Introduction

The U.S. Department of Energy (DOE) is responsible for building the Hanford Tank Waste Treatment and Immobilization Plant (WTP) at the Hanford site in Washington to remediate 55 million gallons of radioactive waste that is temporarily stored in 177 underground tanks. The Office of River Protection (ORP) has requested that the Savannah River National Laboratory (SRNL) contribute in areas of recognized capabilities and expertise for glass waste form development to support successful startup of the WTP.

As part of this effort, the Pacific Northwest National Laboratory (PNNL) is developing, batching, and fabricating simulated high-level waste (HLW) glasses to generate the associated property data needed to validate or identify areas of potential characterization improvement in the current glass property/composition models.[1] Currently, the models cover only a small fraction of the waste compositions projected in the Hanford tank farm; therefore, the models must be expanded to include high fluoride compositions to successfully complete the WTP mission. SRNL support of this work is defined in the Task Technical and Quality Assurance Plan (TTQAP).[2]

This report provides the results of the Product Consistency Test (PCT) leachates from the High Fluoride Glasses-1 (HFG1), a series of simulated nuclear waste glasses fabricated at PNNL. The series included quenched (Q) and canister-centerline cooled (CCC) versions of the glasses. The glasses were selected as part of a broader study of the influence of glass composition on chemical durability, sulfur retention, and other properties.[3,4] These data will be used to validate or identify areas of potential characterization improvements in the current glass property/composition models.

2.0 Experimental Procedure

2.1 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in Savannah River Site Manual E7, Procedure 2.60. SRNL documents the extent and type of review using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2. Laboratory data for this study were recorded in the SRNL Electronic Laboratory Notebook system, experiment L6390-00441-01. The glass leachates were provided by PNNL following a Task Plan.[1]

2.2 Glasses Selected for Study

The baseline (quenched) glass compositions in this study were selected and fabricated by PNNL. PNNL performed CCC heat treatments on a subsample of each of the glasses. ASTM PCT Method A[5] was performed on quenched and CCC versions of each of the study glasses, and the resulting leachates were sent to SRNL for chemical analysis. The leachates were analyzed in several groups. Identifiers for quenched glass leachates are listed in Table 2-1 and CCC glass leachates are listed in Table 2-2.

Table 2-1. Identifiers for the Quenched Glass PCT Leachates

PNNL Solution ID	Lab ID	PNNL Solution ID	Lab ID
HFG1-01-1-Q-PCT-A	S-11661	HFG1-06-Q-PCT-A	S-11693
HFG1-01-1-Q-PCT-B	S-11662	HFG1-06-Q-PCT-B	S-11694
HFG1-01-1-Q-PCT-C	S-11663	HFG1-06-Q-PCT-C	S-11695
HFG1-02-Q-PCT-A	S-11664	HFG1-11-Q-PCT-A	S-11696
HFG1-02-Q-PCT-B	S-11665	HFG1-11-Q-PCT-B	S-11697
HFG1-02-Q-PCT-C	S-11666	HFG1-11-Q-PCT-C	S-11698
HFG1-03-Q-PCT-A	S-11667	HFG1-12-Q-PCT-A	S-11699
HFG1-03-Q-PCT-B	S-11668	HFG1-12-Q-PCT-B	S-11700
HFG1-03-Q-PCT-C	S-11669	HFG1-12-Q-PCT-C	S-11701
HFG1-04-Q-PCT-A	S-11670	HFG1-13-Q-PCT-A	S-11702
HFG1-04-Q-PCT-B	S-11671	HFG1-13-Q-PCT-B	S-11703
HFG1-04-Q-PCT-C	S-11672	HFG1-13-Q-PCT-C	S-11704
HFG1-05-Q-PCT-A	S-11673	HFG1-14-Q-PCT-A	S-11705
HFG1-05-Q-PCT-B	S-11674	HFG1-14-Q-PCT-B	S-11706
HFG1-05-Q-PCT-C	S-11675	HFG1-14-Q-PCT-C	S-11707
HFG1-07-Q-PCT-A	S-11676	HFG1-15-Q-PCT-A	S-11708
HFG1-07-Q-PCT-B	S-11677	HFG1-15-Q-PCT-B	S-11709
HFG1-07-Q-PCT-C	S-11678	HFG1-15-Q-PCT-C	S-11710
HFG1-08-Q-PCT-A	S-11679	HFG1-16-Q-PCT-A	S-11711
HFG1-08-Q-PCT-B	S-11680	HFG1-16-Q-PCT-B	S-11712
HFG1-08-Q-PCT-C	S-11681	HFG1-16-Q-PCT-C	S-11713
HFG1-09-Q-PCT-A	S-11682	HFG1-17-Q-PCT-A	S-11714
HFG1-09-Q-PCT-B	S-11683	HFG1-17-Q-PCT-B	S-11715
HFG1-09-Q-PCT-C	S-11684	HFG1-17-Q-PCT-C	S-11716
HFG1-10-Q-PCT-A	S-11685	HFG1-18-Q-PCT-A	S-11717
HFG1-10-Q-PCT-B	S-11686	HFG1-18-Q-PCT-B	S-11718
HFG1-10-Q-PCT-C	S-11687	HFG1-18-Q-PCT-C	S-11719
ARM-1-STD-PCT-A-100720	S-11688	HFG1-19-Q-PCT-A	S-11720
ARM-1-STD-PCT-B-100720	S-11689	HFG1-19-Q-PCT-B	S-11721
ARM-1-STD-PCT-C-100720	S-11690	HFG1-19-Q-PCT-C	S-11722
BLANK-1-PCT-100720	S-11691	HFG1-20-Q-PCT-A	S-11723
BLANK-2-PCT-100720	S-11692	HFG1-20-Q-PCT-B	S-11724
		HFG1-20-Q-PCT-C	S-11725
		ARM-1-STD-PCT-A-102820	S-11726
		ARM-1-STD-PCT-B-102820	S-11727
		ARM-1-STD-PCT-C-102820	S-11728
		BLANK-1-PCT-102820	S-11729
		BLANK-2-PCT-102820	S-11730

Table 2-2. Identifiers for the CCC Glass PCT Leachates

PNNL Solution ID	Lab ID	PNNL Solution ID	Lab ID
HFG1-01-1-CCC-PCT-A	S-11995	HFG1-11-CCC-PCT-A	S-12030
HFG1-01-1-CCC-PCT-B	S-11996	HFG1-11-CCC-PCT-B	S-12031
HFG1-01-1-CCC-PCT-C	S-11997	HFG1-11-CCC-PCT-C	S-12032
HFG1-02-CCC-PCT-A	S-11998	HFG1-12-CCC-PCT-A	S-12033
HFG1-02-CCC-PCT-B	S-11999	HFG1-12-CCC-PCT-B	S-12034
HFG1-02-CCC-PCT-C	S-12000	HFG1-12-CCC-PCT-C	S-12035
HFG1-03-CCC-PCT-A	S-12001	HFG1-13-CCC-PCT-A	S-12036
HFG1-03-CCC-PCT-B	S-12002	HFG1-13-CCC-PCT-B	S-12037
HFG1-03-CCC-PCT-C	S-12003	HFG1-13-CCC-PCT-C	S-12038
HFG1-04-CCC-PCT-A	S-12004	HFG1-14-CCC-PCT-A	S-12039
HFG1-04-CCC-PCT-B	S-12005	HFG1-14-CCC-PCT-B	S-12040
HFG1-04-CCC-PCT-C	S-12006	HFG1-14-CCC-PCT-C	S-12041
HFG1-05-CCC-PCT-A	S-12007	HFG1-15-CCC-PCT-A	S-12042
HFG1-05-CCC-PCT-B	S-12008	HFG1-15-CCC-PCT-B	S-12043
HFG1-05-CCC-PCT-C	S-12009	HFG1-15-CCC-PCT-C	S-12044
HFG1-06-CCC-PCT-A	S-12010	HFG1-16-CCC-PCT-A	S-12045
HFG1-06-CCC-PCT-B	S-12011	HFG1-16-CCC-PCT-B	S-12046
HFG1-06-CCC-PCT-C	S-12012	HFG1-16-CCC-PCT-C	S-12047
HFG1-07-CCC-PCT-A	S-12013	HFG1-17-CCC-PCT-A	S-12048
HFG1-07-CCC-PCT-B	S-12014	HFG1-17-CCC-PCT-B	S-12049
HFG1-07-CCC-PCT-C	S-12015	HFG1-17-CCC-PCT-C	S-12050
HFG1-08-CCC-PCT-A	S-12016	HFG1-18-CCC-PCT-A	S-12051
HFG1-08-CCC-PCT-B	S-12017	HFG1-18-CCC-PCT-B	S-12052
HFG1-08-CCC-PCT-C	S-12018	HFG1-18-CCC-PCT-C	S-12053
HFG1-09-CCC-PCT-A	S-12019	HFG1-19-CCC-PCT-A	S-12054
HFG1-09-CCC-PCT-B	S-12020	HFG1-19-CCC-PCT-B	S-12055
HFG1-09-CCC-PCT-C	S-12021	HFG1-19-CCC-PCT-C	S-12056
HFG1-10-CCC-PCT-A	S-12022	HFG1-20-CCC-PCT-A	S-12057
HFG1-10-CCC-PCT-B	S-12023	HFG1-20-CCC-PCT-B	S-12058
HFG1-10-CCC-PCT-C	S-12024	HFG1-20-CCC-PCT-C	S-12059
ARM-1-STD-PCT-A-111120	S-12025	ARM-1-STD-PCT-A-120220	S-12060
ARM-1-STD-PCT-B-111120	S-12026	ARM-1-STD-PCT-B-120220	S-12061
ARM-1-STD-PCT-C-111120	S-12027	ARM-1-STD-PCT-C-120220	S-12062
BLANK-1-PCT-111120	S-12028	BLANK-1-PCT-120220	S-12063
BLANK-2-PCT-111120	S-12029	BLANK-2-PCT-120220	S-12064

2.3 PCT Leachate Analysis

The PCT leachate samples were analyzed by Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES)[6] under the auspices of two analytical study plans.[7,8] Samples of a multi-element standard solution[a] were also included in the analytical plans as a check of the accuracy of the instrument used for these measurements. PNNL provided the dilution factor used in preparing the PCT leachates for analyses. The leachate measurements were adjusted using the provided dilution factor of 5 as described further below. Normalized release values were calculated for each glass based on the targeted and measured[9] compositions.

[a] ICP multi-element custom solution, product number SM-744-013, High Purity Standards, Charleston, SC.

3.0 Results and Discussion

JMP Version 14.3.0 (SAS Institute, Inc.)[10] was used to support these analyses.

3.1 Measured Compositions of the PCT Leachates

Table A-1 in Appendix A provides the elemental leachate concentration measurements for the PCT leachates and standard solutions. Values are shown both as received from the analytical laboratory and after correction for dilutions performed at PNNL. Note that the measured concentrations of the analytes in most of the blank samples were generally below detection limits (BDL) and denoted by a less than symbol (<). Two blanks (S-11691 and S-11692) have measurable Si concentrations of 8.2 mg/L and 9.1 mg/L, respectively, and one blank (S-11730) has a measurable Na concentration of 7.65 mg/L.

Several samples of the Approved Reference Material-1 (ARM-1) reference glass have B, Li, Na, and Si leachate concentrations that are above the upper limits in the control charts.[11] The results for the ARM-1 samples are shown in Table A-2 in Appendix A. Values that fall outside control chart values are shaded in the table.

- ARM-1-STD-PCT-A-100720 (S-11688), ARM-1-STD-PCT-C-111120 (S-12027), and ARM-STD-PCT-C-120220 (S-12062) consistently fall outside the control chart limits for all analytes.

Following the guidance in ASTM C 1285-14,[5] the mean, standard deviation, and percent relative standard deviation (%RSD) were determined for each element present in the solution standard for each analytical block. As shown in Table A-4 in Appendix A, the mean value for each analytical block was found to be less than 10% from the reference value (i.e., a percent relative bias less than 10%), and the %RSD was less than 10% for each element. Thus, these analytical results are acceptable per the criteria in ASTM C1285-14, which indicates no significant issues with the analytical outcomes for the measurements of the PCT leachates.

Exhibit A-1 in Appendix A provides plots of the dilution corrected leachate concentrations (mg/L) in analytical sequence by analytical block. Plotting the data in this format provides an opportunity to identify gross trends in performance of the analytical instrument within and among calibration blocks. No issues were observed in a review of these plots.

Exhibit A-2 in Appendix A provides plots of the triplicate leachate concentrations by the glass ID. Both linear and logarithmic plots are provided for each analyte. Plotting the data in this format allows for the assessment of the repeatability of the measurements for each glass. For some of the glasses, minor scatter among the triplicate values of some analytes is observed. For several glasses shown below, there are more significant differences among the triplicate values for certain analytes.

- HFG1-07-CCC-PCT-A (S-12013) and HFG1-10-Q-PCT-A (S-11685) both have measured B concentration values that are about 2x higher than their other replicates.
- HFG1-01-1-CCC-PCT samples (S-11995, S-11996, and S-11997) have varying measured Li concentrations.
- HFG1-10-Q-PCT-A (S-11685) and HFG1-19-Q-PCT-B (S-11721) both have measured Na concentrations 2x higher than their other replicates.
- HFG1-06-CCC-PCT-A (S-12010) has a measured Si concentration that is 1.5x higher than the other replicates.

Several of the above-mentioned samples were rerun to verify the original measurements and analysis. These measurements are provided in Table A-3 in Appendix A. There were no significant changes in the measurements which indicated that differences in triplicate measurement values were not caused by analytical error. Therefore, all measurements were used for normalizing the PCT data.

3.2 Normalization of PCT Data

The PCT leachate data were used to determine normalized concentrations for each element of interest using both the targeted and average measured compositions[9] of the glasses following the expression given in ASTM C1285:[5]

$$NC_i = \frac{c_i\left(sample\right)}{f_i}$$

where NC_i is the normalized concentration in units of $g_{waste\ form}/L_{leachant}$, $c_i(sample)$ is the concentration of element "*i*" in the leachate in units of g_i/L (corrected for the dilutions performed at PNNL), and f_i is the mass fraction of element "*i*" in the unleached glass in units of g_i/g_{glass}.[b]

An equation was developed to allow for calculation of the NC_i values using the units of measurement provided with the analytical results for this study, and to accommodate the triplicate leachate measurements for each of the study glasses. Note that the symbols in this second equation were kept consistent with those used in ASTM C1285,[5] but the units of measurement differ. The common logarithm of the normalized concentration for each element "*i*" (NC_i) for each of the study glasses was determined using the equation:

$$\log_{10}\left(NC_i\right) = \overline{\log_{10} c_i} - \left[1 + \log_{10} f_i\right]$$

where NC_i remains in units of $g_{waste\ form}/L_{leachant}$, $\overline{\log_{10} c_i}$ is the average of the common logarithms of the measured concentrations of element "*i*" in the triplicate leachates in units of mg/L (corrected for the dilutions performed at PNNL as discussed in Section 2.3), and $\log_{10} f_i$ is either the common logarithm of the targeted concentration of element "*i*" in the glass in units of wt.%, or the common logarithm of the average measured concentration of element "*i*" in the glass in units of wt.% (reported previously[9]).

Table B-1 in Appendix B provides the normalized PCT responses for the Q and CCC for each of the study glasses as well as the responses for the ARM-1 reference glass[12] (labeled "ARM-1-STD-PCT" in the PNNL experiments). The results are grouped by compositional view. Note that an indicator is provided as part of these plots to show results involving BDL values. The plots of Exhibit B-1 in Appendix B provide a graphical comparison between the PCT responses for the two versions of each study glass.

A review of the PCT data resulted in the following observations:

- Little difference is seen when evaluating the normalized values using the targeted or measured glass compositions. Some examples of exceptions include the following samples.
  - HFG1-03 has notable differences in NC_{Li} values due to differences in the measured and targeted concentrations of Li_2O of the baseline glasses.
- Heat treatment had only a marginal impact on the NC_i values in most cases.
  - The heat-treated version of HFG1-16 has notably higher NC_B, NC_{Li}, and NC_{Na} values than the quenched version.
  - The heat-treated versions of HFG1-01-1, HFG1-02, HFG1-09, and HFG1-11 have notably higher NC_{Li} values than the quenched versions.
- HFG1-06-Q, HFG1-06-CCC, and HFG1-16-CCC have NC_B, NC_{Li}, and NC_{Na} values higher than the EA benchmark NC_B value of 16.695 g/L, NC_{Li} value of 9.565 g/L, and NC_{Na} value of 13.346 g/L.[13]

[b] Note that the waste forms in this study were assumed to be of similar density. The PCT-A reference volume of leachant to sample mass ratio was used, and the 100 to 200 mesh reference particle size was used. Thus, no adjustment for the density of the glasses was made in normalizing the PCT results. Data provided in the appendices of this report allow for the calculation of normalized elemental mass loss (NL_i) if glass densities are measured at a later date.

Exhibit B-2 provides the results of an evaluation of congruent leaching among the analytes for the study glasses. The release rates for B and Na are highly correlated in the study glasses. Less correlation is seen among the release rates of the other analytes for the study glasses.

4.0 Summary

Some of the glass leachates were noted to have significant differences among the triplicate values for certain analytes. Several of these samples were rerun to verify the original measurements and analysis; however, there were no significant differences in the measured values. A review of the PCT data indicated that there was generally little difference between the normalized values based on targeted or measured glass composition. Three of the study glasses have NC_i values that are greater than the EA benchmark NC_B value of 16.695 g/L, NC_{Li} value of 9.565 g/L, and NC_{Na} value of 13.346 g/L NC_i. Heat treatment had only a marginal impact on the NC_i values in most cases. Several samples of the ARM-1 reference glass included with each PCT have concentrations that are outside of the control chart limits. The release rates for B and Na were highly correlated for the study glasses.

5.0 References

1. R.L. Russell, "High-Level Waste Matrix 2 (HLW2) Glass Testing," Pacific Northwest National Laboratory, Richland, WA, EWG-TP-0115, Revision 0, 2020.

2. K.M. Fox, "Task Technical and Quality Assurance Plan for Hanford Waste Glass Development and Characterization," Savannah River National Laboratory, Aiken, SC, SRNL-RP-2013-00692, Revision 1, 2016.

3. D.K. Peeler, D.S. Kim, J.D. Vienna, M.J. Schweiger, and G.F. Piepel, "Office of River Protection Advanced Low-Activity Waste Glass Research and Development Plan," Pacific Northwest National Laboratory, Richland, WA, PNNL-24883, EWG-RPT-008, Revision 0, 2015.

4. D.K. Peeler, J.D. Vienna, M.J. Schweiger, and K.M. Fox, "Advanced High-Level Waste Glass Research and Development Plan," Pacific Northwest National Laboratory, Richland, WA, PNNL-24450, Revision 0, 2015.

5. ASTM, "Standard Test Methods for Determining Chemical Durability of Nuclear, Hazardous, and Mixed Waste Glasses and Multiphase Glass Ceramics: The Product Consistency Test (PCT)," ASTM International, West Conshohocken, PA, C1285 - 14, 2014.

6. "Calibration, Verification, and Operation of the Agilent 5110 ICP-OES Inductively Coupled Plasma-Optical Emission Spectrometer," Savannah River National Laboratory, Aiken, SC, Manual L33, Procedure 0242, Rev. 0, 2020.

7. M.C. Hsieh, "An Analytical Plan for Measuring the PCT Solutions of the HFG1 High-Fluorine High Level Waste Study Glasses," Savannah River National Laboratory, Aiken, SC, SRNL-L3300-2020-00053, Revision 0, 2020.

8. M.C. Hsieh, "An Analytical Plan for Measuring the PCT Solutions of the CCC Heat Treated HFG1 High-Fluorine High Level Waste Study Glasses," Savannah River National Laboratory, Aiken, SC, SRNL-L3300-2020-00056, Revision 0, 2020.

9. M.C. Hsieh, "Composition Measurements of the HFG1 Glasses," Savannah River National Laboratory, Aiken, SC, SRNL-STI-2021-00147, Revision 0, 2021.

10. JMP, Version 14.3.0, SAS Institute Inc., Cary, NC, 2018.

11. C.M. Jantzen, J.B. Pickett, K.G. Brown, T.B. Edwards, and D.C. Beam, "Process/Product Models for the Defense Waste Processing Facility (DWPF): Part I. Predicting Glass Durability from Composition Using a Thermodynamic Hydration Energy Reaction Model (THERMO)," Westinghouse Savannah River Company, Aiken, SC, WSRC-TR-93-672, Rev. 1, 1995.

12. G.B. Mellinger and J.L. Daniel, "Approved Reference and Testing Materials for Use in Nuclear Waste Management Research and Development Programs," Pacific Northwest Laboratory, Richland, WA, PNL-4955-2, Revision 0, 1984.

13. C.M. Jantzen, N.E. Bibler, D.C. Beam, C.L. Crawford, and M.A. Pickett, "Characterization of the Defense Waste Processing Facility (DWPF) Environmental Assessment (EA) Glass Standard Reference Material," Westinghouse Savannah River Company, Aiken, SC, WSRC-TR-92-346, Revision 1, 1993.

