



# Analytical Plans Supporting the SWPF Gap Analysis Being Conducted with EnergySolutions and the Vitreous State Laboratory at the CUA

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November 2014

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## EXECUTIVE SUMMARY

EnergySolutions (ES) and its partner, the Vitreous State Laboratory (VSL) of The Catholic University of America (CUA), are to provide engineering and technical services support to Savannah River Remediation, LLC (SRR) for ongoing operation of the Defense Waste Processing Facility (DWPF) flowsheet as well as for modifications to improve overall plant performance. SRR has requested that the glass formulation team of Savannah River National Laboratory (SRNL) and ES-VSL develop a technical basis that validates the current Product Composition Control System models for use during the processing of the coupled flowsheet or that leads to the refinements of or modifications to the models that are needed so that they may be used during the processing of the coupled flowsheet. SRNL has developed a matrix of test glasses that are to be batched and fabricated by ES-VSL as part of this effort. This document provides two analytical plans for use by ES-VSL: one plan is to guide the measurement of the chemical composition of the study glasses while the second is to guide the measurement of the durability of the study glasses based upon the results of testing by ASTM's Product Consistency Test (PCT) Method A.

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## LIST OF ABBREVIATIONS

ARM-1	Approved Reference Material – One
ANL-LRM	Argonne National Laboratory – Low Activity Reference Material
CUA	The Catholic University of America
DCP	Direct Coupled Plasma Atomic Emission Spectroscopy
DWPF	Defense Waste Processing Facility
DWPF-EA	Defense Waste Processing Facility – Environmental Assessment
ES	Energy <i>Solutions</i>
HLW	High-Level Waste
ICP	Inductively Coupled Plasma – Atomic Emission Spectroscopy
LAW	Low-Activity Waste
NIST	National Institute of Standards and Technology (NIST)
PCCS	Product Composition Control System
PCT	Product Consistency Test
SOW	Statement of Work
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation, LLC
TTQAP	Task Technical and Quality Assurance Plan
VSL	Vitreous State Laboratory
WTP	Waste Treatment Plant
XRF	X-ray fluorescence spectroscopy



## 1.0 Introduction

EnergySolutions (ES) and its partner, the Vitreous State Laboratory (VSL) of The Catholic University of America (CUA), are providing engineering and technical services support to Savannah River Remediation, LLC (SRR) for ongoing operation of the Defense Waste Processing Facility (DWPF) flowsheet as well as for modifications to improve overall plant performance. SRR has issued scopes of work to both the Savannah River National Laboratory (SRNL) and ES-VSL for glass formulation activities to support the integration of the Salt Waste Processing Facility (SWPF) into the DWPF flowsheet. Specifically, SRR has requested that the glass formulation team of SRNL and ES-VSL develop a technical basis that validates the current Product