Appendix A. Tables and Exhibits Supporting Analysis of the HFG1 PCT Leachates

Table A-1. PCT Leachate Measurements (mg/L) in Analytical Sequence

Quenched Glass PCT Leachates																			
PNNL Solution ID	**Lab ID**	**Block**	**Sequence**	**Al (ar)**	**B (ar)**	**Cr (ar)**	**K (ar)**	**Li (ar)**	**Na (ar)**	**Si (ar)**	**Zr (ar)**	**Dil. Fac.**	**Al ***	**B ***	**Cr ***	**K ***	**Li ***	**Na ***	**Si ***	**Zr ***
standard	std-11	1	1	3.98	20.6	<1.00	10.6	9.61	81.7	49.5	<1.00	1	3.98	20.6	<1.00	10.6	9.61	81.7	49.5	<1.00
HFG1-18-Q-PCT-B	S-11718	1	2	<1.00	16.7	<1.00	<1.00	8.71	30.7	19.1	<1.00	5	<5.00	83.5	<5.00	<5.00	43.6	154	95.5	<5.00
HFG1-06-Q-PCT-B	S-11694	1	3	<1.00	92.0	<1.00	14.1	52.5	654	170	<1.00	5	<5.00	460	<5.00	70.5	263	3270	850	<5.00
HFG1-01-1-Q-PCT-B	S-11662	1	4	2.49	1.97	<1.00	<1.00	1.93	16.3	9.02	<1.00	5	12.5	9.85	<5.00	<5.00	9.65	81.5	45.1	<5.00
HFG1-17-Q-PCT-B	S-11715	1	5	1.54	2.13	<1.00	<1.00	3.46	50.1	15.1	<1.00	5	7.70	10.7	<5.00	<5.00	17.3	251	75.5	<5.00
HFG1-11-Q-PCT-B	S-11697	1	6	1.09	9.18	<1.00	<1.00	<1.00	32.8	4.46	<1.00	5	5.45	45.9	<5.00	<5.00	<5.00	164	22.3	<5.00
HFG1-05-Q-PCT-B	S-11674	1	7	<1.00	49.4	<1.00	<1.00	10.0	210	36.2	<1.00	5	<5.00	247	<5.00	<5.00	50.0	1050	181	<5.00
ARM-1-STD-PCT-B-102820	S-11727	1	8	<1.00	3.26	<1.00	<1.00	2.4	10.3	11.1	<1.00	5	<5.00	16.3	<5.00	<5.00	12.0	51.5	55.5	<5.00
HFG1-15-Q-PCT-B	S-11709	1	9	<1.00	23.9	<1.00	3.42	14.8	93.8	55.2	<1.00	5	<5.00	120	<5.00	17.1	74.0	469	276	<5.00
HFG1-14-Q-PCT-B	S-11706	1	10	<1.00	16.2	<1.00	<1.00	4.33	169	70.3	<1.00	5	<5.00	81.0	<5.00	<5.00	21.7	845	352	<5.00
HFG1-12-Q-PCT-B	S-11700	1	11	<1.00	9.32	<1.00	<1.00	7.63	38.8	21.4	<1.00	5	<5.00	46.6	<5.00	<5.00	38.2	194	107	<5.00
HFG1-03-Q-PCT-B	S-11668	1	12	<1.00	1.89	<1.00	<1.00	<1.00	13.3	8.28	<1.00	5	<5.00	9.45	<5.00	<5.00	<5.00	66.5	41.4	<5.00
HFG1-02-Q-PCT-B	S-11665	1	13	<1.00	1.14	<1.00	<1.00	<1.00	13.9	9.18	<1.00	5	<5.00	5.70	<5.00	<5.00	<5.00	69.5	45.9	<5.00
standard	std-12	1	14	3.97	20.0	<1.00	10.0	9.73	82.0	48.9	<1.00	1	3.97	20.0	<1.00	10.0	9.73	82.0	48.9	<1.00
ARM-1-STD-PCT-B-100720	S-11689	1	15	<1.00	3.48	<1.00	<1.00	2.55	8.85	13.3	<1.00	5	<5.00	17.4	<5.00	<5.00	12.8	44.3	66.5	<5.00
HFG1-10-Q-PCT-B	S-11686	1	16	1.30	20.7	<1.00	1.34	4.82	85.6	8.80	<1.00	5	6.50	104	<5.00	6.70	24.1	428	44.0	<5.00
HFG1-20-Q-PCT-B	S-11724	1	17	5.48	4.62	<1.00	<1.00	2.23	114	21.0	<1.00	5	27.4	23.1	<5.00	<5.00	11.2	570	105	<5.00
HFG1-13-Q-PCT-B	S-11703	1	18	1.53	2.63	<1.00	<1.00	2.95	12.4	10.1	<1.00	5	7.65	13.2	<5.00	<5.00	14.8	62.0	50.5	<5.00
BLANK-2-PCT-100720	S-11692	1	19	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.85	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	9.25	<5.00
HFG1-19-Q-PCT-B	S-11721	1	20	<1.00	26.2	<1.00	2.98	2.68	161	18.4	<1.00	5	<5.00	131	<5.00	14.9	13.4	805	92.0	<5.00
HFG1-16-Q-PCT-B	S-11712	1	21	6.22	5.15	<1.00	4.51	15.1	148	27.0	<1.00	5	31.1	25.8	<5.00	22.6	75.5	740	135	<5.00
HFG1-07-Q-PCT-B	S-11677	1	22	1.51	25.0	<1.00	1.10	<1.00	66.0	7.57	<1.00	5	7.55	125	<5.00	5.50	<5.00	330	37.9	<5.00
HFG1-09-Q-PCT-B	S-11683	1	23	<1.00	2.03	<1.00	<1.00	1.79	39.7	18.9	<1.00	5	<5.00	10.2	<5.00	<5.00	8.95	199	94.5	<5.00
HFG1-04-Q-PCT-B	S-11671	1	24	<1.00	82.2	<1.00	15.8	6.97	419	166	<1.00	5	<5.00	411	<5.00	79.0	34.9	2100	830	<5.00
HFG1-08-Q-PCT-B	S-11680	1	25	<1.00	5.80	<1.00	1.83	<1.00	76.8	18.7	<1.00	5	<5.00	29.0	<5.00	9.15	<5.00	384	93.5	<5.00
standard	std-13	1	26	3.94	19.8	<1.00	9.91	9.65	81.9	48.4	<1.00	1	3.94	19.8	<1.00	9.91	9.65	81.9	48.4	<1.00
standard	std-21	2	1	3.90	19.7	<1.00	9.62	9.62	79.4	48.3	<1.00	1	3.90	19.7	<1.00	9.62	9.62	79.4	48.3	<1.00
BLANK-1-PCT-100720	S-11691	2	2	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.66	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	8.30	<5.00
HFG1-12-Q-PCT-A	S-11699	2	3	<1.00	9.68	<1.00	<1.00	8.06	39.4	22.5	<1.00	5	<5.00	48.4	<5.00	<5.00	40.3	197	113	<5.00
HFG1-06-Q-PCT-A	S-11693	2	4	<1.00	88.9	<1.00	13.3	51.7	608	195	<1.00	5	<5.00	445	<5.00	66.5	259	3040	975	<5.00
ARM-1-STD-PCT-A-100720	S-11688	2	5	<1.00	6.26	<1.00	<1.00	4.57	13.5	16.5	<1.00	5	<5.00	31.3	<5.00	<5.00	22.9	67.5	82.5	<5.00
ARM-1-STD-PCT-A-102820	S-11726	2	6	<1.00	4.55	<1.00	<1.00	3.29	10.3	13.1	<1.00	5	<5.00	22.8	<5.00	<5.00	16.5	51.5	65.5	<5.00
HFG1-08-Q-PCT-A	S-11679	2	7	<1.00	5.79	<1.00	1.78	<1.00	71.9	19.0	<1.00	5	<5.00	29.0	<5.00	8.90	<5.00	360	95.0	<5.00
HFG1-20-Q-PCT-A	S-11723	2	8	5.06	4.53	<1.00	<1.00	2.22	112	22.2	<1.00	5	25.3	22.7	<5.00	<5.00	11.1	560	111	<5.00
HFG1-13-Q-PCT-A	S-11702	2	9	1.60	2.77	<1.00	<1.00	3.02	12.5	10.5	<1.00	5	8.00	13.9	<5.00	<5.00	15.1	62.5	52.5	<5.00
HFG1-09-Q-PCT-A	S-11682	2	10	<1.00	1.98	<1.00	<1.00	1.73	38.3	20.4	<1.00	5	<5.00	9.90	<5.00	<5.00	8.65	192	102	<5.00
HFG1-03-Q-PCT-A	S-11667	2	11	<1.00	1.32	<1.00	<1.00	<1.00	8.29	6.93	<1.00	5	<5.00	6.60	<5.00	<5.00	<5.00	41.5	34.7	<5.00
HFG1-14-Q-PCT-A	S-11705	2	12	<1.00	17.2	<1.00	<1.00	4.64	164	73.7	<1.00	5	<5.00	86.0	<5.00	<5.00	23.2	820	369	<5.00
HFG1-15-Q-PCT-A	S-11708	2	13	<1.00	18.7	<1.00	2.74	11.5	68.9	48.4	<1.00	5	<5.00	93.5	<5.00	13.7	57.5	345	242	<5.00
standard	std-22	2	14	3.91	19.9	<1.00	9.60	9.61	80.4	48.7	<1.00	1	3.91	19.9	<1.00	9.60	9.61	80.4	48.7	<1.00
HFG1-16-Q-PCT-A	S-11711	2	15	5.80	5.02	<1.00	4.18	14.5	147	26.2	<1.00	5	29.0	25.1	<5.00	20.9	72.5	735	131	<5.00
HFG1-07-Q-PCT-A	S-11676	2	16	1.34	23.0	<1.00	1.01	<1.00	60.7	7.34	<1.00	5	6.70	115	<5.00	5.05	<5.00	304	36.7	<5.00
HFG1-19-Q-PCT-A	S-11720	2	17	2.08	16.0	<1.00	1.94	1.65	93.2	11.2	<1.00	5	10.4	80.0	<5.00	9.70	8.25	466	56.0	<5.00
HFG1-02-Q-PCT-A	S-11664	2	18	<1.00	1.17	<1.00	<1.00	<1.00	13.9	8.97	<1.00	5	<5.00	5.85	<5.00	<5.00	<5.00	69.5	44.9	<5.00
BLANK-1-PCT-102820	S-11729	2	19	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
HFG1-01-1-Q-PCT-A	S-11661	2	20	2.63	2.16	<1.00	<1.00	2.05	17.1	9.72	<1.00	5	13.2	10.8	<5.00	<5.00	10.3	85.5	48.6	<5.00
HFG1-04-Q-PCT-A	S-11670	2	21	<1.00	80.8	<1.00	14.8	6.75	432	155	<1.00	5	<5.00	404	<5.00	74.0	33.8	2160	775	<5.00
HFG1-05-Q-PCT-A	S-11673	2	22	<1.00	46.1	<1.00	<1.00	9.39	199	34.0	<1.00	5	<5.00	231	<5.00	<5.00	47.0	995	170	<5.00
HFG1-11-Q-PCT-A	S-11696	2	23	1.33	9.64	<1.00	<1.00	1.46	33.8	5.31	<1.00	5	6.65	48.2	<5.00	<5.00	7.30	169	26.6	<5.00
HFG1-18-Q-PCT-A	S-11717	2	24	<1.00	26.3	<1.00	<1.00	13.9	46.9	22.1	<1.00	5	<5.00	132	<5.00	<5.00	69.5	235	111	<5.00
HFG1-10-Q-PCT-A	S-11685	2	25	1.17	40.4	<1.00	2.00	9.43	169	11.7	<1.00	5	5.85	202	<5.00	10.0	47.2	845	58.5	<5.00

ar = as received measurements prior to correction for dilution factor (Dil. Fac)
* = dilution corrected values

Table A-1. PCT Leachate Measurements (mg/L) in Analytical Sequence (continued)

Quenched Glass PCT Leachates																			
PNNL Solution ID	**Lab ID**	**Block**	**Sequence**	**Al (ar)**	**B (ar)**	**Cr (ar)**	**K (ar)**	**Li (ar)**	**Na (ar)**	**Si (ar)**	**Zr (ar)**	**Dil. Fac.**	**Al ***	**B ***	**Cr ***	**K ***	**Li ***	**Na ***	**Si ***	**Zr ***
HFG1-17-Q-PCT-A	S-11714	2	26	1.51	2.25	<1.00	<1.00	3.60	50.3	15.4	<1.00	5	7.55	11.3	<5.00	<5.00	18.0	252	77.0	<5.00
standard	std-23	2	27	3.97	20.0	<1.00	9.69	9.74	79.3	48.6	<1.00	1	3.97	20.0	<1.00	9.69	9.74	79.3	48.6	<1.00
standard	std-31	3	1	4.00	20.0	<1.00	10.1	9.57	81.1	48.4	<1.00	1	4.00	20.0	<1.00	10.1	9.57	81.1	48.4	<1.00
HFG1-03-Q-PCT-C	S-11669	3	2	<1.00	1.84	<1.00	<1.00	<1.00	12.5	7.49	<1.00	5	<5.00	9.20	<5.00	<5.00	<5.00	62.5	37.5	<5.00
HFG1-10-Q-PCT-C	S-11687	3	3	1.62	21.2	<1.00	1.31	4.83	88.3	7.83	<1.00	5	8.10	106	<5.00	6.55	24.2	442	39.2	<5.00
HFG1-18-Q-PCT-C	S-11719	3	4	<1.00	14.8	<1.00	<1.00	7.68	29.6	18.8	<1.00	5	<5.00	74.0	<5.00	<5.00	38.4	148	94.0	<5.00
HFG1-14-Q-PCT-C	S-11707	3	5	<1.00	16.4	<1.00	<1.00	4.29	167	70.8	<1.00	5	<5.00	82.0	<5.00	<5.00	21.5	835	354	<5.00
HFG1-15-Q-PCT-C	S-11710	3	6	<1.00	19.7	<1.00	2.94	12.0	75.9	50.3	<1.00	5	<5.00	98.5	<5.00	14.7	60.0	380	252	<5.00
HFG1-01-1-Q-PCT-C	S-11663	3	7	2.71	2.05	<1.00	<1.00	1.99	16.6	9.88	<1.00	5	13.6	10.3	<5.00	<5.00	9.95	83.0	49.4	<5.00
HFG1-12-Q-PCT-C	S-11701	3	8	<1.00	9.32	<1.00	<1.00	7.63	37.9	20.7	<1.00	5	<5.00	46.6	<5.00	<5.00	38.2	190	104	<5.00
HFG1-19-Q-PCT-C	S-11722	3	9	1.92	16.2	<1.00	2.04	1.62	95.5	12.4	<1.00	5	9.60	81.0	<5.00	10.2	8.10	478	62.0	<5.00
HFG1-04-Q-PCT-C	S-11672	3	10	<1.00	74.2	<1.00	14.5	6.20	389	145	<1.00	5	<5.00	371	<5.00	72.5	31.0	1950	725	<5.00
HFG1-08-Q-PCT-C	S-11681	3	11	<1.00	7.13	<1.00	2.06	<1.00	95.1	19.9	<1.00	5	<5.00	35.7	<5.00	10.3	<5.00	476	99.5	<5.00
ARM-1-STD-PCT-C-102820	S-11728	3	12	<1.00	3.05	<1.00	<1.00	2.32	8.84	13.1	<1.00	5	<5.00	15.3	<5.00	<5.00	11.6	44.2	65.5	<5.00
HFG1-09-Q-PCT-C	S-11684	3	13	<1.00	2.13	<1.00	<1.00	1.71	39.8	17.8	<1.00	5	<5.00	10.7	<5.00	<5.00	8.55	199	89.0	<5.00
standard	std-32	3	14	3.91	19.5	<1.00	9.75	9.31	81.3	47.5	<1.00	1	3.91	19.5	<1.00	9.75	9.31	81.3	47.5	<1.00
HFG1-13-Q-PCT-C	S-11704	3	15	1.52	2.74	<1.00	<1.00	2.94	12.9	10.2	<1.00	5	7.60	13.7	<5.00	<5.00	14.7	64.5	51.0	<5.00
HFG1-07-Q-PCT-C	S-11678	3	16	1.47	24.7	<1.00	1.06	<1.00	64.9	6.90	<1.00	5	7.35	124	<5.00	5.30	<5.00	325	34.5	<5.00
HFG1-16-Q-PCT-C	S-11713	3	17	5.95	5.07	<1.00	4.35	14.3	144	25.7	<1.00	5	29.8	25.4	<5.00	21.8	71.5	720	129	<5.00
ARM-1-STD-PCT-C-100720	S-11690	3	18	<1.00	3.34	<1.00	<1.00	2.42	8.46	12.1	<1.00	5	<5.00	16.7	<5.00	<5.00	12.1	42.3	60.5	<5.00
HFG1-06-Q-PCT-C	S-11695	3	19	<1.00	86.0	<1.00	13.0	49.1	606	193	<1.00	5	<5.00	430	<5.00	65.0	246	3030	965	<5.00
HFG1-20-Q-PCT-C	S-11725	3	20	4.84	4.66	<1.00	<1.00	2.18	110	21.6	<1.00	5	24.2	23.3	<5.00	<5.00	10.9	550	108	<5.00
HFG1-17-Q-PCT-C	S-11716	3	21	1.52	1.95	<1.00	<1.00	3.24	48.9	14.0	<1.00	5	7.60	9.75	<5.00	<5.00	16.2	245	70.0	<5.00
HFG1-02-Q-PCT-C	S-11666	3	22	<1.00	1.08	<1.00	<1.00	<1.00	13.3	8.05	<1.00	5	<5.00	5.40	<5.00	<5.00	<5.00	66.5	40.3	<5.00
HFG1-05-Q-PCT-C	S-11675	3	23	<1.00	48.8	<1.00	<1.00	9.74	206	34.4	<1.00	5	<5.00	244	<5.00	<5.00	48.7	1030	172	<5.00
HFG1-11-Q-PCT-C	S-11698	3	24	1.06	9.44	<1.00	<1.00	1.05	35.7	4.81	<1.00	5	5.30	47.2	<5.00	<5.00	5.25	179	24.1	<5.00
BLANK-2-PCT-102820	S-11730	3	25	<1.00	<1.00	<1.00	<1.00	<1.00	1.57	<1.00	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	7.85	<5.00	<5.00
standard	std-33	3	26	3.97	19.7	<1.00	9.99	9.46	80.0	47.7	<1.00	1	3.97	19.7	<1.00	9.99	9.46	80.0	47.7	<1.00
CCC Glass PCT Leachates																				
PNNL Solution ID	**Lab ID**	**Block**	**Sequence**	**Al (ar)**	**B (ar)**	**Cr (ar)**	**K (ar)**	**Li (ar)**	**Na (ar)**	**Si (ar)**	**Zr (ar)**	**Dil. Fac.**	**Al ***	**B ***	**Cr ***	**K ***	**Li ***	**Na ***	**Si ***	**Zr ***
standard	std-11	1	1	4.02	20.2	<1.00	9.73	9.42	79.8	49.7	<1.00	1	4.02	20.2	<1.00	9.73	9.42	79.8	49.7	<1.00
HFG1-14-CCC-PCT-A	S-12039	1	2	<1.00	17.9	<1.00	<1.00	4.76	168	79.4	<1.00	5	<5.00	89.5	<5.00	<5.00	23.8	840	397	<5.00
HFG1-06-CCC-PCT-A	S-12010	1	3	<1.00	97.3	<1.00	13.8	57.9	625	230	<1.00	5	<5.00	487	<5.00	69.0	290	3130	1150	<5.00
HFG1-05-CCC-PCT-A	S-12007	1	4	<1.00	47.4	<1.00	<1.00	9.92	176	37.6	<1.00	5	<5.00	237	<5.00	<5.00	49.6	880	188	<5.00
HFG1-09-CCC-PCT-A	S-12019	1	5	<1.00	2.49	<1.00	<1.00	15.0	53.5	18.7	<1.00	5	<5.00	12.5	<5.00	<5.00	75.0	268	93.5	<5.00
HFG1-13-CCC-PCT-A	S-12036	1	6	1.69	2.79	<1.00	<1.00	14.8	17.0	11.5	<1.00	5	8.45	14.0	<5.00	<5.00	74.0	85.0	57.5	<5.00
HFG1-15-CCC-PCT-A	S-12042	1	7	<1.00	21.4	<1.00	3.19	12.9	75.4	56.0	<1.00	5	<5.00	107	<5.00	16.0	64.5	377	280	<5.00
HFG1-16-CCC-PCT-A	S-12045	1	8	5.73	82.5	2.88	1.32	80.0	666	66.2	<1.00	5	28.7	413	14.4	6.60	400	3330	331	<5.00
HFG1-19-CCC-PCT-A	S-12054	1	9	2.04	10.2	<1.00	1.77	<1.00	105	10.6	<1.00	5	10.2	51.0	<5.00	8.85	<5.00	525	53.0	<5.00
HFG1-02-CCC-PCT-A	S-11998	1	10	1.49	1.31	<1.00	<1.00	17.2	29.9	9.17	<1.00	5	7.45	6.55	<5.00	<5.00	86.0	150	45.9	<5.00
ARM-1-STD-PCT-A-111120	S-12025	1	11	1.10	3.75	<1.00	<1.00	2.22	8.11	13.0	<1.00	5	5.50	18.8	<5.00	<5.00	11.1	40.6	65.0	<5.00
HFG1-10-CCC-PCT-A	S-12022	1	12	1.80	20.9	<1.00	1.27	5.11	78.1	8.49	<1.00	5	9.00	105	<5.00	6.35	25.6	391	42.5	<5.00
HFG1-07-CCC-PCT-A	S-12013	1	13	2.05	35.4	<1.00	1.59	<1.00	85.8	11.3	<1.00	5	10.3	177	<5.00	7.95	<5.00	429	56.5	<5.00
standard	std-12	1	14	4.24	21.7	<1.00	10.4	9.85	83.2	51.9	<1.00	1	4.24	21.7	<1.00	10.4	9.85	83.2	51.9	<1.00
HFG1-20-CCC-PCT-A	S-12057	1	15	6.19	4.40	<1.00	<1.00	2.31	99.4	21.9	<1.00	5	31.0	22.0	<5.00	<5.00	11.6	497	110	<5.00
ARM-1-STD-PCT-A-120220	S-12060	1	16	1.08	4.07	<1.00	<1.00	2.32	8.34	13.1	<1.00	5	5.40	20.4	<5.00	<5.00	11.6	41.7	65.5	<5.00
HFG1-11-CCC-PCT-A	S-12030	1	17	8.20	16.5	<1.00	1.18	22.7	98.0	8.98	<1.00	5	41.0	82.5	<5.00	5.90	114	490	44.9	<5.00
HFG1-08-CCC-PCT-A	S-12016	1	18	<1.00	4.29	<1.00	1.82	<1.00	182	14.9	<1.00	5	<5.00	21.5	<5.00	9.10	<5.00	910	74.5	<5.00
HFG1-12-CCC-PCT-A	S-12033	1	19	<1.00	12.4	<1.00	<1.00	14.6	47.8	31.1	<1.00	5	<5.00	62.0	<5.00	<5.00	73.0	239	156	<5.00
HFG1-17-CCC-PCT-A	S-12048	1	20	2.00	2.73	<1.00	<1.00	5.32	53.4	20.9	<1.00	5	10.0	13.7	<5.00	<5.00	26.6	267	105	<5.00

ar = as received measurements prior to correction for dilution factor (Dil. Fac)
* = dilution corrected values

Table A-1. PCT Leachate Measurements (mg/L) in Analytical Sequence (continued)

CCC Glass PCT Leachates																			
PNNL Solution ID	Lab ID	Block	Sequence	Al (ar)	B (ar)	Cr (ar)	K (ar)	Li (ar)	Na (ar)	Si (ar)	Zr (ar)	Dil. Fac.	Al *	B *	Cr *	K *	Li *	Na *	Si *	Zr *
HFG1-01-1-CCC-PCT-A	S-11995	1	21	2.17	1.99	<1.00	<1.00	61.9	32.6	8.26	<1.00	5	10.9	9.95	<5.00	<5.00	310	163	41.3	<5.00
HFG1-04-CCC-PCT-A	S-12004	1	22	<1.00	68.5	<1.00	11.4	5.07	314	140	<1.00	5	<5.00	343	<5.00	57.0	25.4	1570	700	<5.00
HFG1-03-CCC-PCT-A	S-12001	1	23	<1.00	2.45	<1.00	<1.00	<1.00	16.3	9.17	<1.00	5	<5.00	12.3	<5.00	<5.00	<5.00	81.5	45.9	<5.00
BLANK-1-PCT-111120	S-12028	1	24	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
HFG1-18-CCC-PCT-A	S-12051	1	25	<1.00	9.71	<1.00	<1.00	8.08	20.7	17.9	<1.00	5	<5.00	48.6	<5.00	<5.00	40.4	104	89.5	<5.00
standard	std-13	1	26	4.33	21.9	<1.00	9.78	10.2	84.7	52.5	<1.00	1	4.33	21.9	<1.00	9.78	10.2	84.7	52.5	<1.00
standard	std-21	2	1	3.91	19.7	<1.00	9.95	9.36	79.3	48.6	<1.00	1	3.91	19.7	<1.00	9.95	9.36	79.3	48.6	<1.00
HFG1-16-CCC-PCT-B	S-12046	2	2	5.38	76.2	2.81	1.24	75.6	681	61.5	<1.00	5	26.9	381	14.1	6.20	378	3410	308	<5.00
HFG1-08-CCC-PCT-B	S-12017	2	3	<1.00	3.68	<1.00	1.89	<1.00	179	13.6	<1.00	5	<5.00	18.4	<5.00	9.45	<5.00	895	68.0	<5.00
BLANK-2-PCT-111120	S-12029	2	4	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
HFG1-17-CCC-PCT-B	S-12049	2	5	1.85	2.15	<1.00	<1.00	4.57	46.0	18.0	<1.00	5	9.25	10.8	<5.00	<5.00	22.9	230	90.0	<5.00
ARM-1-STD-PCT-B-111120	S-12026	2	6	1.09	4.08	<1.00	<1.00	2.50	8.72	13.2	<1.00	5	5.45	20.4	<5.00	<5.00	12.5	43.6	66.0	<5.00
BLANK-2-PCT-120220	S-12064	2	7	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
HFG1-03-CCC-PCT-B	S-12002	2	8	<1.00	2.13	<1.00	<1.00	<1.00	14.9	8.16	<1.00	5	<5.00	10.7	<5.00	<5.00	<5.00	74.5	40.8	<5.00
HFG1-11-CCC-PCT-B	S-12031	2	9	4.69	7.93	<1.00	<1.00	9.77	48.3	5.47	<1.00	5	23.5	39.7	<5.00	<5.00	48.9	242	27.4	<5.00
HFG1-20-CCC-PCT-B	S-12058	2	10	5.45	3.91	<1.00	<1.00	2.15	90.4	20.3	<1.00	5	27.3	19.6	<5.00	<5.00	10.8	452	102	<5.00
HFG1-14-CCC-PCT-B	S-12040	2	11	<1.00	16.2	<1.00	<1.00	4.59	163	71.8	<1.00	5	<5.00	81.0	<5.00	<5.00	23.0	815	359	<5.00
ARM-1-STD-PCT-B-120220	S-12061	2	12	1.09	3.67	<1.00	<1.00	2.15	7.64	12.2	<1.00	5	5.45	18.4	<5.00	<5.00	10.8	38.2	61.0	<5.00
HFG1-18-CCC-PCT-B	S-12052	2	13	<1.00	9.11	<1.00	<1.00	7.56	19.6	16.7	<1.00	5	<5.00	45.6	<5.00	<5.00	37.8	98.0	83.5	<5.00
standard	std-22	2	14	3.96	19.6	<1.00	10.1	9.45	79.2	48.5	<1.00	1	3.96	19.6	<1.00	10.1	9.45	79.2	48.5	<1.00
HFG1-05-CCC-PCT-B	S-12008	2	15	<1.00	45.5	<1.00	<1.00	10.2	189	36.6	<1.00	5	<5.00	228	<5.00	<5.00	51.0	945	183	<5.00
HFG1-12-CCC-PCT-B	S-12034	2	16	<1.00	16.7	<1.00	<1.00	22.9	69.4	36.2	<1.00	5	<5.00	83.5	<5.00	<5.00	115	347	181	<5.00
HFG1-13-CCC-PCT-B	S-12037	2	17	1.54	2.40	<1.00	<1.00	13.4	15.5	10.4	<1.00	5	7.70	12.0	<5.00	<5.00	67.0	77.5	52.0	<5.00
HFG1-02-CCC-PCT-B	S-11999	2	18	1.48	1.13	<1.00	<1.00	16.0	27.4	8.35	<1.00	5	7.40	5.65	<5.00	<5.00	80.0	137	41.8	<5.00
HFG1-04-CCC-PCT-B	S-12005	2	19	<1.00	57.7	<1.00	12.0	4.58	309	137	<1.00	5	<5.00	289	<5.00	60.0	22.9	1550	685	<5.00
HFG1-01-1-CCC-PCT-B	S-11996	2	20	2.87	1.69	<1.00	<1.00	31.0	20.1	10.8	<1.00	5	14.4	8.45	<5.00	<5.00	155	101	54.0	<5.00
HFG1-19-CCC-PCT-B	S-12055	2	21	2.03	9.19	<1.00	1.53	<1.00	98.2	9.85	<1.00	5	10.2	46.0	<5.00	7.65	<5.00	491	49.3	<5.00
HFG1-09-CCC-PCT-B	S-12020	2	22	<1.00	2.28	<1.00	<1.00	14.7	51.6	17.2	<1.00	5	<5.00	11.4	<5.00	<5.00	73.5	258	86.0	<5.00
HFG1-07-CCC-PCT-B	S-12014	2	23	2.81	17.0	<1.00	<1.00	<1.00	47.6	12.1	<1.00	5	14.1	85.0	<5.00	<5.00	<5.00	238	60.5	<5.00
HFG1-15-CCC-PCT-B	S-12043	2	24	<1.00	19.4	<1.00	3.18	12.6	72.2	51.5	<1.00	5	<5.00	97.0	<5.00	15.9	63.0	361	258	<5.00
HFG1-10-CCC-PCT-B	S-12023	2	25	1.78	18.7	<1.00	1.23	4.95	75.1	8.23	<1.00	5	8.90	93.5	<5.00	6.15	24.8	376	41.2	<5.00
HFG1-06-CCC-PCT-B	S-12011	2	26	<1.00	87.3	<1.00	12.9	55.1	619	151	<1.00	5	<5.00	437	<5.00	64.5	276	3100	755	<5.00
standard	std-23	2	27	3.81	19.0	<1.00	9.58	9.18	77.8	47.5	<1.00	1	3.81	19.0	<1.00	9.58	9.18	77.8	47.5	<1.00
standard	std-31	3	1	4.24	21.5	<1.00	9.91	9.75	82.1	51.6	<1.00	1	4.24	21.5	<1.00	9.91	9.75	82.1	51.6	<1.00
HFG1-10-CCC-PCT-C	S-12024	3	2	1.83	20.9	<1.00	1.18	4.90	76.4	8.78	<1.00	5	9.15	105	<5.00	5.90	24.5	382	43.9	<5.00
HFG1-09-CCC-PCT-C	S-12021	3	3	1.02	2.76	<1.00	<1.00	15.8	55.8	19.3	<1.00	5	5.10	13.8	<5.00	<5.00	79.0	279	96.5	<5.00
HFG1-13-CCC-PCT-C	S-12038	3	4	1.75	2.85	<1.00	<1.00	14.4	16.7	11.4	<1.00	5	8.75	14.3	<5.00	<5.00	72.0	83.5	57.0	<5.00
ARM-1-STD-PCT-C-111120	S-12027	3	5	1.24	6.69	<1.00	<1.00	4.22	12.9	17.3	<1.00	5	6.20	33.5	<5.00	<5.00	21.1	64.5	86.5	<5.00
HFG1-11-CCC-PCT-C	S-12032	3	6	5.38	9.30	<1.00	<1.00	10.6	52.7	6.23	<1.00	5	26.9	46.5	<5.00	<5.00	53.0	264	31.2	<5.00
HFG1-20-CCC-PCT-C	S-12059	3	7	6.13	4.43	<1.00	<1.00	2.25	96.1	21.9	<1.00	5	30.7	22.2	<5.00	<5.00	11.3	481	110	<5.00
HFG1-12-CCC-PCT-C	S-12035	3	8	<1.00	16.9	<1.00	<1.00	21.5	65.8	36.7	<1.00	5	<5.00	84.5	<5.00	<5.00	108	329	184	<5.00
HFG1-14-CCC-PCT-C	S-12041	3	9	<1.00	17.6	<1.00	<1.00	4.80	158	75.7	<1.00	5	<5.00	88.0	<5.00	<5.00	24.0	790	379	<5.00
HFG1-08-CCC-PCT-C	S-12018	3	10	<1.00	3.92	<1.00	1.99	<1.00	182	13.9	<1.00	5	<5.00	19.6	<5.00	9.95	<5.00	910	69.5	<5.00
HFG1-03-CCC-PCT-C	S-12003	3	11	<1.00	2.39	<1.00	<1.00	<1.00	16.0	8.99	<1.00	5	<5.00	12.0	<5.00	<5.00	<5.00	80.0	45.0	<5.00
HFG1-04-CCC-PCT-C	S-12006	3	12	<1.00	62.7	<1.00	12.8	4.85	304	135	<1.00	5	<5.00	314	<5.00	64.0	24.3	1520	675	<5.00
ARM-1-STD-PCT-C-120220	S-12062	3	13	1.16	5.71	<1.00	<1.00	3.56	11.0	15.3	<1.00	5	5.80	28.6	<5.00	<5.00	17.8	55.0	76.5	<5.00
standard	std-32	3	14	4.11	20.7	<1.00	9.57	9.43	80.3	49.7	<1.00	1	4.11	20.7	<1.00	9.57	9.43	80.3	49.7	<1.00
HFG1-01-1-CCC-PCT-C	S-11997	3	15	2.52	3.28	<1.00	1.32	104	57.8	10.6	<1.00	5	12.6	16.4	<5.00	6.60	520	289	53.0	<5.00
BLANK-1-PCT-120220	S-12063	3	16	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
HFG1-06-CCC-PCT-C	S-12012	3	17	<1.00	97.9	<1.00	13.3	58.3	623	160	<1.00	5	<5.00	490	<5.00	66.5	292	3120	800	<5.00
HFG1-05-CCC-PCT-C	S-12009	3	18	<1.00	46.6	<1.00	<1.00	10.2	183	37.1	<1.00	5	<5.00	233	<5.00	<5.00	51.0	915	186	<5.00

ar = as received measurements prior to correction for dilution factor (Dil. Fac)
* = dilution corrected values

Table A-1. PCT Leachate Measurements (mg/L) in Analytical Sequence (continued)

CCC Glass PCT Leachates																			
PNNL Solution ID	**Lab ID**	**Block**	**Sequence**	**Al (ar)**	**B (ar)**	**Cr (ar)**	**K (ar)**	**Li (ar)**	**Na (ar)**	**Si (ar)**	**Zr (ar)**	**Dil. Fac.**	**Al ***	**B ***	**Cr ***	**K ***	**Li ***	**Na ***	**Si ***	**Zr ***
HFG1-19-CCC-PCT-C	S-12056	3	19	1.99	9.98	<1.00	1.65	<1.00	104	10.3	<1.00	5	9.95	49.9	<5.00	8.25	<5.00	520	51.5	<5.00
HFG1-07-CCC-PCT-C	S-12015	3	20	1.78	17.6	<1.00	<1.00	<1.00	46.3	8.33	<1.00	5	8.90	88.0	<5.00	<5.00	<5.00	232	41.7	<5.00
HFG1-18-CCC-PCT-C	S-12053	3	21	<1.00	9.16	<1.00	<1.00	7.51	19.7	17.1	<1.00	5	<5.00	45.8	<5.00	<5.00	37.6	98.5	85.5	<5.00
HFG1-16-CCC-PCT-C	S-12047	3	22	5.56	76.6	2.84	1.14	75.8	674	62.5	<1.00	5	27.8	383	14.2	5.70	379	3370	313	<5.00
HFG1-02-CCC-PCT-C	S-12000	3	23	1.52	1.21	<1.00	<1.00	16.7	28.5	8.92	<1.00	5	7.60	6.05	<5.00	<5.00	83.5	143	44.6	<5.00
HFG1-17-CCC-PCT-C	S-12050	3	24	2.01	2.33	<1.00	<1.00	4.88	49.7	19.9	<1.00	5	10.1	11.7	<5.00	<5.00	24.4	249	99.5	<5.00
HFG1-15-CCC-PCT-C	S-12044	3	25	<1.00	20.7	<1.00	3.37	12.6	73.6	52.5	<1.00	5	<5.00	104	<5.00	16.9	63.0	368	263	<5.00
standard	std-33	3	26	4.19	20.6	<1.00	10.0	9.62	81.3	49.6	<1.00	1	4.19	20.6	<1.00	10.0	9.62	81.3	49.6	<1.00

ar = as received measurements prior to correction for dilution factor (Dil. Fac)
* = dilution corrected values

Table A-2. Dilution ARM-1 Leachate Measurements (mg/L)

PNNL Solution ID	Lab ID	B *	Li *	Na *	Si *
ARM-1-STD-PCT-A-100720	S-11688	31.3	22.9	67.5	82.5
ARM-1-STD-PCT-B-100720	S-11689	17.4	12.8	44.3	66.5
ARM-1-STD-PCT-C-100720	S-11690	16.7	12.1	42.3	60.5
ARM-1-STD-PCT-A-102820	S-11726	22.8	16.5	51.5	65.5
ARM-1-STD-PCT-B-102820	S-11727	16.3	12.0	51.5	55.5
ARM-1-STD-PCT-C-102820	S-11728	15.3	11.6	44.2	65.5
ARM-1-STD-PCT-A-111120	S-12025	18.8	11.1	40.6	65.0
ARM-1-STD-PCT-B-111120	S-12026	20.4	12.5	43.6	66.0
ARM-1-STD-PCT-C-111120	S-12027	33.5	21.1	64.5	86.5
ARM-1-STD-PCT-A-120220	S-12060	20.4	11.6	41.7	65.5
ARM-1-STD-PCT-B-120220	S-12061	18.4	10.8	38.2	61.0
ARM-1-STD-PCT-C-120220	S-12062	28.6	17.8	55.0	76.5

* = dilution corrected values

Control Chart Concentration Limits[11]

Boron: 12.87 – 22.65 ppm
Lithium: 10.80 – 16.32 ppm
Sodium: 28.86 – 43.58 ppm
Silicon: 49.03 – 73.43 ppm

Table A-3. Sample Rerun Results (mg/L)

PNNL Solution ID	Lab ID	Al (ar)	B (ar)	Cr (ar)	K (ar)	Li (ar)	Na (ar)	Si (ar)	Zr (ar)	Dil. Fac.	Al *	B *	Cr *	K *	Li *	Na *	Si *	Zr *
HFG1-10-Q-PCT	S-11685_1	1.23	42.1	<1.00	2.05	9.99	175	12.4	<1.00	5	6.15	211	<5.00	10.3	50.0	875	62.0	<5.00
ARM-1-STD-PCT-100720	S-11688_1	<1.00	6.16	<1.00	<1.00	4.85	12.8	16.3	<1.00	5	<5.00	30.8	<5.00	<5.00	24.3	64.0	81.5	<5.00
BLANK-PCT-100720	S-11691_1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.64	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	8.20	<5.00
BLANK-PCT-100720	S-11692_1	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.82	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	9.10	<5.00
HFG1-15-Q-PCT	S-11709_1	<1.00	23.9	<1.00	3.26	14.9	92.5	55.4	<1.00	5	<5.00	120	<5.00	16.3	74.5	463	277	<5.00
HFG1-18-Q-PCT	S-11717_1	<1.00	27.2	<1.00	<1.00	14.5	47.7	23.3	<1.00	5	<5.00	136	<5.00	<5.00	72.5	239	117	<5.00
BLANK-PCT-102820	S-11730_1	<1.00	<1.00	<1.00	<1.00	<1.00	1.53	<1.00	<1.00	5	<5.00	<5.00	<5.00	<5.00	<5.00	7.65	<5.00	<5.00
standard	std-11_1	3.97	20.2	<1.00	9.86	9.97	80.0	49.1	<1.00	1	3.97	20.2	<1.00	9.86	9.97	80.0	49.1	<1.00
standard	std-12_1	4.01	20.1	<1.00	9.46	10.0	80.2	49.2	<1.00	1	4.01	20.1	<1.00	9.46	10.0	80.2	49.2	<1.00
HFG1-08-Q-PCT	S-11681_2	<1.00	7.12	<1.00	2.17	<1.00	94.9	21.6	<1.00	5	<5.00	35.6	<5.00	10.9	<5.00	475	108	<5.00
HFG1-10-Q-PCT	S-11685_2	1.05	43.3	<1.00	2.13	9.22	176	12.9	<1.00	5	5.25	217	<5.00	10.7	46.1	880	64.5	<5.00
ARM-1-STD-PCT-100720	S-11688_2	<1.00	5.98	<1.00	<1.00	4.10	13.2	17.2	<1.00	5	<5.00	29.9	<5.00	<5.00	20.5	66.0	86.0	<5.00
HFG1-19-Q-PCT	S-11721_2	<1.00	27.5	<1.00	3.07	2.25	165	19.5	<1.00	5	<5.00	138	<5.00	15.4	11.3	825	97.5	<5.00
HFG1-01-1-CCC-PCT	S-11995_2	1.85	1.27	<1.00	<1.00	57.9	31.9	8.05	<1.00	5	9.25	6.35	<5.00	<5.00	290	160	40.3	<5.00
HFG1-01-1-CCC-PCT	S-11996_2	2.69	1.16	<1.00	<1.00	30.9	20.9	11.5	<1.00	5	13.5	5.80	<5.00	<5.00	155	105	57.5	<5.00
HFG1-01-1-CCC-PCT	S-11997_2	2.16	2.58	<1.00	1.36	101	59.0	10.7	<1.00	5	10.8	12.9	<5.00	6.80	505	295	53.5	<5.00
HFG1-07-CCC-PCT	S-12013_2	1.72	32.9	<1.00	1.52	<1.00	83.7	10.9	<1.00	5	8.60	165	<5.00	7.60	<5.00	419	54.5	<5.00
HFG1-11-CCC-PCT	S-12030_2	7.51	14.9	<1.00	1.30	20.7	94.2	8.60	<1.00	5	37.6	74.5	<5.00	6.50	104	471	43.0	<5.00
HFG1-12-CCC-PCT	S-12033_2	<1.00	11.0	<1.00	<1.00	13.2	45.9	29.8	<1.00	5	<5.00	55.0	<5.00	<5.00	66.0	230	149	<5.00
standard	std-11_2	3.85	20.0	<1.00	10.3	9.17	82.8	50.5	<1.00	1	3.85	20.0	<1.00	10.3	9.17	82.8	50.5	<1.00
standard	std-12_2	3.91	20.4	<1.00	10.1	9.24	81.8	51.0	<1.00	1	3.91	20.4	<1.00	10.1	9.24	81.8	51.0	<1.00
standard	std-13_2	3.95	20.9	<1.00	10.5	9.29	82.0	51.6	<1.00	1	3.95	20.9	<1.00	10.5	9.29	82.0	51.6	<1.00

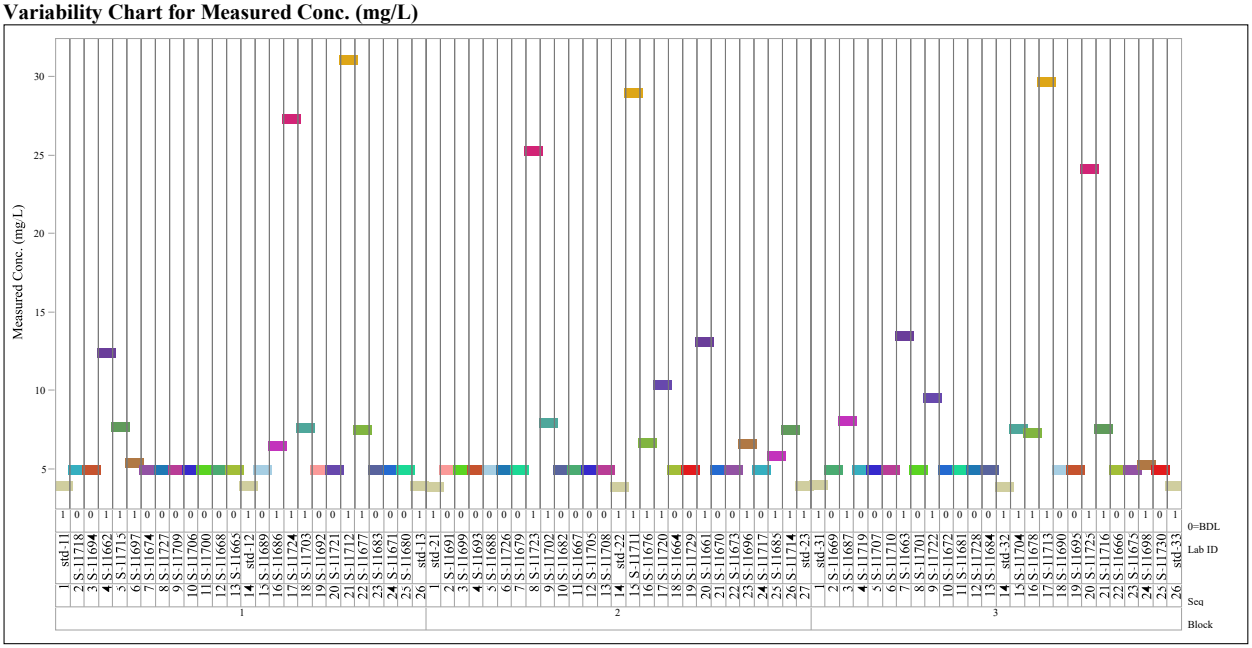
ar = as received measurements prior to correction for dilution factor (Dil. Fac)
* = dilution corrected values

Table A-4. Results from Samples of the Multi-Element Solution Standard Included with the PCT Leachates

Analytical Block	1 Quenched	2 Quenched	3 Quenched	1 CCC	2 CCC	3 CCC	Reference Values (mg/L)
Mean (Al (mg/L))	3.96	3.96	3.96	3.96	3.96	3.96	4
Mean (B (mg/L))	20.1	19.9	19.7	21.3	19.4	20.9	20
Mean (K (mg/L))	10.2	9.64	9.95	9.97	9.88	9.83	10
Mean (Li (mg/L))	9.66	9.66	9.45	9.82	9.33	9.6	10
Mean (Na (mg/L))	81.9	79.7	80.8	82.6	78.8	81.2	81
Mean (Si (mg/L))	48.9	48.5	47.9	51.4	48.2	50.3	50
% relative bias, Al	-0.92	-1.83	-1.00	4.92	-2.67	4.50	<10% per ASTM C1285
% relative bias, B	0.67	-0.67	-1.33	6.33	-2.83	4.67	
% relative bias, K	1.70	-3.63	-0.53	-0.30	-1.23	-1.73	
% relative bias, Li	-3.37	-3.43	-5.53	-1.77	-6.70	-4.00	
% relative bias, Na	1.07	-1.60	-0.25	1.93	-2.76	0.29	
% relative bias, Si	-2.13	-2.93	-4.27	2.73	-3.60	0.60	
Standard Deviation (Al (mg/L))	0.021	0.038	0.046	0.159	0.076	0.066	
Standard Deviation (B (mg/L))	0.416	0.153	0.252	0.929	0.379	0.493	
Standard Deviation (K (mg/L))	0.375	0.047	0.179	0.373	0.268	0.227	
Standard Deviation (Li (mg/L))	0.061	0.072	0.131	0.391	0.137	0.161	
Standard Deviation (Na (mg/L))	0.153	0.608	0.700	2.511	0.839	0.902	
Standard Deviation (Si (mg/L))	0.551	0.208	0.473	1.474	0.608	1.127	
%RSD (Al (mg/L))	0.53	0.96	1.16	3.80	1.96	1.57	<10% per ASTM C1285
%RSD (B (mg/L))	2.07	0.77	1.28	4.37	1.95	2.36	
%RSD (K (mg/L))	3.69	0.49	1.80	3.74	2.71	2.31	
%RSD (Li (mg/L))	0.63	0.75	1.38	3.98	1.47	1.68	
%RSD (Na (mg/L))	0.19	0.76	0.87	3.04	1.06	1.11	
%RSD (Si (mg/L))	1.13	0.43	0.99	2.87	1.26	2.24	

Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence

Analyte=Al (mg/L), Quenched Glass
Variability Chart for Measured Conc. (mg/L)



Analyte=Al (mg/L), CCC Glass
Variability Chart for Measured Conc. (mg/L)

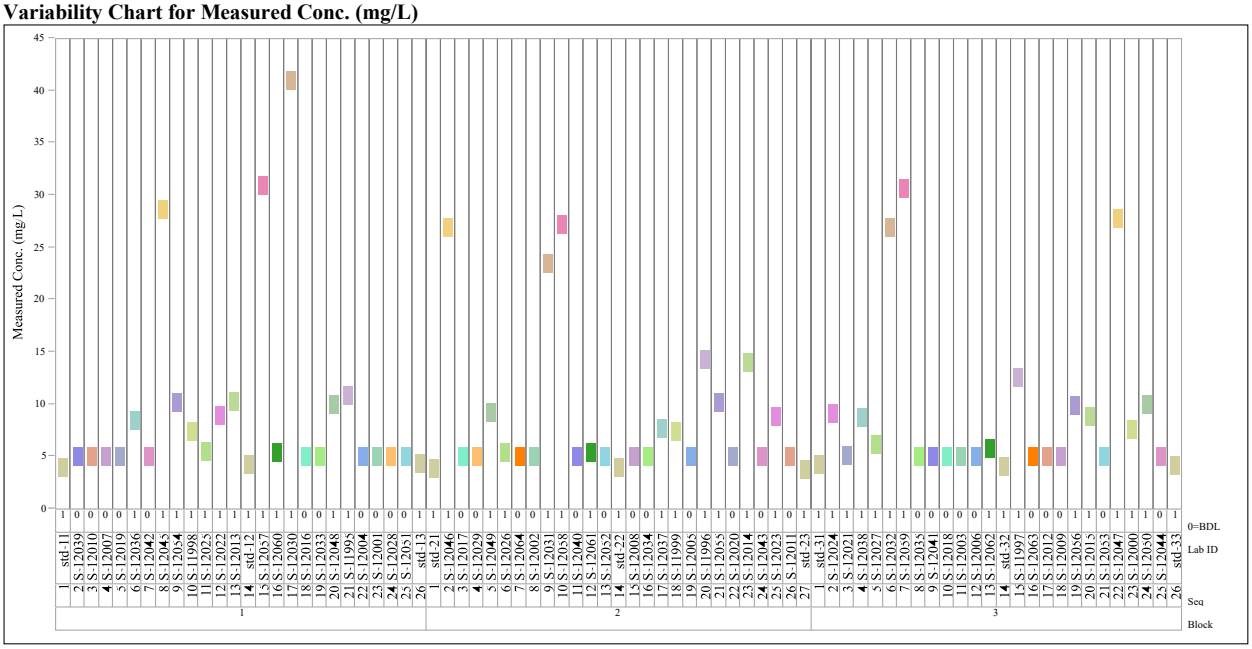
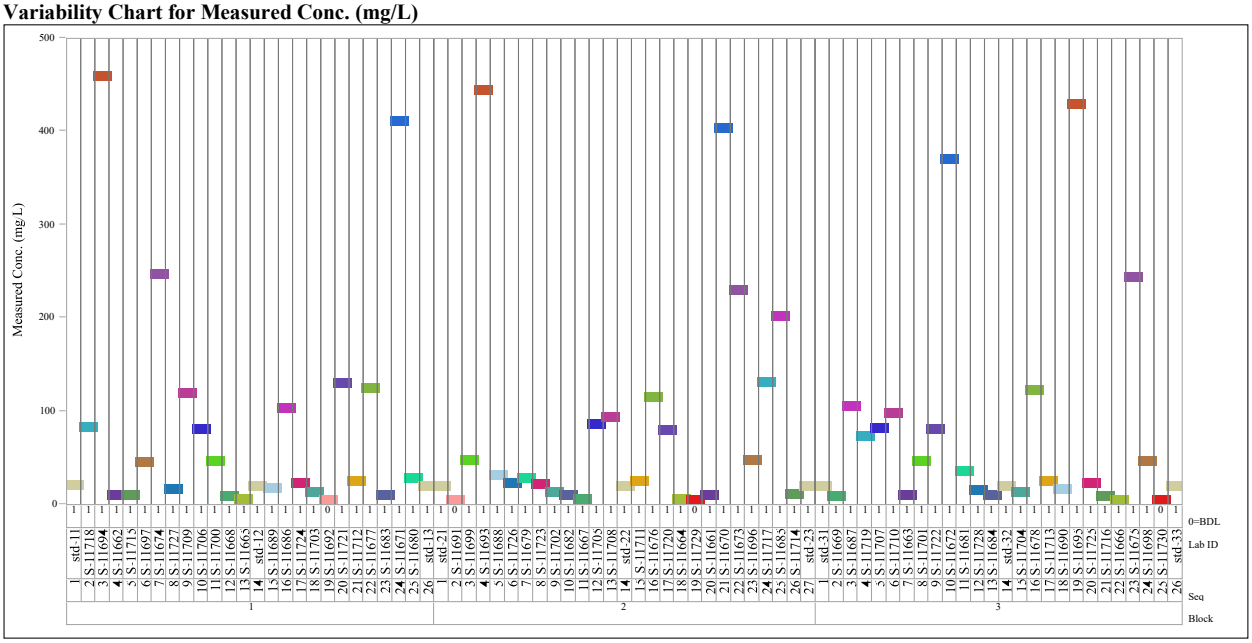


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=B (mg/L), Quenched Glass
Variability Chart for Measured Conc. (mg/L)



Analyte=B (mg/L), CCC Glass
Variability Chart for Measured Conc. (mg/L)

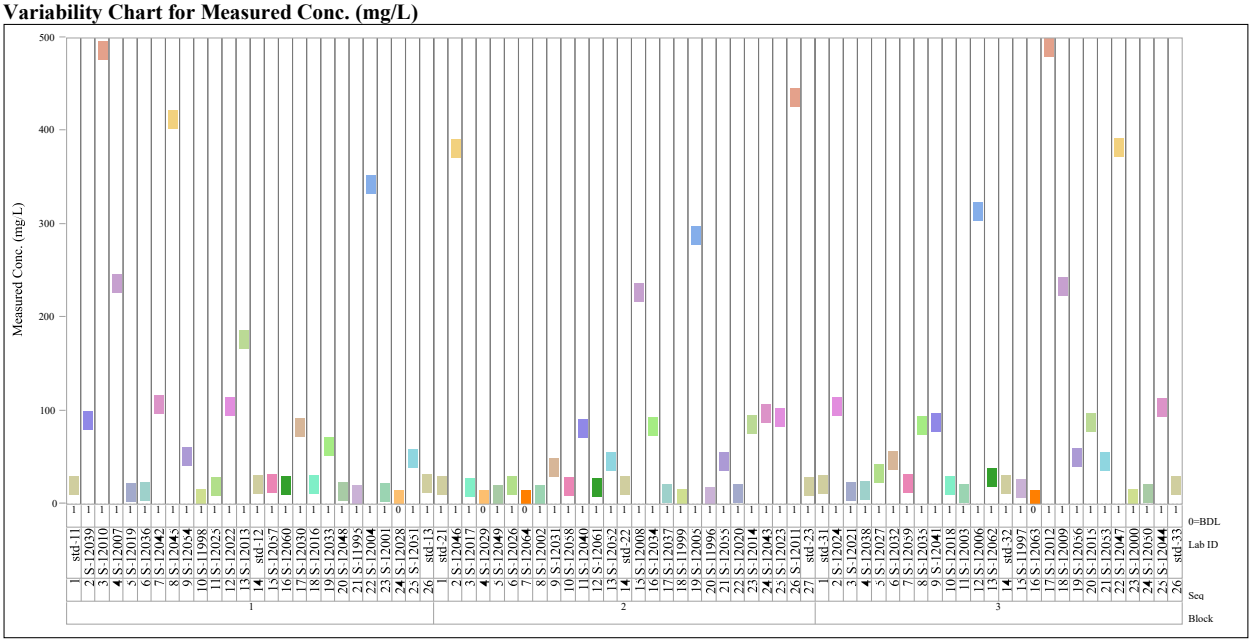
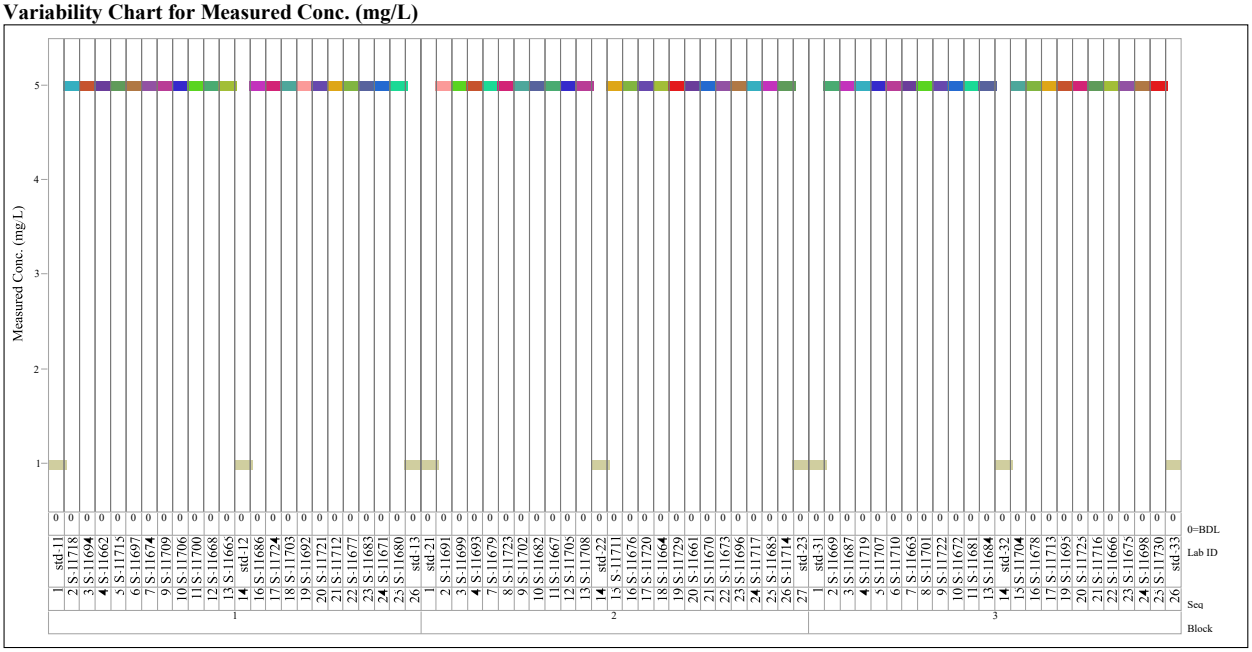


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Cr (mg/L), Quenched Glass
Variability Chart for Measured Conc. (mg/L)



Analyte=Cr (mg/L), CCC Glass
Variability Chart for Measured Conc. (mg/L)

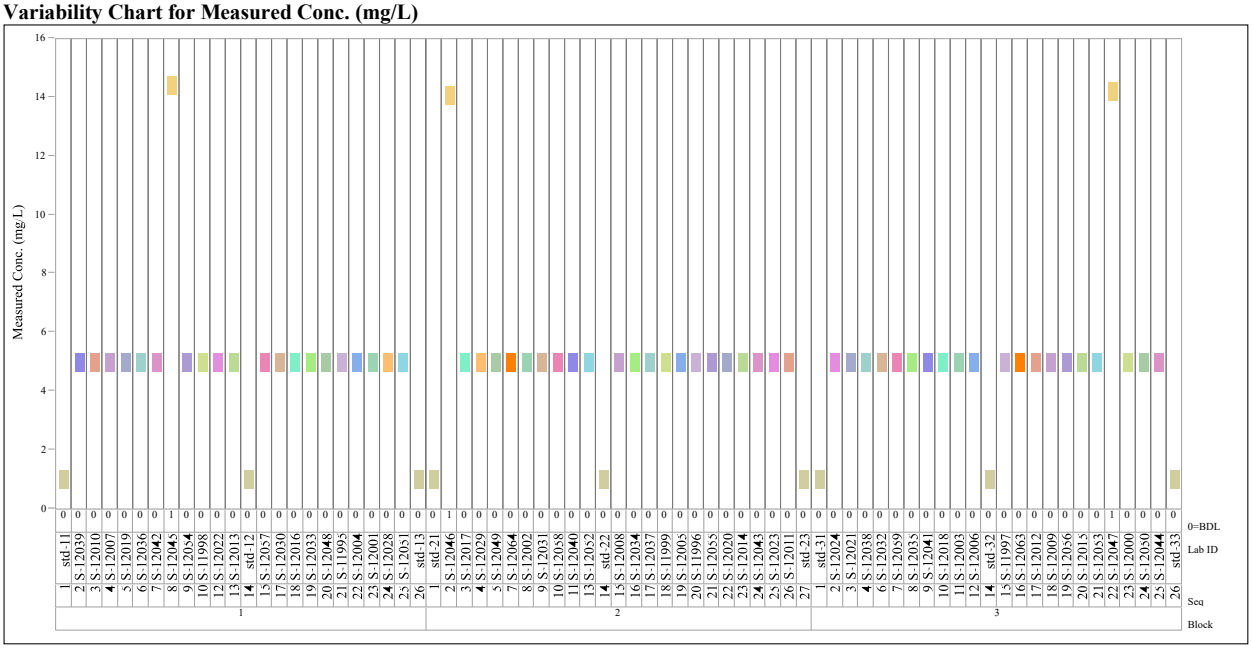
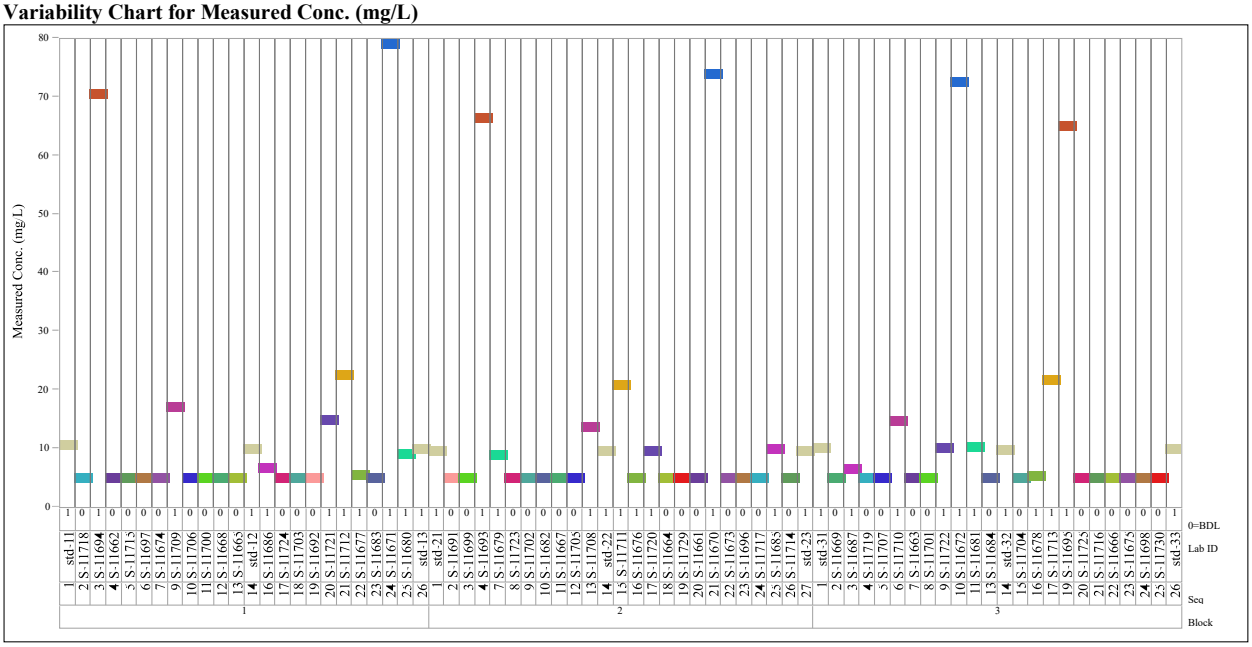


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=K (mg/L), Quenched Glass
Variability Chart for Measured Conc. (mg/L)



Analyte=K (mg/L), CCC Glass
Variability Chart for Measured Conc. (mg/L)

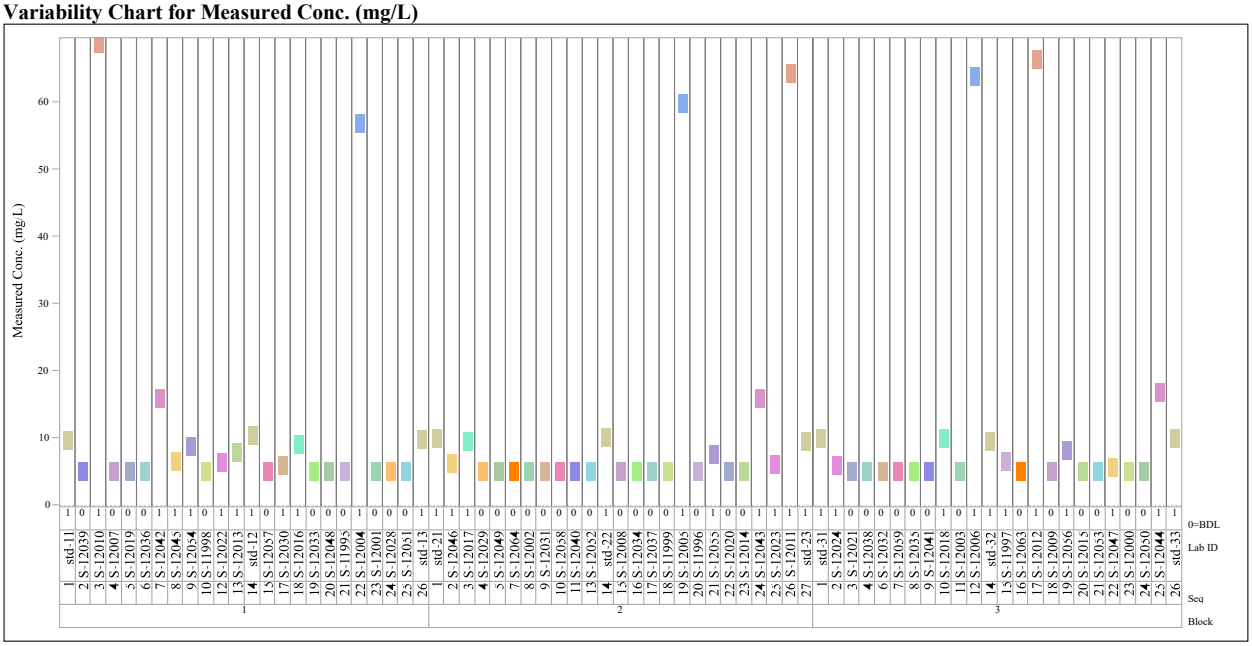
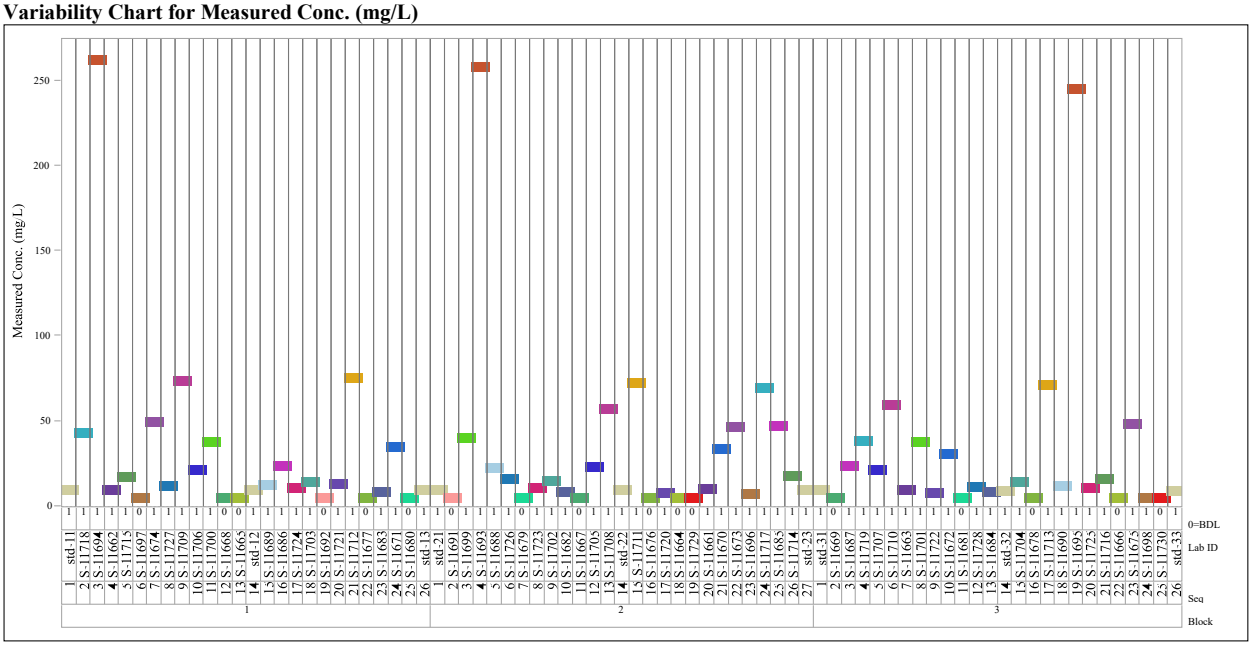


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Li (mg/L), Quenched Glass
Variability Chart for Measured Conc. (mg/L)



Analyte=Li (mg/L), CCC Glass
Variability Chart for Measured Conc. (mg/L)

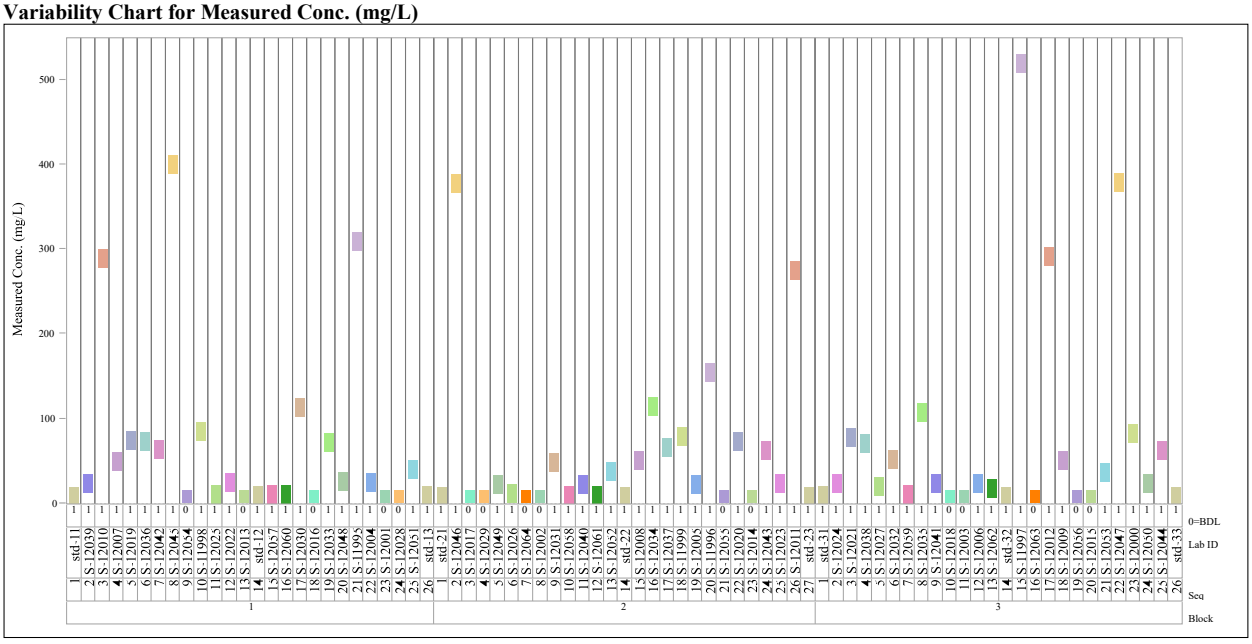
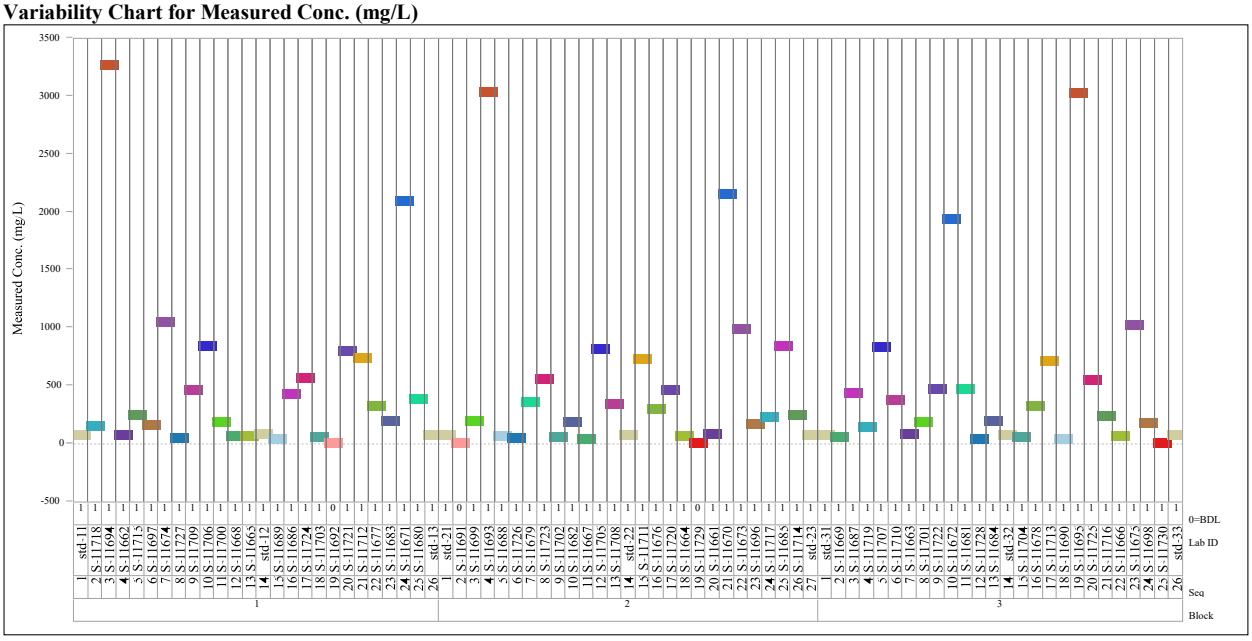


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Na (mg/L), Quenched Glass
Variability Chart for Measured Conc. (mg/L)



Analyte=Na (mg/L), CCC Glass
Variability Chart for Measured Conc. (mg/L)

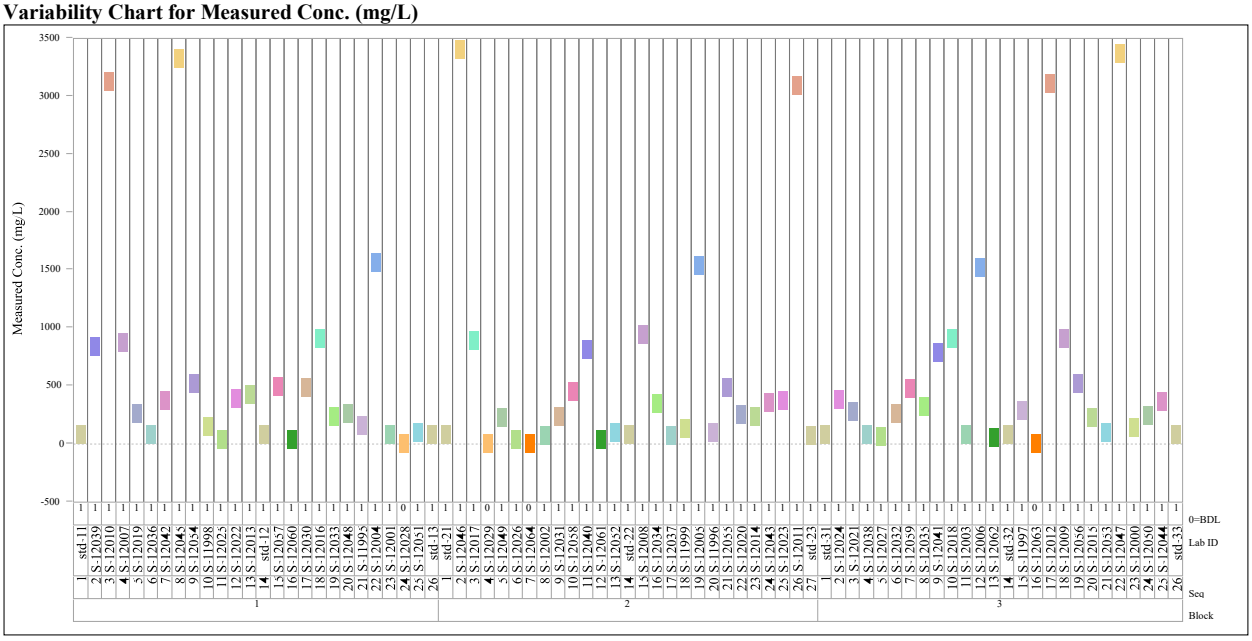
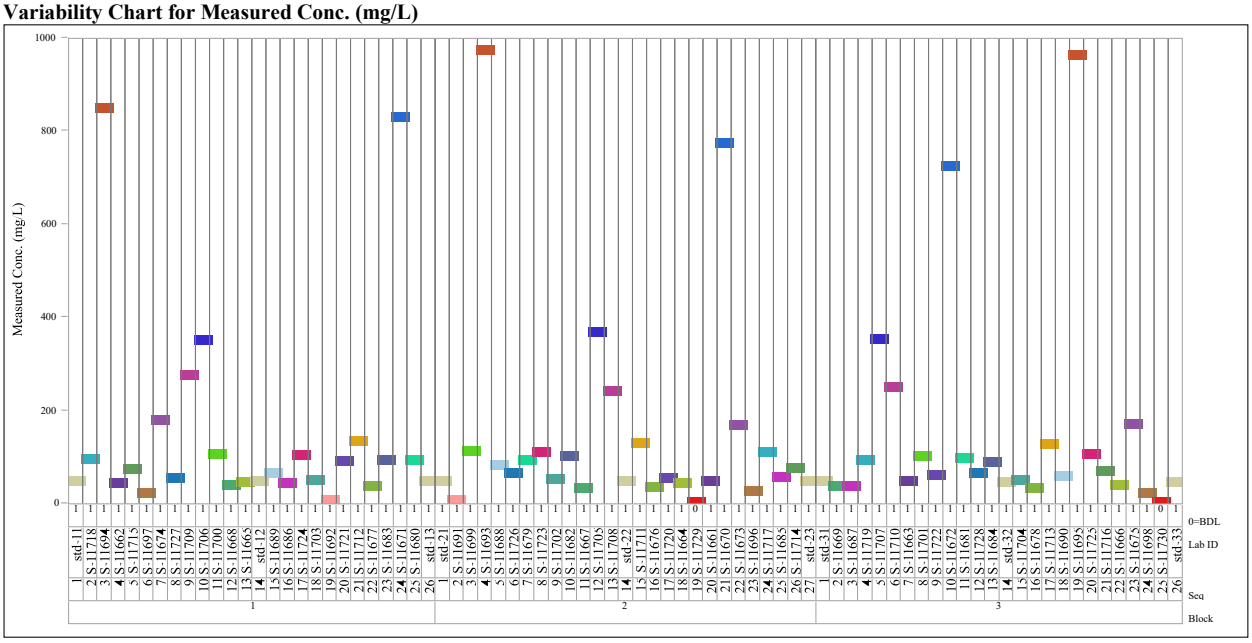


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Si (mg/L), Quenched Glass
Variability Chart for Measured Conc. (mg/L)



Analyte=Si (mg/L), CCC Glass
Variability Chart for Measured Conc. (mg/L)

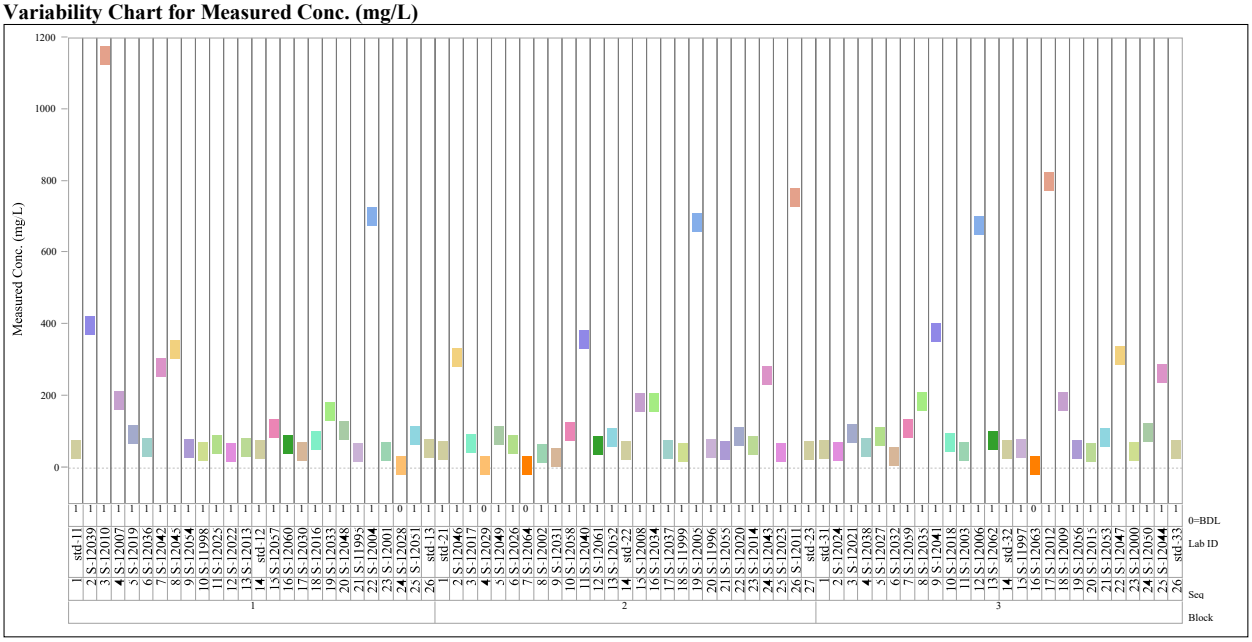
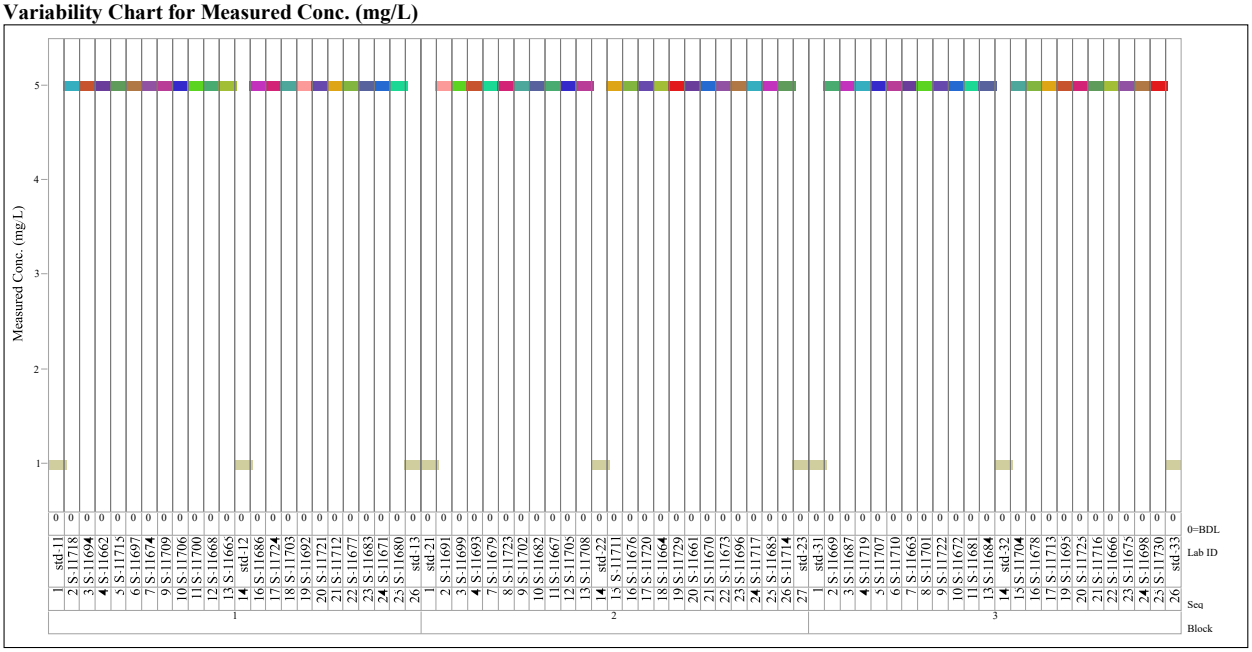


Exhibit A-1. Dilution Corrected PCT Leachate Measurements in Analytical Sequence (continued)

Analyte=Zr (mg/L), Quenched Glass
Variability Chart for Measured Conc. (mg/L)



Analyte=Zr (mg/L), CCC Glass
Variability Chart for Measured Conc. (mg/L)

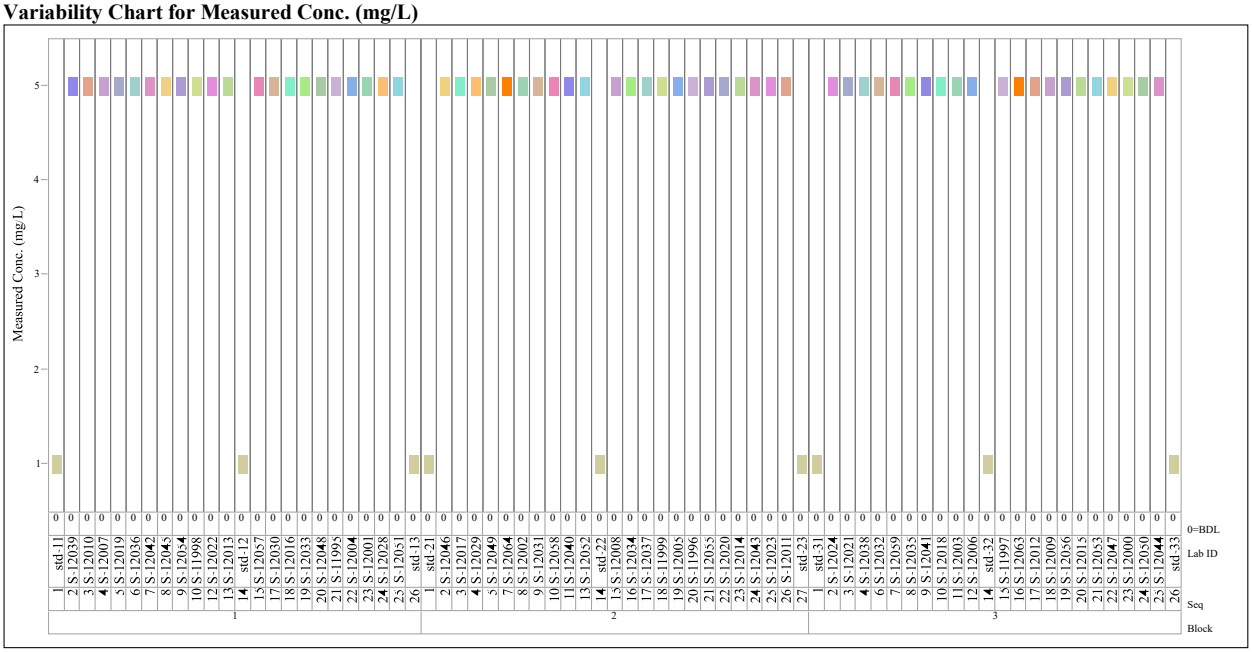
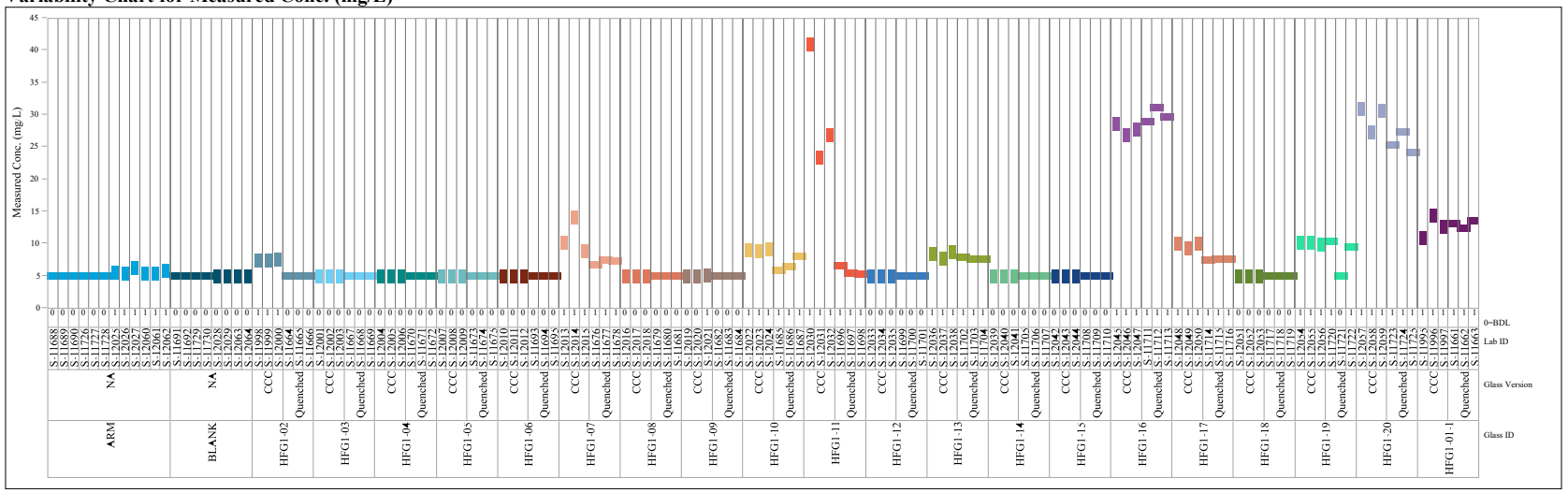


Exhibit A-2. Dilution Corrected PCT Measurements by Glass ID

Analyte=Al (mg/L)
Variability Chart for Measured Conc. (mg/L)



Analyte=Al (mg/L)
Variability Chart for log[Conc.(mg/L)]

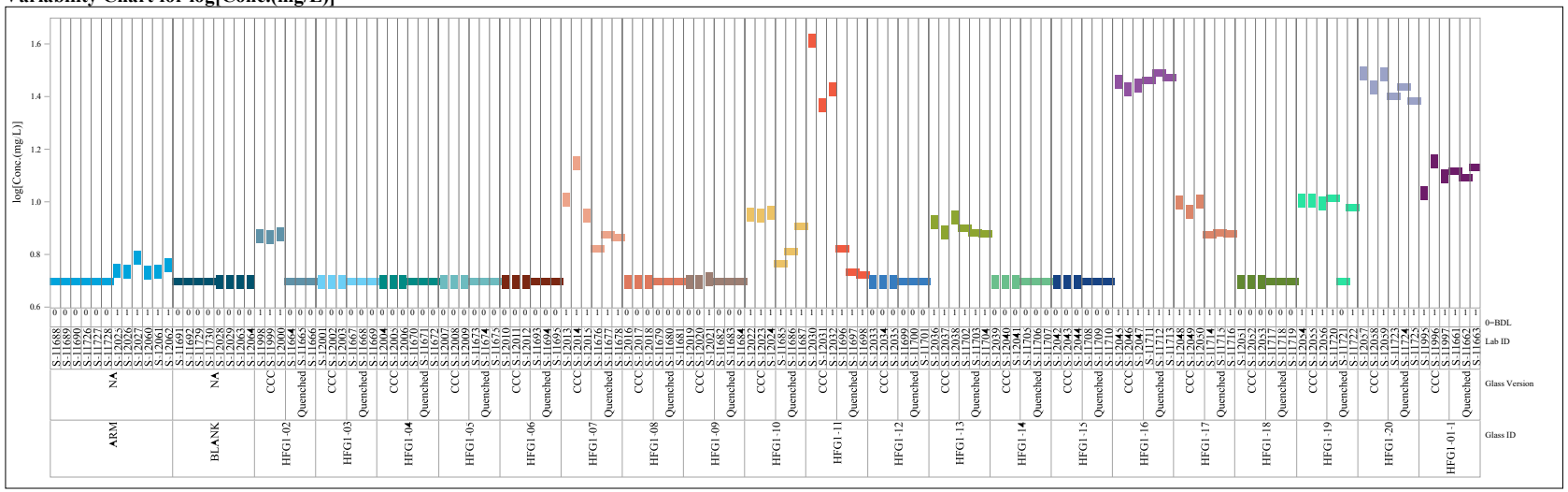
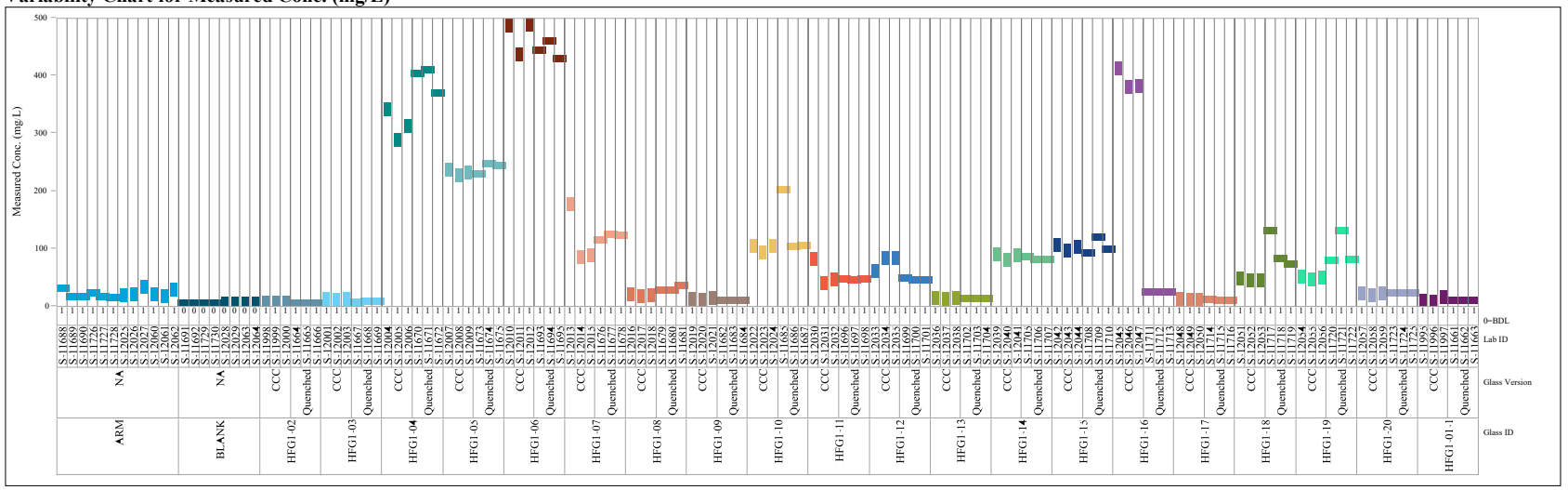


Exhibit A-2. Dilution Corrected PCT Measurements by Glass ID (continued)

Analyte=B (mg/L)
Variability Chart for Measured Conc. (mg/L)



Analyte=B (mg/L)
Variability Chart for log[Conc.(mg/L)]

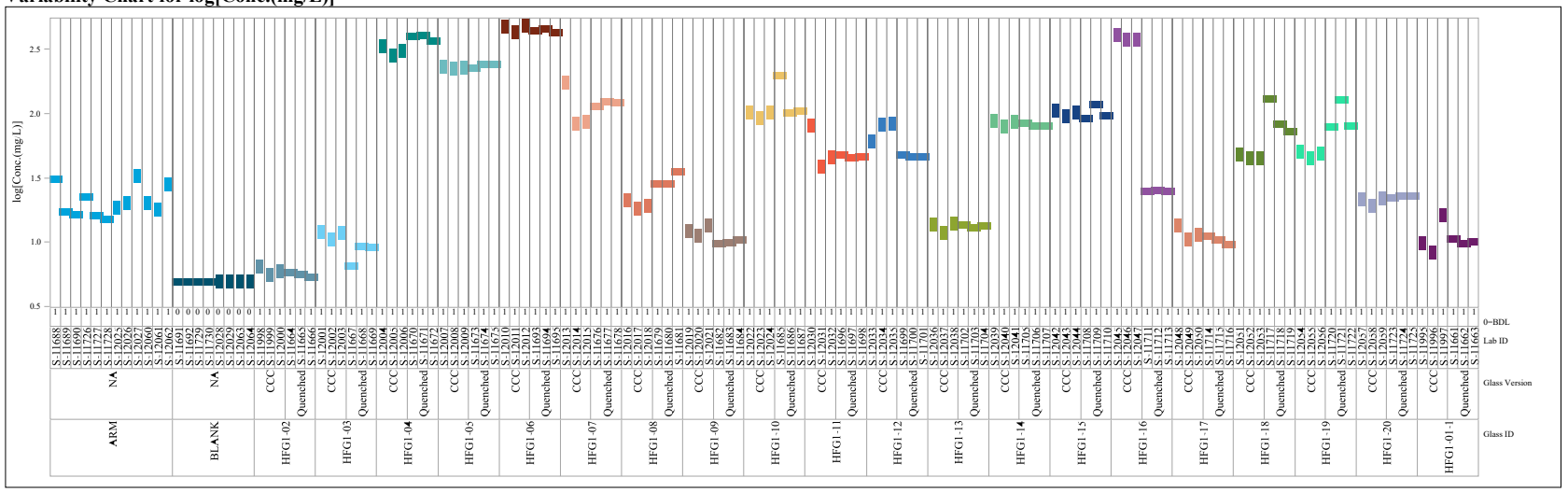
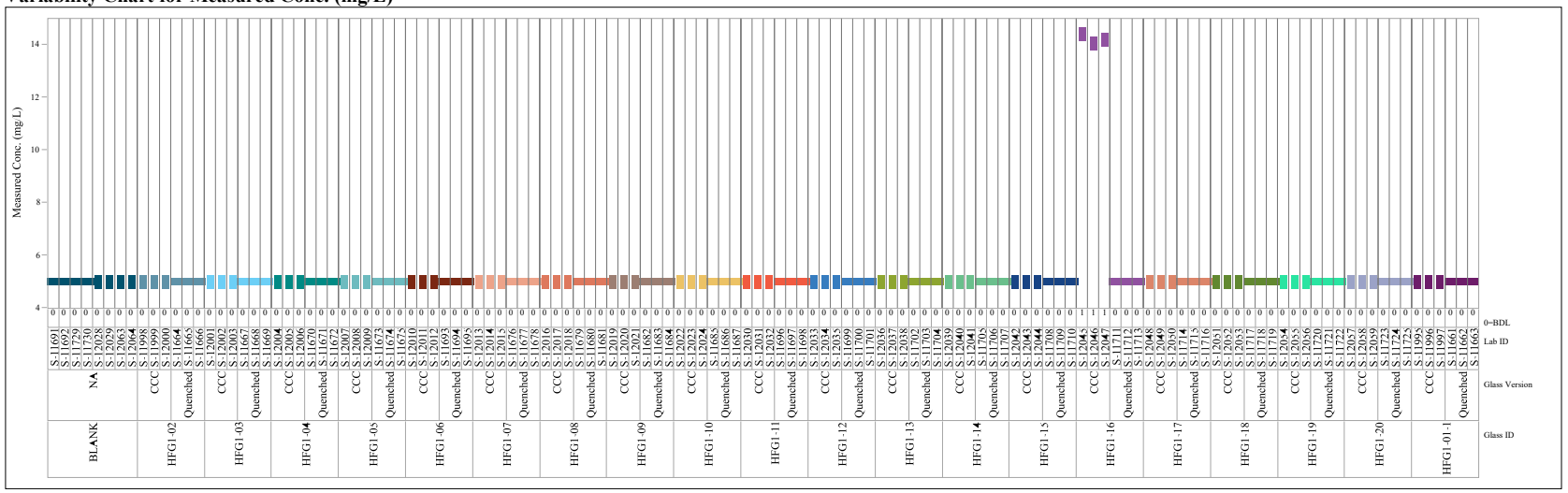


Exhibit A-2. Dilution Corrected PCT Measurements by Glass ID (continued)

Analyte=Cr (mg/L)
Variability Chart for Measured Conc. (mg/L)



Analyte=Cr (mg/L)
Variability Chart for log[Conc.(mg/L)]

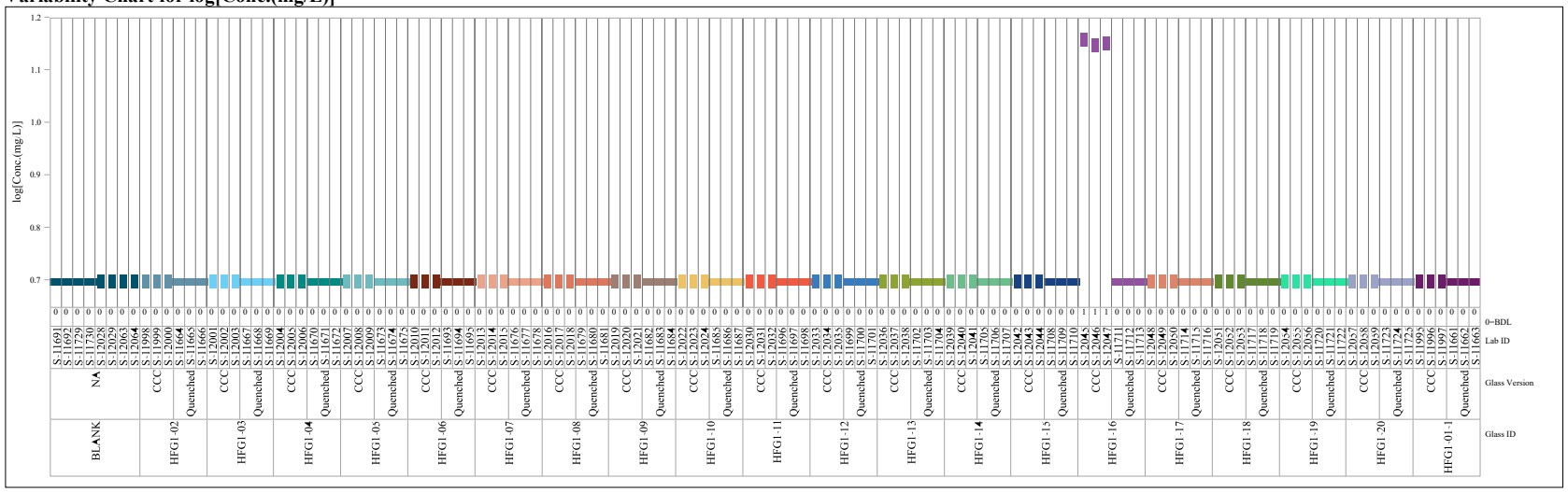
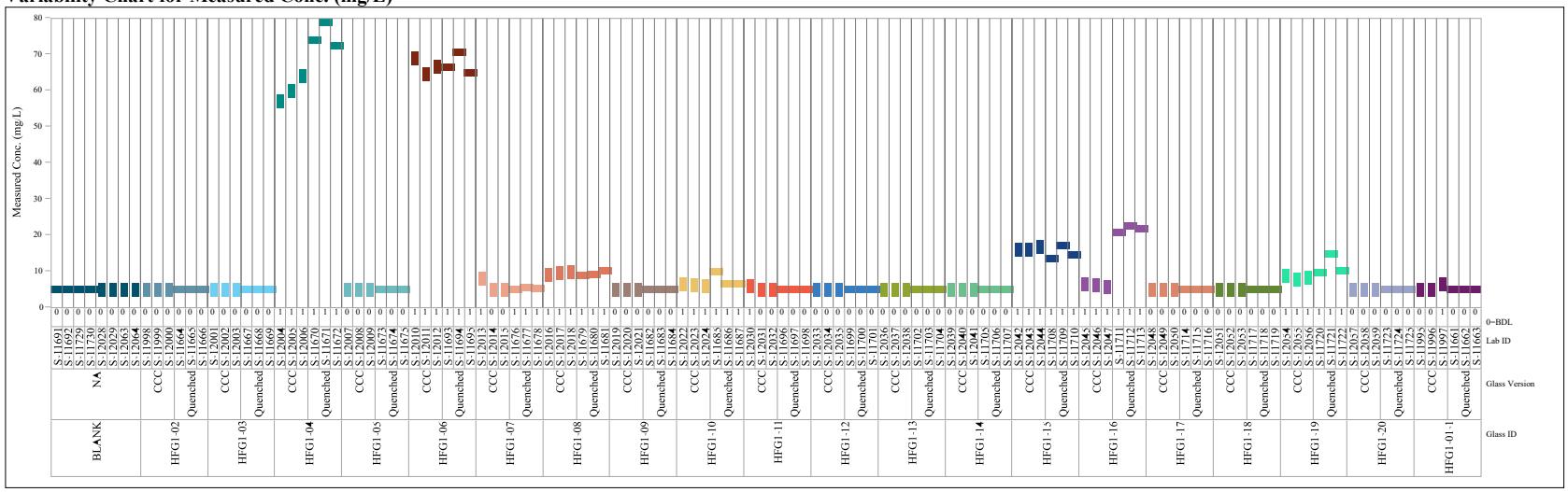


Exhibit A-2. Dilution Corrected PCT Measurements by Glass ID (continued)

Analyte=K (mg/L)
Variability Chart for Measured Conc. (mg/L)



Analyte=K (mg/L)
Variability Chart for log[Conc.(mg/L)]

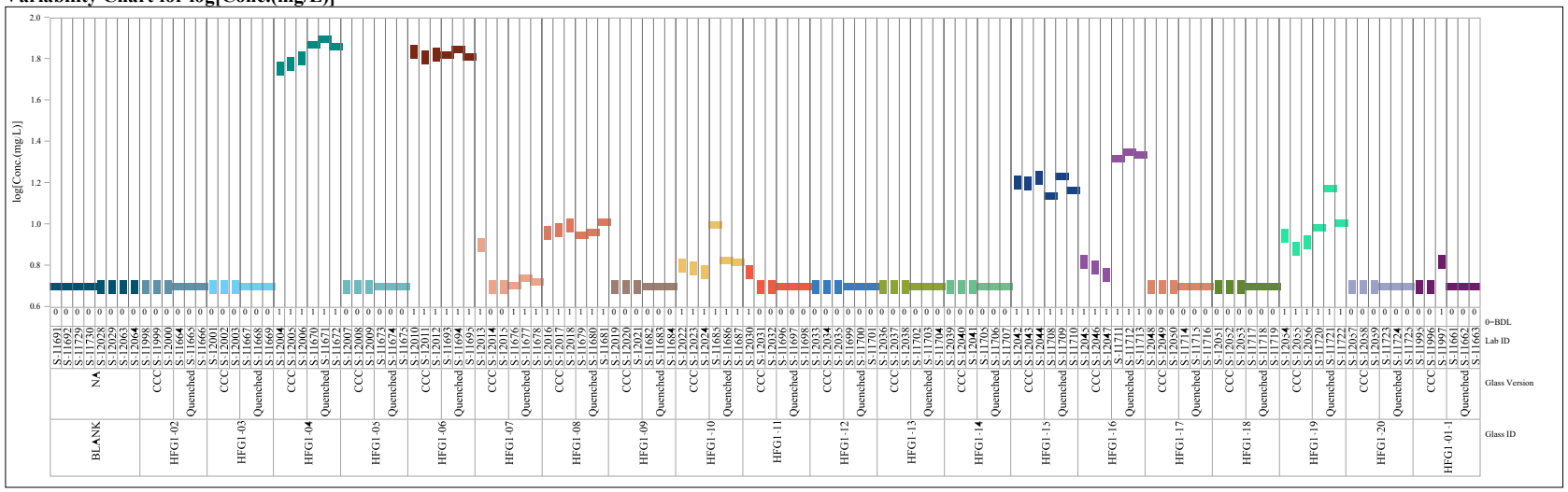
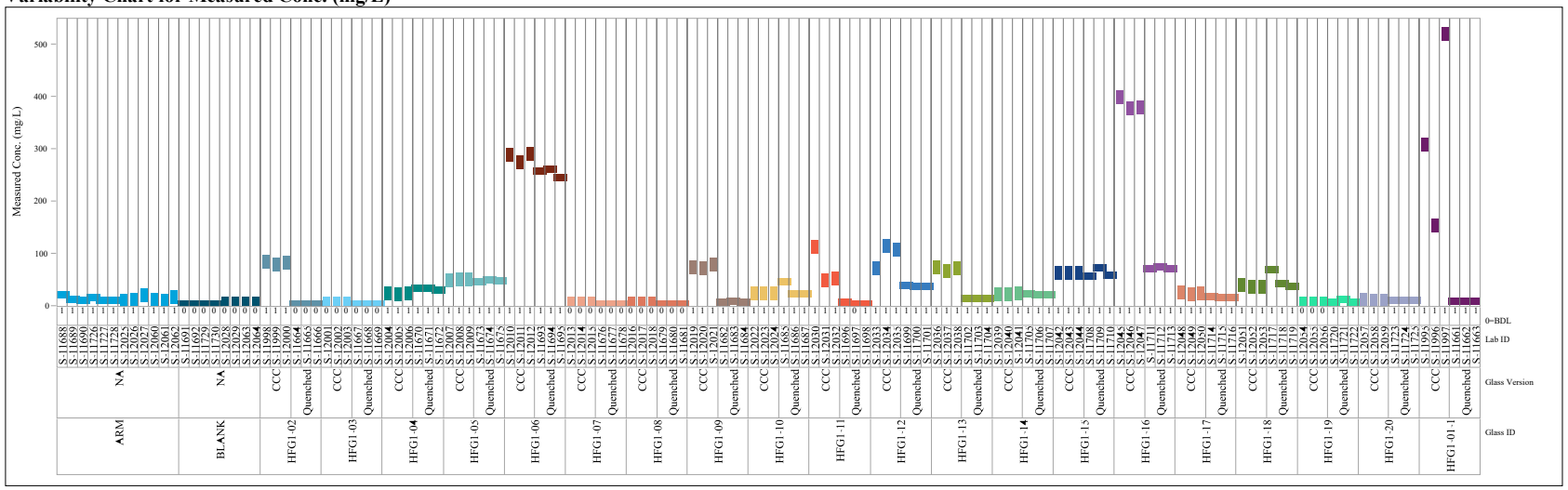


Exhibit A-2. Dilution Corrected PCT Measurements by Glass ID (continued)

Analyte=Li (mg/L)
Variability Chart for Measured Conc. (mg/L)



Analyte=Li (mg/L)
Variability Chart for log[Conc.(mg/L)]

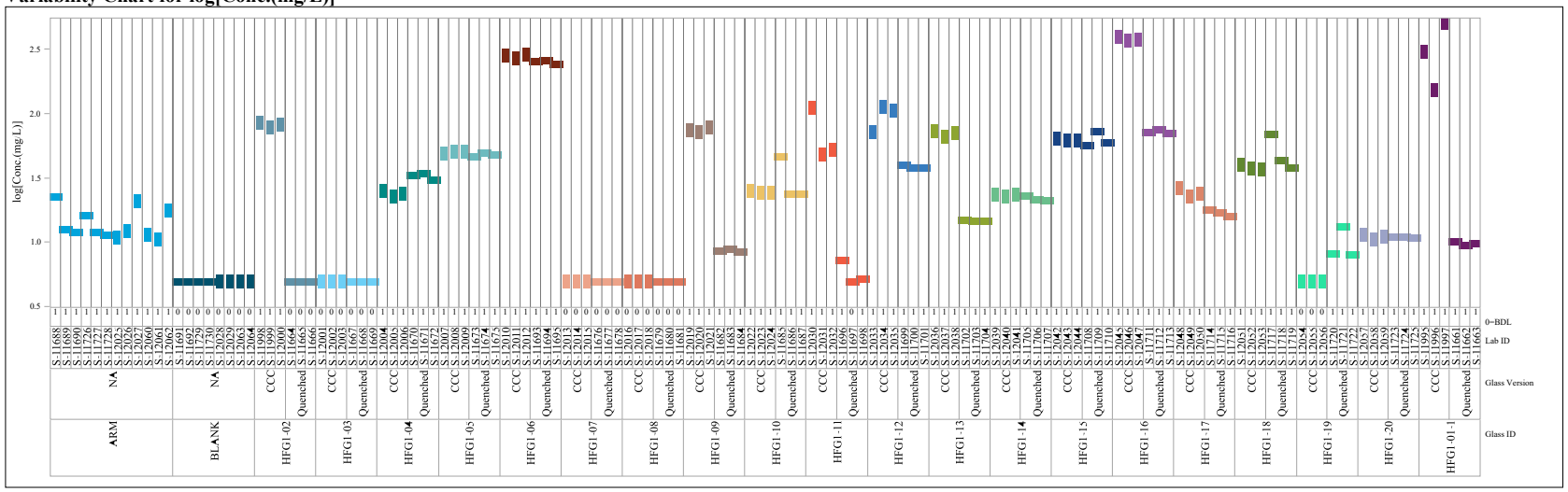
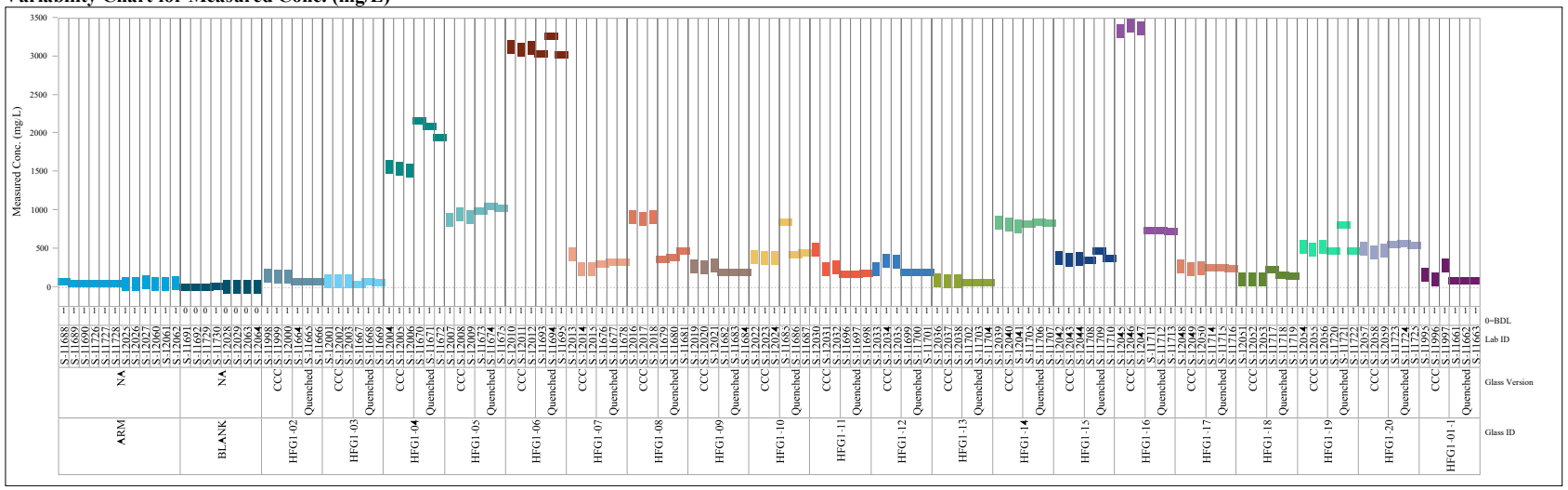


Exhibit A-2. Dilution Corrected PCT Measurements by Glass ID (continued)

Analyte=Na (mg/L)
Variability Chart for Measured Conc. (mg/L)



Analyte=Na (mg/L)
Variability Chart for log[Conc.(mg/L)]

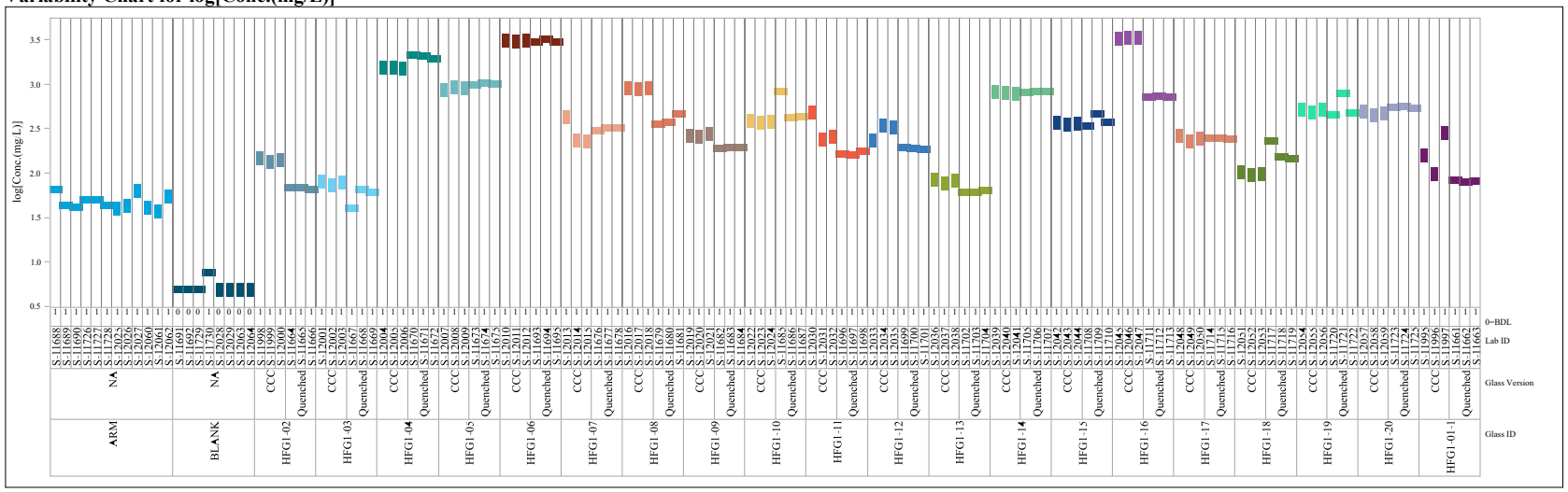
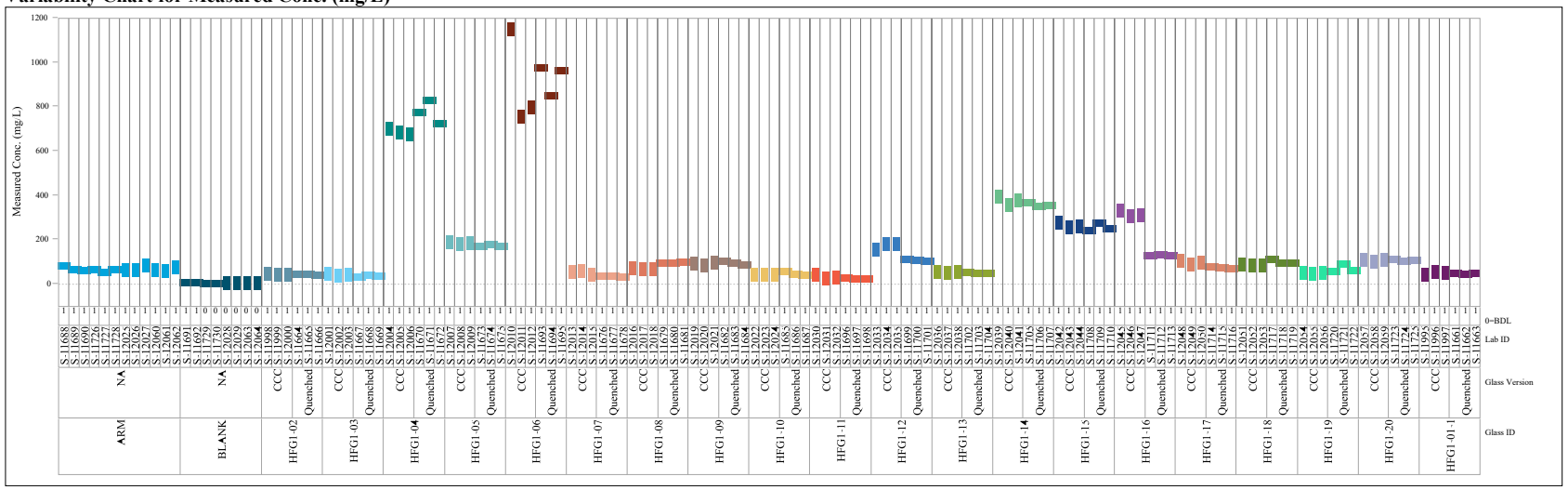


Exhibit A-2. Dilution Corrected PCT Measurements by Glass ID (continued)

Analyte=Si (mg/L)
Variability Chart for Measured Conc. (mg/L)



Analyte=Si (mg/L)
Variability Chart for log[Conc.(mg/L)]

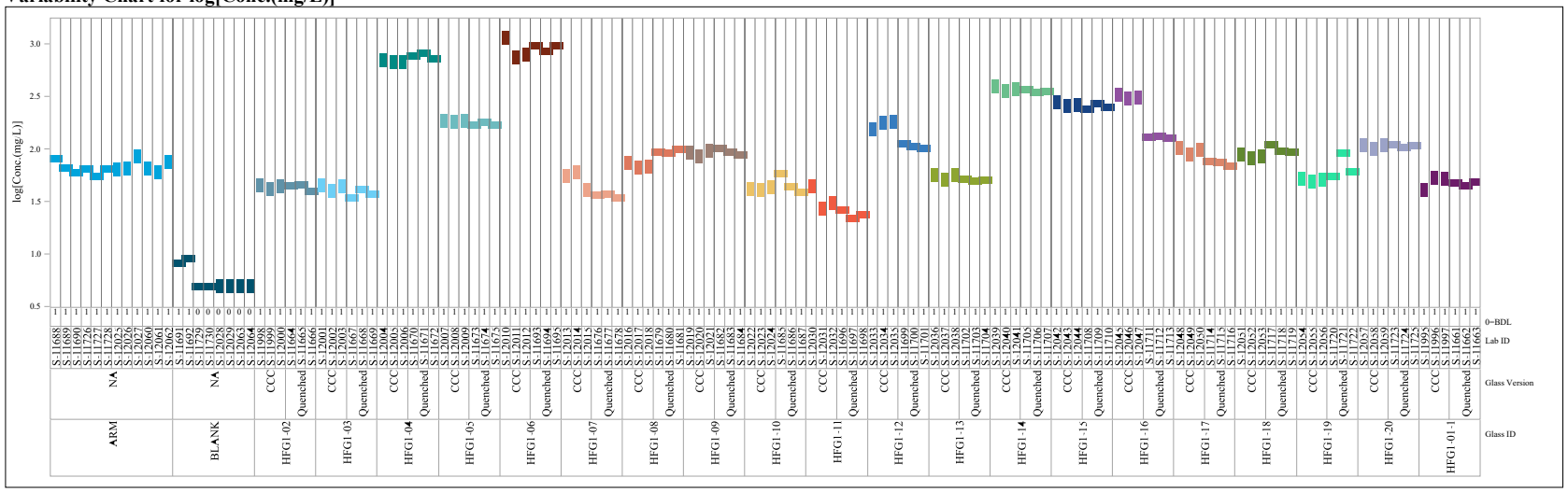
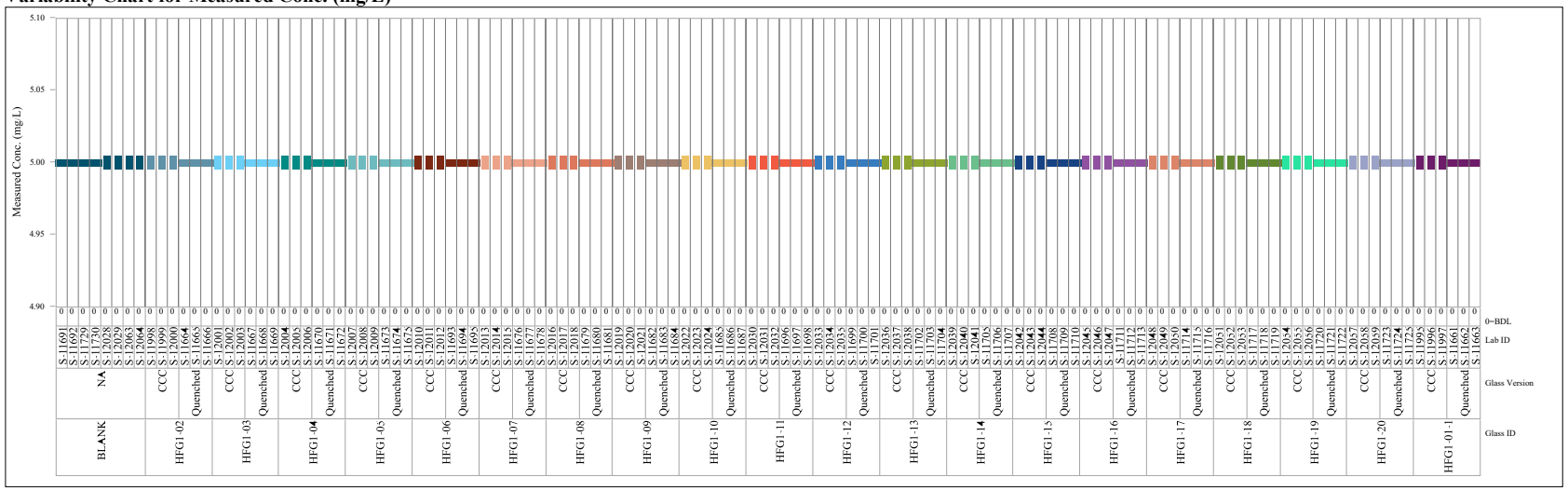
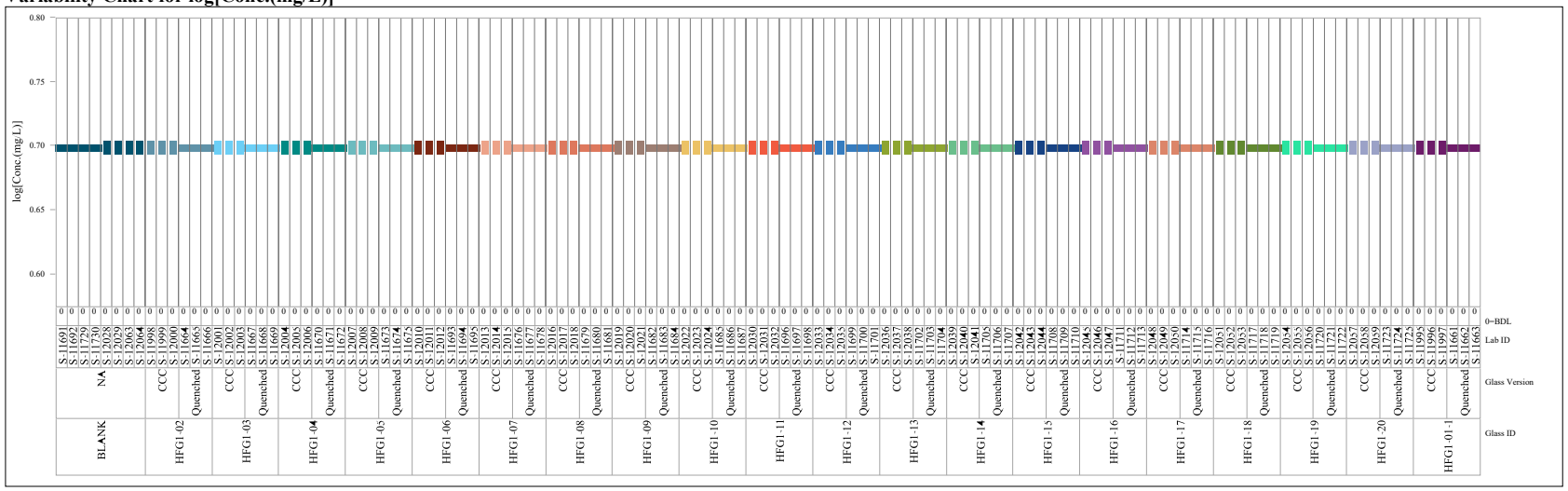


Exhibit A-2. Dilution Corrected PCT Measurements by Glass ID (continued)

Analyte=Zr (mg/L)
Variability Chart for Measured Conc. (mg/L)



Analyte=Zr (mg/L)
Variability Chart for log[Conc.(mg/L)]



Appendix B. Normalized PCT Results

Table B-1. Normalized PCT Results

Glass ID	Comp. View	NC_{Al} (g/L)	NC_{B} (g/L)	NC_{Cr} (g/L)	NC_{K} (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)	NC_{Zr} (g/L)
ARM-1-STD-PCT-100720	Reference	<0.169	0.595	N/A	N/A	0.645	0.699	0.319	<0.375
ARM-1-STD-PCT-102820	Reference	<0.169	0.508	N/A	N/A	0.559	0.682	0.285	<0.375
ARM-1-STD-PCT-111120	Reference	0.193	0.666	N/A	N/A	0.606	0.676	0.331	<0.375
ARM-1-STD-PCT-120220	Reference	0.188	0.627	N/A	N/A	0.553	0.619	0.31	<0.375
HFG1-01-1-Q	Targeted	0.254	0.475	<8.03	<0.388	0.383	0.812	0.233	<0.0813
HFG1-01-1-Q	Measured	0.264	0.493	<5.00	<0.464	0.372	0.817	0.229	<0.0817
HFG1-01-1-CCC	Targeted	0.244	0.514	<8.03	<0.425	11.2	1.64	0.240	<0.0813
HFG1-01-1-CCC	Measured	0.253	0.533	<5.00	<0.509	10.9	1.65	0.236	<0.0817
HFG1-02-Q	Targeted	<0.119	0.310	<8.60	<0.602	<0.612	0.594	0.177	<0.157
HFG1-02-Q	Measured	<0.120	0.318	<5.00	<0.543	<0.588	0.619	0.177	<0.154
HFG1-02-CCC	Targeted	0.178	0.333	<8.60	<0.602	10.2	1.24	0.178	<0.157
HFG1-02-CCC	Measured	0.179	0.342	<5.00	<0.543	9.78	1.29	0.179	<0.154
HFG1-03-Q	Targeted	<0.245	0.317	<9.25	<0.789	<18.9	0.450	0.167	<0.0629
HFG1-03-Q	Measured	<0.248	0.327	<5.00	<0.745	<5.00	0.440	0.168	<0.0637
HFG1-03-CCC	Targeted	<0.245	0.443	<9.25	<0.789	<18.9	0.636	0.194	<0.0629
HFG1-03-CCC	Measured	<0.248	0.457	<5.00	<0.745	<5.00	0.621	0.195	<0.0637
HFG1-04-Q	Targeted	<0.501	13.7	<5.71	6.04	10.8	12.0	3.62	<0.143
HFG1-04-Q	Measured	<0.483	14.1	<5.00	6.67	10.5	12.1	3.68	<0.142
HFG1-04-CCC	Targeted	<0.501	10.9	<5.71	4.85	7.83	8.95	3.20	<0.143
HFG1-04-CCC	Measured	<0.483	11.2	<5.00	5.35	7.61	9.09	3.25	<0.142
HFG1-05-Q	Targeted	<0.248	7.95	<3.79	<2.47	3.92	6.18	0.857	<0.0590
HFG1-05-Q	Measured	<0.250	8.33	<4.15	<2.16	3.43	6.41	0.878	<0.0607
HFG1-05-CCC	Targeted	<0.248	7.69	<3.79	<2.47	4.08	5.50	0.913	<0.0590
HFG1-05-CCC	Measured	<0.250	8.06	<4.15	<2.16	3.57	5.71	0.934	<0.0607
HFG1-06-Q	Targeted	<0.170	23.6	<6.89	6.90	16.1	18.2	4.34	<0.0914
HFG1-06-Q	Measured	<0.174	24.1	<5.00	6.64	13.6	18.0	4.46	<0.0925
HFG1-06-CCC	Targeted	<0.170	24.9	<6.89	6.84	18.0	18.2	4.14	<0.0914
HFG1-06-CCC	Measured	<0.174	25.5	<5.00	6.58	15.2	18.0	4.25	<0.0925
HFG1-07-Q	Targeted	0.137	3.43	<17.4	0.504	<2.17	2.28	0.164	<0.140
HFG1-07-Q	Measured	0.143	3.50	<5.00	0.632	<1.86	2.32	0.167	<0.142
HFG1-07-CCC	Targeted	0.207	3.11	<17.4	<0.557	<2.17	2.05	0.235	<0.140
HFG1-07-CCC	Measured	0.216	3.18	<5.00	<0.698	<1.86	2.09	0.241	<0.142

Table B-1. Normalized PCT Results (continued)

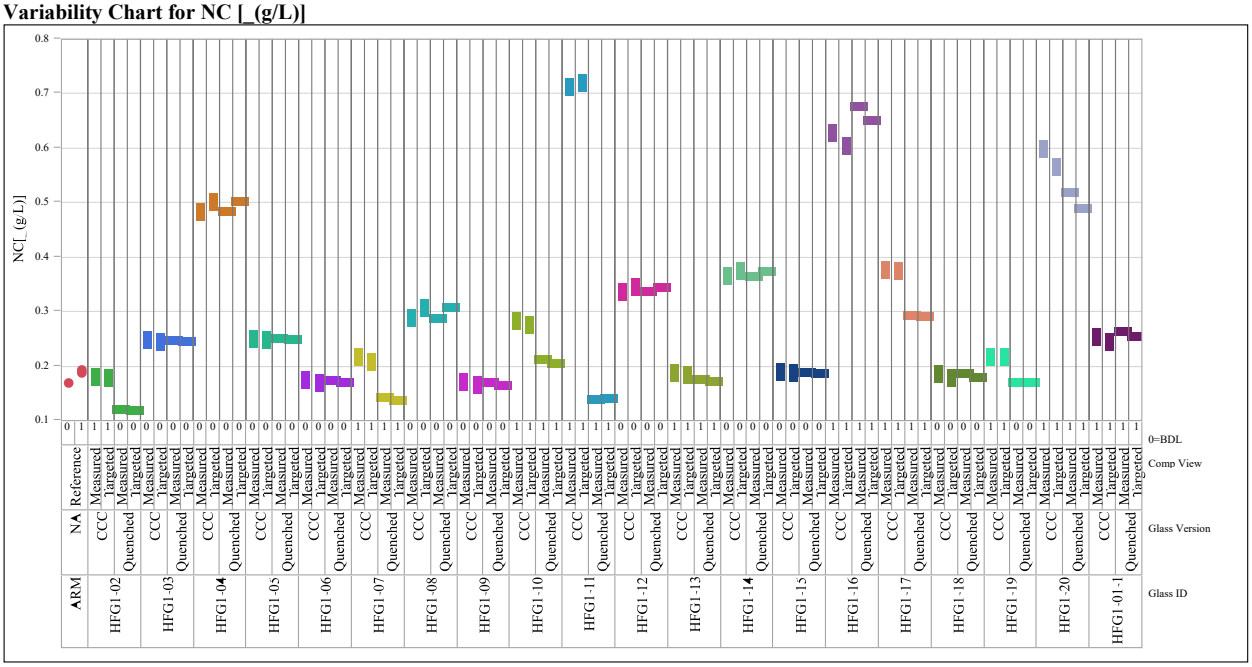
Glass ID	Comp. View	NC_{Al} (g/L)	NC_{B} (g/L)	NC_{Cr} (g/L)	NC_{K} (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)	NC_{Zr} (g/L)
HFG1-08-Q	Targeted	<0.307	2.21	<4.06	0.846	<2.32	2.32	0.494	<0.0537
HFG1-08-Q	Measured	<0.288	2.27	<4.47	0.903	<2.16	2.39	0.490	<0.0540
HFG1-08-CCC	Targeted	<0.307	1.41	<4.06	0.852	<2.32	5.21	0.363	<0.0537
HFG1-08-CCC	Measured	<0.288	1.45	<4.47	0.909	<2.16	5.36	0.360	<0.0540
HFG1-09-Q	Targeted	<0.164	0.765	<3.99	<1.68	0.491	1.52	0.433	<0.163
HFG1-09-Q	Measured	<0.170	0.805	<2.99	<1.56	0.486	1.47	0.443	<0.162
HFG1-09-CCC	Targeted	<0.165	0.936	<3.99	<1.68	4.27	2.07	0.419	<0.163
HFG1-09-CCC	Measured	<0.171	0.985	<2.99	<1.56	4.23	2.01	0.429	<0.162
HFG1-10-Q	Targeted	0.206	4.16	<27.1	1.13	2.28	3.71	0.282	<0.0506
HFG1-10-Q	Measured	0.212	4.31	<5.00	1.05	2.07	3.76	0.285	<0.0517
HFG1-10-CCC	Targeted	0.275	3.21	<27.1	0.909	1.89	2.62	0.257	<0.0506
HFG1-10-CCC	Measured	0.283	3.33	<5.00	0.846	1.71	2.65	0.261	<0.0517
HFG1-11-Q	Targeted	0.140	1.60	<4.32	<0.671	<0.836	1.30	0.131	<0.0545
HFG1-11-Q	Measured	0.139	1.64	<3.99	<0.613	<0.796	1.33	0.131	<0.0543
HFG1-11-CCC	Targeted	0.719	1.82	<4.32	<0.710	9.64	2.40	0.182	<0.0545
HFG1-11-CCC	Measured	0.712	1.85	<3.99	<0.647	9.18	2.46	0.182	<0.0543
HFG1-12-Q	Targeted	<0.345	2.20	<22.8	<0.938	1.76	2.06	0.487	<0.0560
HFG1-12-Q	Measured	<0.337	2.27	<5.00	<0.888	1.71	1.99	0.494	<0.0561
HFG1-12-CCC	Targeted	<0.345	3.54	<22.8	<0.938	4.37	3.21	0.783	<0.0560
HFG1-12-CCC	Measured	<0.337	3.65	<5.00	<0.888	4.24	3.10	0.794	<0.0561
HFG1-13-Q	Targeted	0.171	0.539	<4.43	<1.18	0.540	0.698	0.224	<0.147
HFG1-13-Q	Measured	0.175	0.521	<5.00	<1.03	0.493	0.755	0.215	<0.146
HFG1-13-CCC	Targeted	0.183	0.531	<4.43	<1.18	2.58	0.908	0.242	<0.147
HFG1-13-CCC	Measured	0.187	0.513	<5.00	<1.03	2.35	0.982	0.232	<0.146
HFG1-14-Q	Targeted	<0.374	5.40	<13.1	<5.10	3.16	5.10	1.58	<0.0803
HFG1-14-Q	Measured	<0.365	5.34	<5.00	<3.68	2.88	5.22	1.55	<0.0805
HFG1-14-CCC	Targeted	<0.374	5.61	<13.1	<5.10	3.38	4.98	1.67	<0.0803
HFG1-14-CCC	Measured	<0.365	5.54	<5.00	<3.68	3.07	5.11	1.64	<0.0805
HFG1-15-Q	Targeted	<0.187	3.90	<4.13	1.26	3.40	3.39	1.09	<0.104
HFG1-15-Q	Measured	<0.189	4.04	<4.72	1.38	3.26	3.53	1.11	<0.107
HFG1-15-CCC	Targeted	<0.187	3.87	<4.13	1.36	3.40	3.16	1.14	<0.104
HFG1-15-CCC	Measured	<0.189	4.00	<4.72	1.49	3.26	3.30	1.16	<0.107

Table B-1. Normalized PCT Results (continued)

Glass ID	Comp. View	NC_{Al} (g/L)	NC_{B} (g/L)	NC_{Cr} (g/L)	NC_{K} (g/L)	NC_{Li} (g/L)	NC_{Na} (g/L)	NC_{Si} (g/L)	NC_{Zr} (g/L)
HFG1-16-Q	Targeted	0.652	1.92	<5.26	2.00	2.70	4.85	0.752	<0.0515
HFG1-16-Q	Measured	0.676	2.02	<5.00	2.69	2.65	5.02	0.758	<0.0559
HFG1-16-CCC	Targeted	0.604	29.6	14.9	0.566	14.2	22.3	1.81	<0.0515
HFG1-16-CCC	Measured	0.627	31.2	<14.2	0.762	14.0	23.1	1.83	<0.0559
HFG1-17-Q	Targeted	0.292	0.839	<9.62	<3.06	0.685	1.89	0.355	<0.0508
HFG1-17-Q	Measured	0.294	0.859	<5.00	<2.57	0.610	1.96	0.359	<0.0527
HFG1-17-CCC	Targeted	0.374	0.952	<9.62	<3.06	0.981	1.88	0.468	<0.0508
HFG1-17-CCC	Measured	0.376	0.975	<5.00	<2.57	0.874	1.95	0.474	<0.0527
HFG1-18-Q	Targeted	<0.179	2.55	<11.8	<1.55	2.14	1.82	0.423	<0.0946
HFG1-18-Q	Measured	<0.186	2.60	<5.00	<1.48	2.03	1.82	0.421	<0.0956
HFG1-18-CCC	Targeted	<0.179	1.27	<11.8	<1.55	1.69	1.04	0.366	<0.0946
HFG1-18-CCC	Measured	<0.186	1.30	<5.00	<1.48	1.60	1.04	0.364	<0.0956
HFG1-19-Q	Targeted	<0.170	3.67	<22.8	1.20	1.59	3.37	0.377	<0.120
HFG1-19-Q	Measured	<0.171	3.73	<5.00	1.17	1.50	3.43	0.369	<0.119
HFG1-19-CCC	Targeted	0.217	1.90	<22.8	0.865	<0.825	3.06	0.283	<0.120
HFG1-19-CCC	Measured	0.217	1.93	<5.00	0.844	<0.777	3.12	0.277	<0.119
HFG1-20-Q	Targeted	0.489	1.63	<6.19	<22.3	0.561	3.17	0.564	<0.0973
HFG1-20-Q	Measured	0.519	1.72	<4.37	<5.00	0.551	3.15	0.575	<0.0998
HFG1-20-CCC	Targeted	0.565	1.50	<6.19	<22.3	0.567	2.69	0.557	<0.0973
HFG1-20-CCC	Measured	0.599	1.59	<4.37	<5.00	0.558	2.67	0.569	<0.0998

Exhibit B-1. Normalized PCT Results by Compositional View by Glass Version for Each Glass

Analyte=Al
Variability Chart for NC [_(g/L)]



Analyte=B
Variability Chart for NC [_(g/L)]

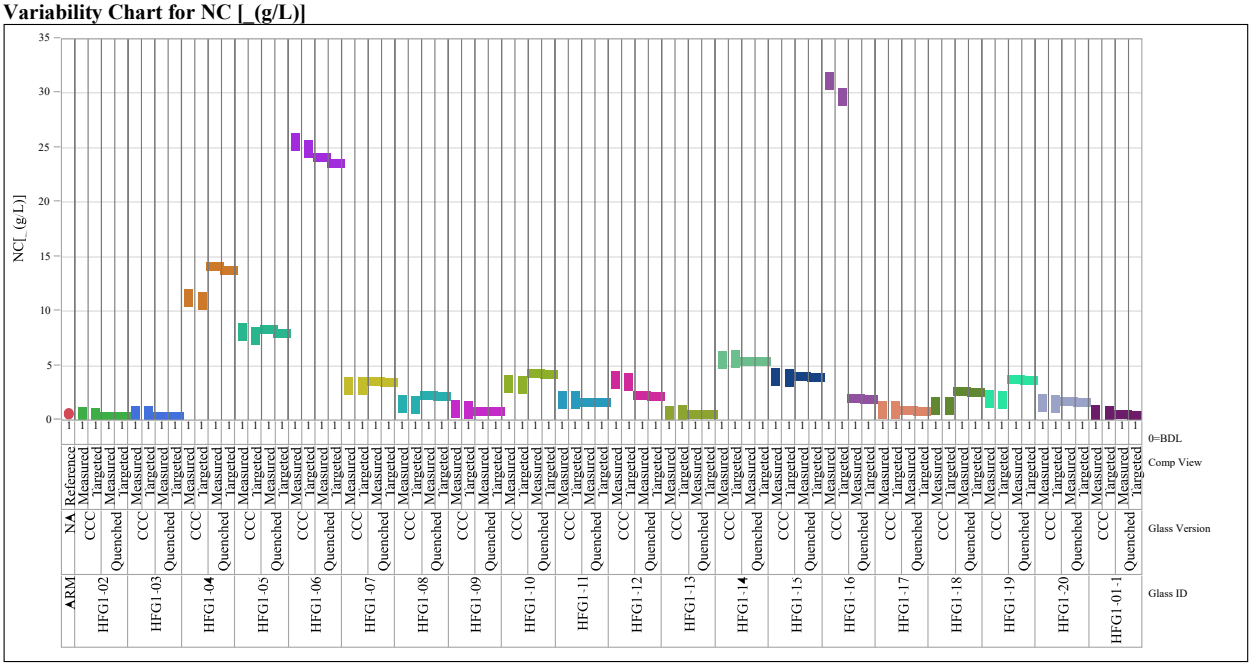
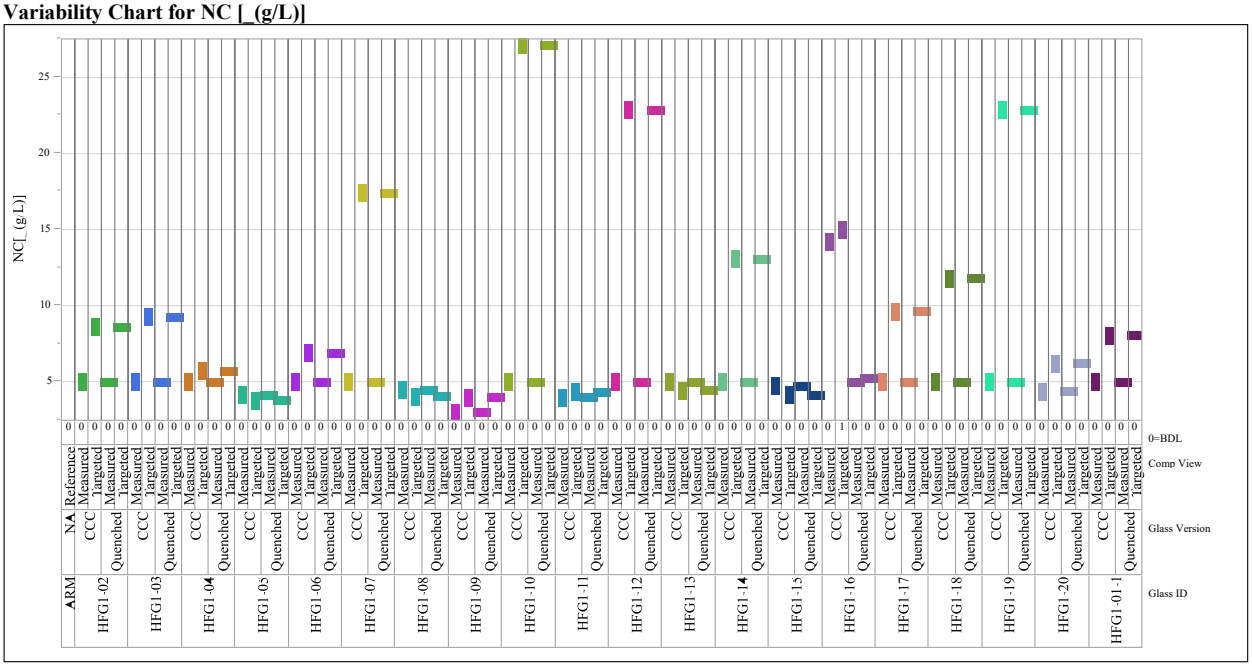


Exhibit B-1. Normalized PCT Results by Compositional View by Glass Version for Each Glass (continued)

Analyte=Cr
Variability Chart for NC [_(g/L)]



Analyte=K
Variability Chart for NC [_(g/L)]

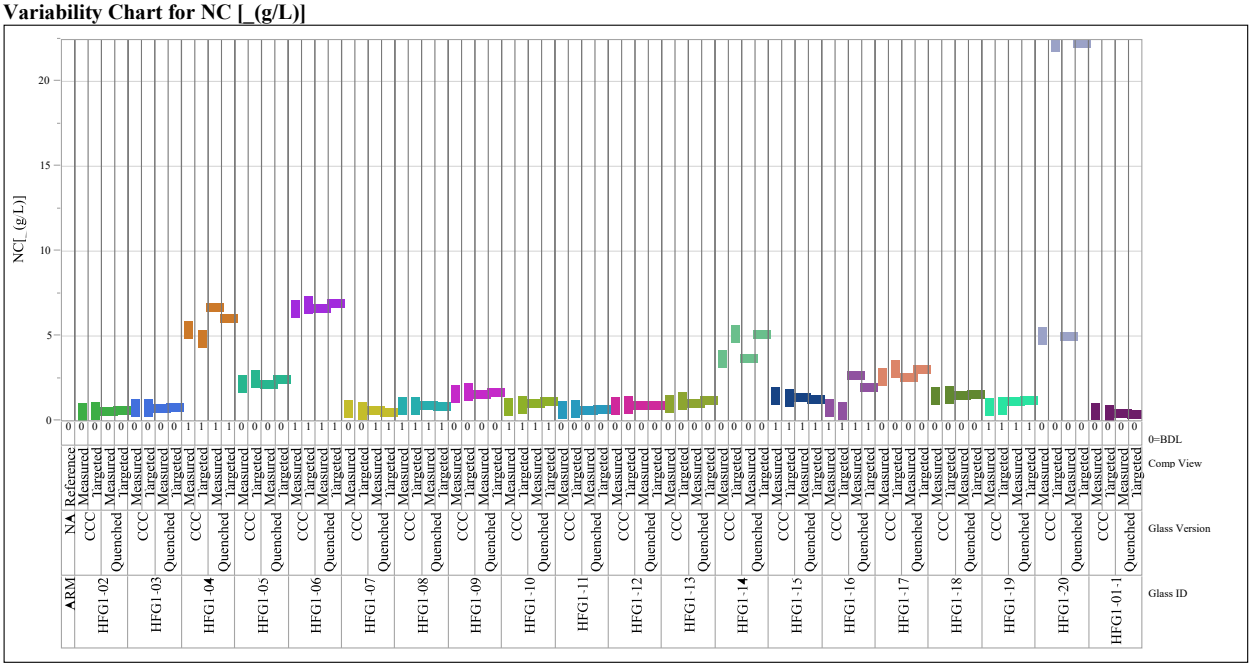
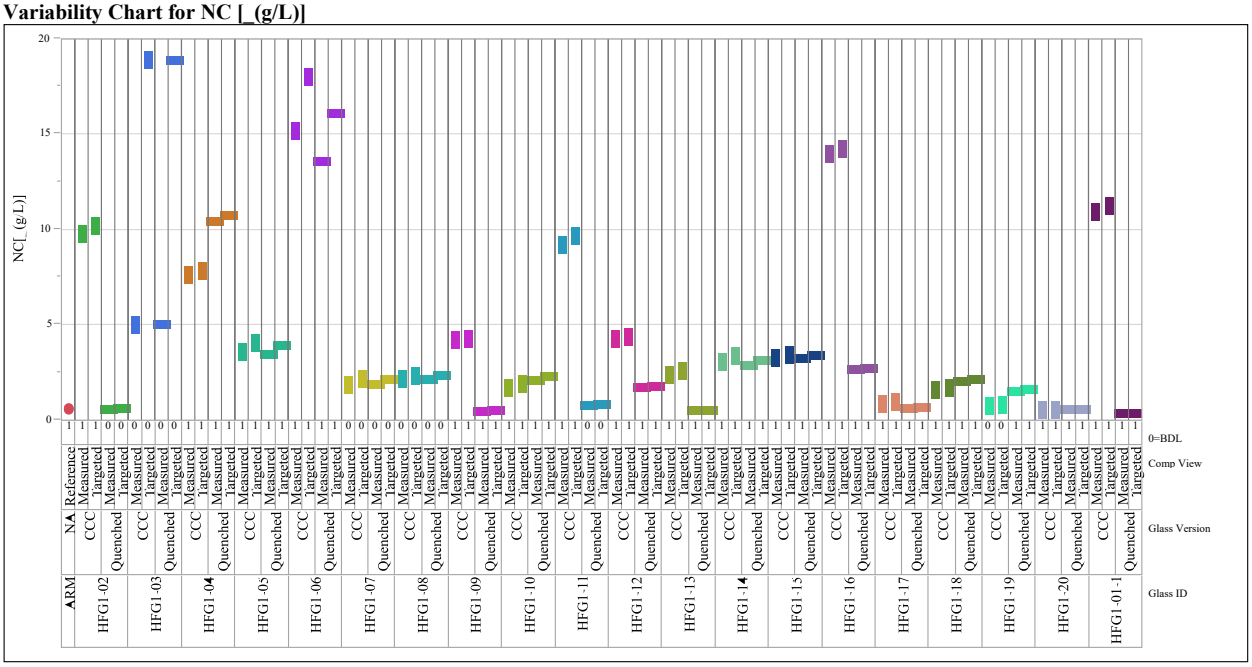


Exhibit B-1. Normalized PCT Results by Compositional View by Glass Version for Each Glass (continued)

Analyte=Li
Variability Chart for NC [_(g/L)]



Analyte=Na
Variability Chart for NC [_(g/L)]

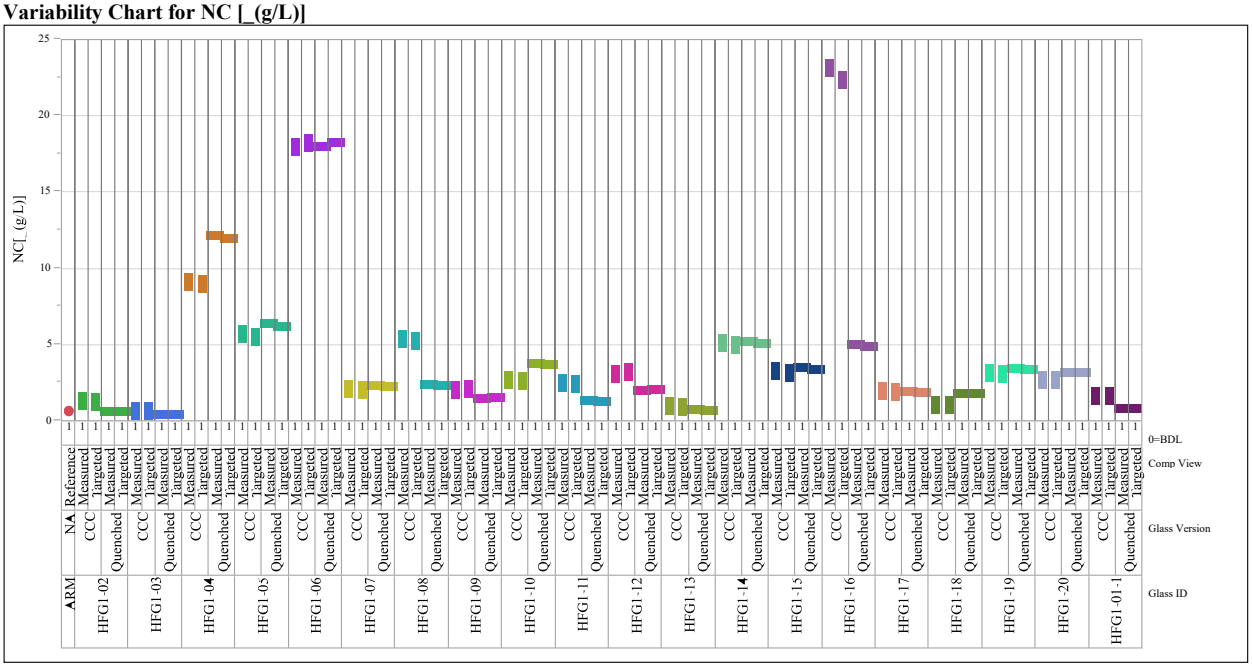
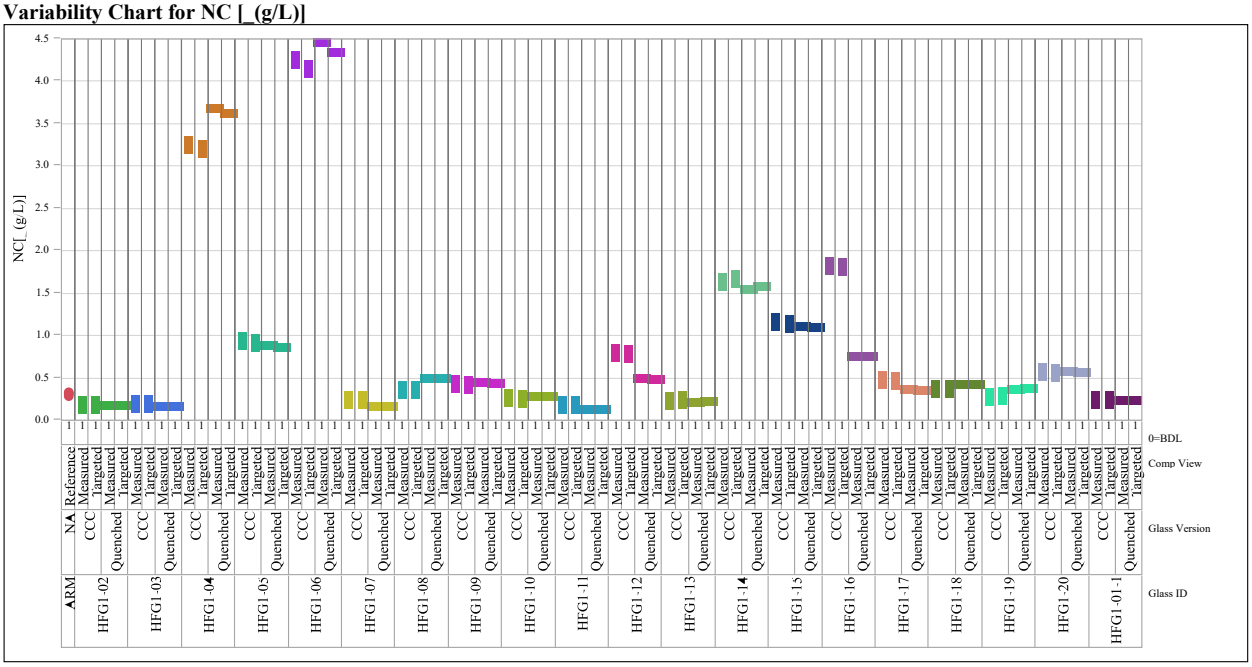


Exhibit B-1. Normalized PCT Results by Compositional View by Glass Version for Each Glass (continued)

Analyte=Si
Variability Chart for NC [_(g/L)]



Analyte=Zr
Variability Chart for NC [_(g/L)]

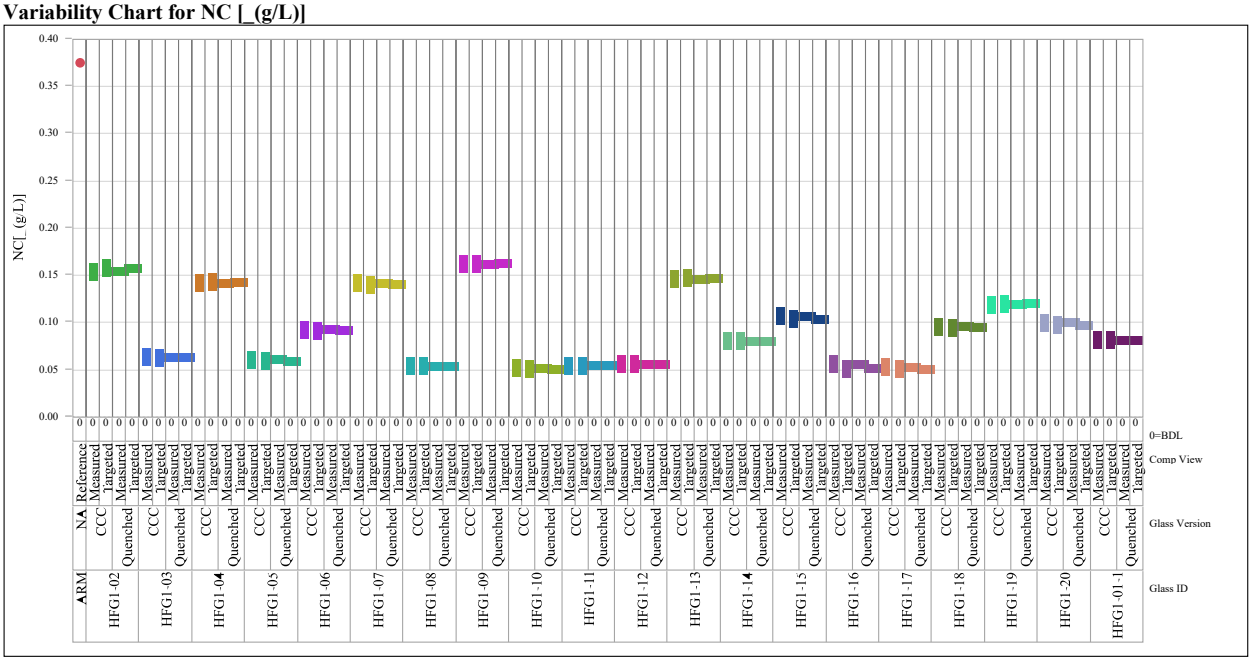


Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results

Multivariate Correlations

Targeted-Quenched

	log NC[B (g/L)]	log NC[K (g/L)]	log NC[Li (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[B (g/L)]	1.0000	0.4891	0.5857	0.9439	0.7786
log NC[K (g/L)]	0.4891	1.0000	0.2245	0.6491	0.7059
log NC[Li (g/L)]	0.5857	0.2245	1.0000	0.5156	0.5582
log NC[Na (g/L)]	0.9439	0.6491	0.5156	1.0000	0.8674
log NC[Si (g/L)]	0.7786	0.7059	0.5582	0.8674	1.0000

The correlations are estimated by Row-wise method.

Scatterplot Matrix

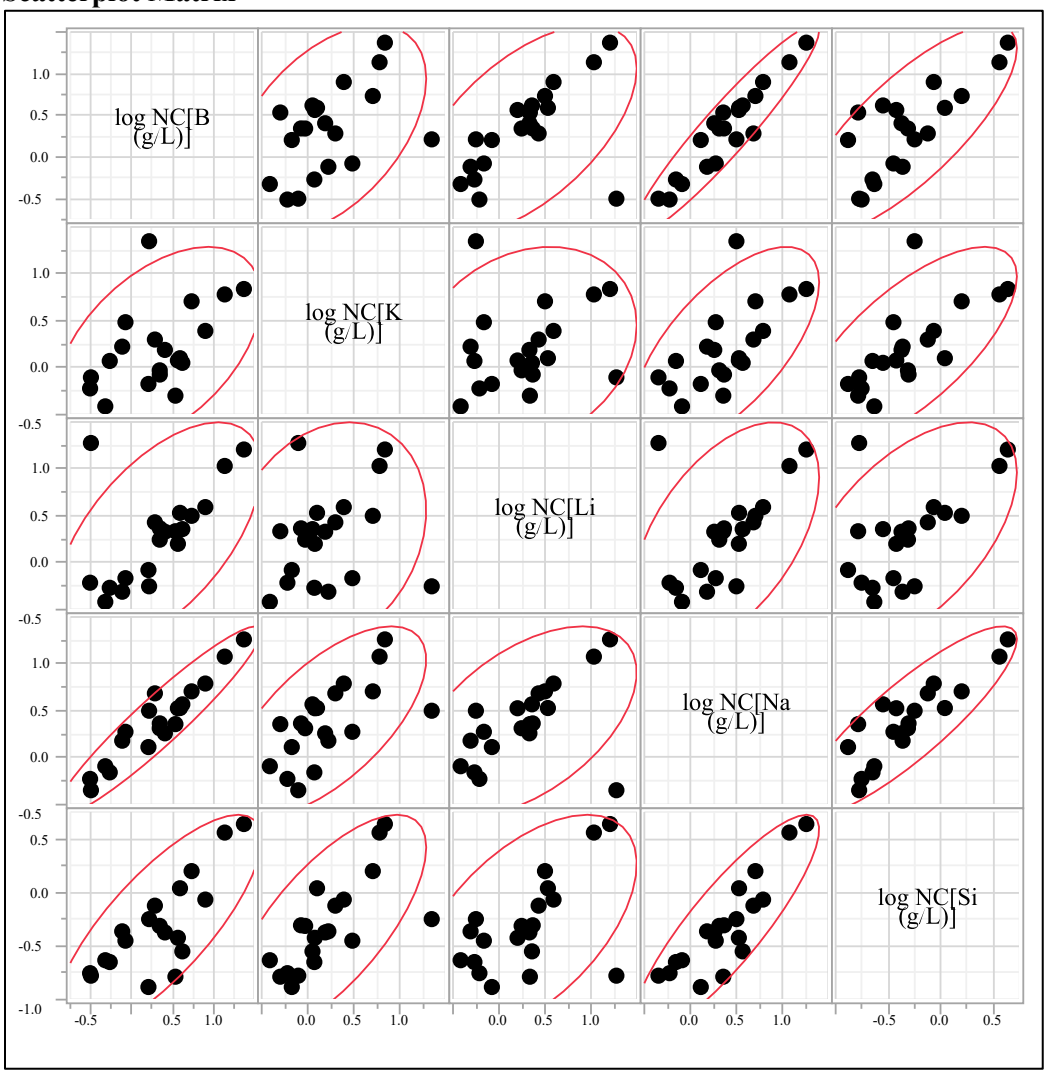


Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results (continued)

Multivariate Correlations

Measured-Quenched

	log NC[B (g/L)]	log NC[K (g/L)]	log NC[Li (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[B (g/L)]	1.0000	0.6336	0.7396	0.9455	0.7816
log NC[K (g/L)]	0.6336	1.0000	0.4907	0.7902	0.8565
log NC[Li (g/L)]	0.7396	0.4907	1.0000	0.6732	0.6919
log NC[Na (g/L)]	0.9455	0.7902	0.6732	1.0000	0.8682
log NC[Si (g/L)]	0.7816	0.8565	0.6919	0.8682	1.0000

The correlations are estimated by Row-wise method.

Scatterplot Matrix

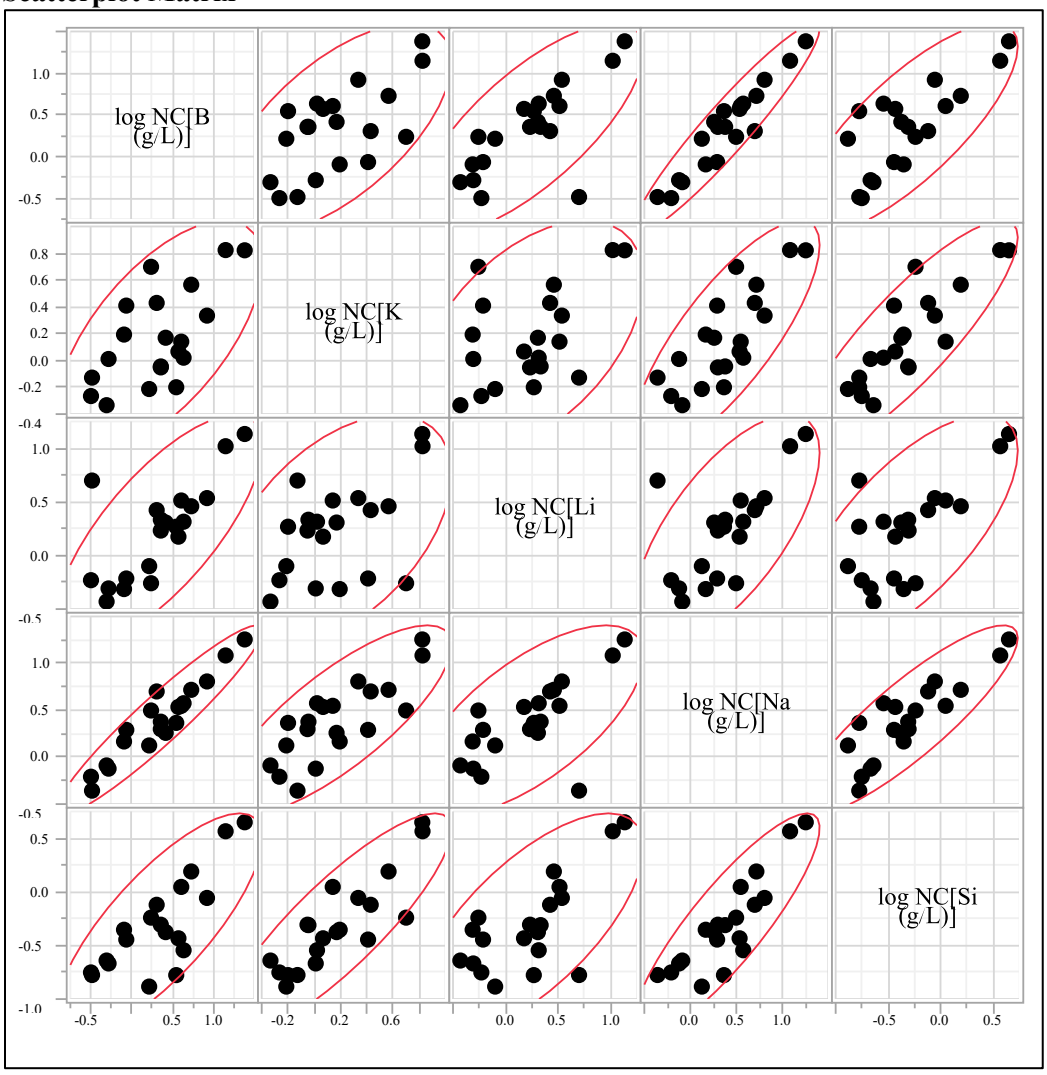


Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results (continued)

Multivariate Correlations

Targeted-CCC

	log NC[B (g/L)]	log NC[K (g/L)]	log NC[Li (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[B (g/L)]	1.0000	0.3103	0.1964	0.9124	0.8433
log NC[K (g/L)]	0.3103	1.0000	-0.3141	0.3029	0.5764
log NC[Li (g/L)]	0.1964	-0.3141	1.0000	0.2308	0.2234
log NC[Na (g/L)]	0.9124	0.3029	0.2308	1.0000	0.8275
log NC[Si (g/L)]	0.8433	0.5764	0.2234	0.8275	1.0000

The correlations are estimated by Row-wise method.

Scatterplot Matrix

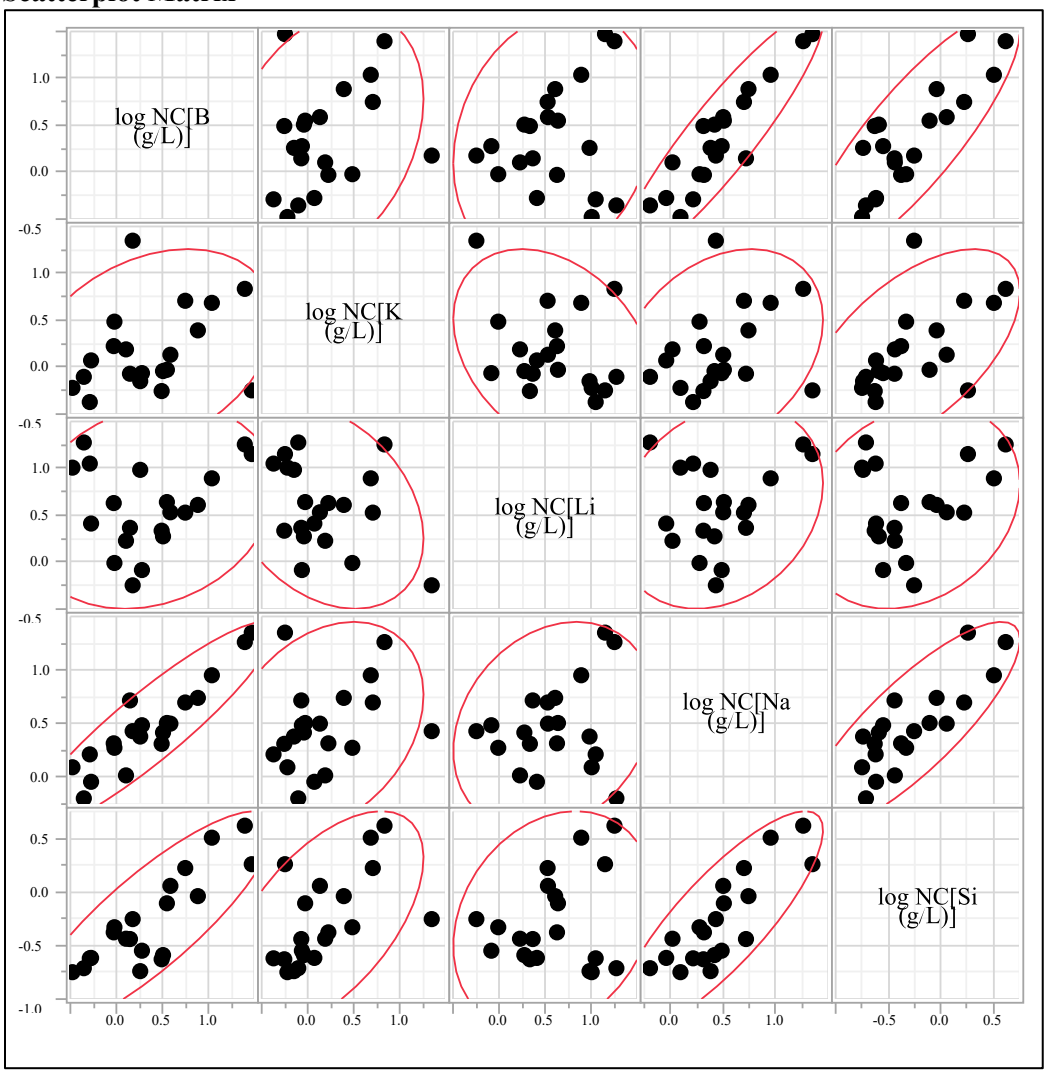


Exhibit B-2. Congruent Leaching Analysis for the Normalized PCT Results (continued)

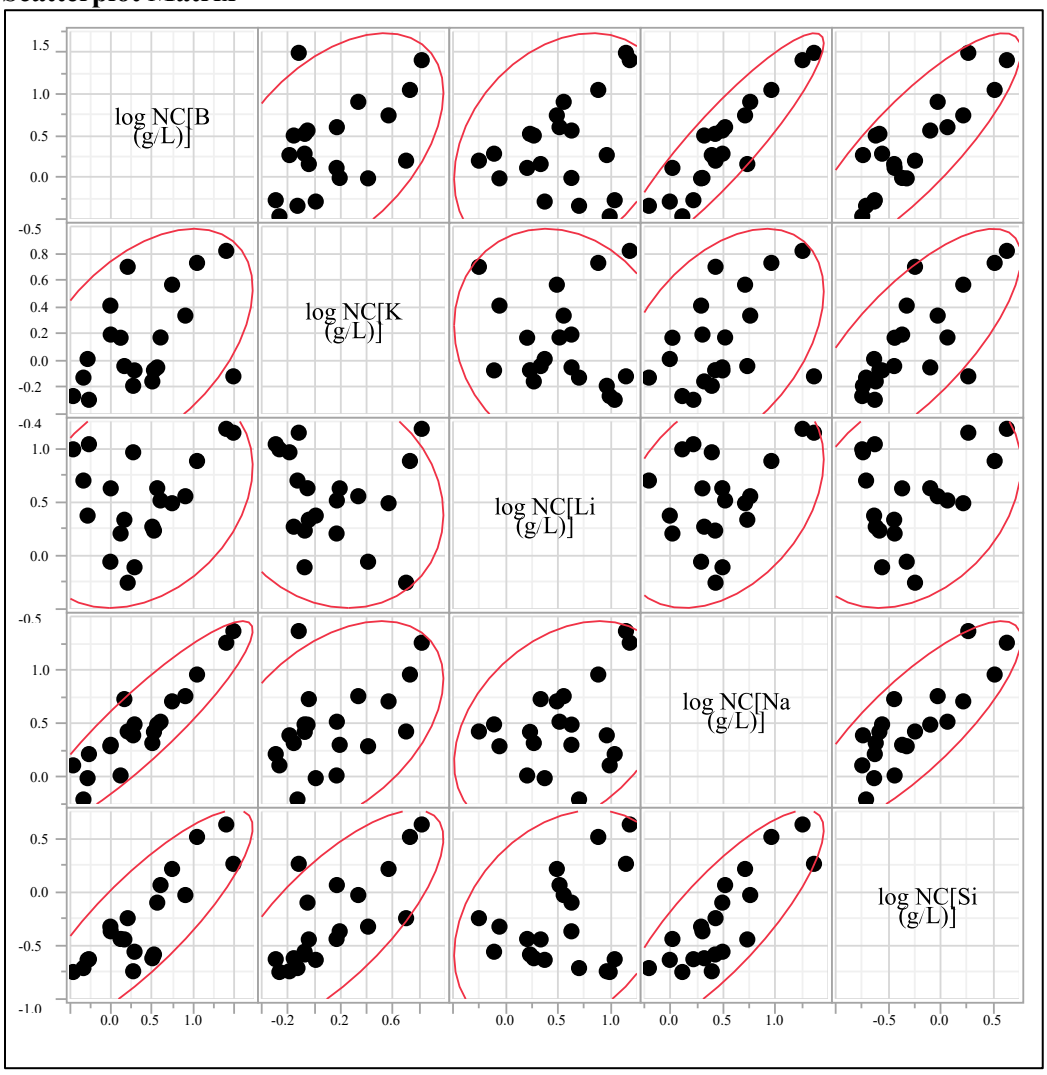
Multivariate Correlations

Measured-CCC

	log NC[B (g/L)]	log NC[K (g/L)]	log NC[Li (g/L)]	log NC[Na (g/L)]	log NC[Si (g/L)]
log NC[B (g/L)]	1.0000	0.4745	0.2864	0.9119	0.8445
log NC[K (g/L)]	0.4745	1.0000	-0.1471	0.4467	0.7471
log NC[Li (g/L)]	0.2864	-0.1471	1.0000	0.3523	0.3036
log NC[Na (g/L)]	0.9119	0.4467	0.3523	1.0000	0.8244
log NC[Si (g/L)]	0.8445	0.7471	0.3036	0.8244	1.0000

The correlations are estimated by Row-wise method.

Scatterplot Matrix



Distribution:
Jake.Amoroso@srnl.doe.gov
CJ.Bannochie@srnl.doe.gov
Alex.Cozzi@srnl.doe.gov
Charles.Crawford@srnl.doe.gov
Elaine_N_Diaz@orp.doe.gov
William.C.Eaton@pnnl.gov
A.Fellinger@srnl.doe.gov
Terry.Foster@srnl.doe.gov
Brenda.Garcia-Diaz@srnl.doe.gov
Holly.Hall@srnl.doe.gov
Erich.Hansen@srnl.doe.gov
Connie.Herman@srnl.doe.gov
Anthony.Howe@srnl.doe.gov
Madison.Hsieh@srnl.doe.gov
Dennis.Jackson@srnl.doe.gov
Fabienne.Johnson@srnl.doe.gov
Albert_A_Kruger@orp.doe.gov
Christine.Langton@srnl.doe.gov
Brady.Lee@srnl.doe.gov
Joseph.Manna@srnl.doe.gov
Daniel.McCabe@srnl.doe.gov
Kandice.Miles@srnl.doe.gov
Gregg.Morgan@srnl.doe.gov
Frank.Pennebaker@srnl.doe.gov
William.Ramsey@srnl.doe.gov
Whitney.Riley@srnl.doe.gov
Renee.Russell@pnnl.gov
Eric.Skidmore@srnl.doe.gov
Anna.Stanfield@srnl.doe.gov
Michael.Stone@srnl.doe.gov
John.Vienna@pnnl.gov
Boyd.Wiedenman@srnl.doe.gov
Richard.Wyrwas@srnl.doe.gov
Records Administration (EDWS)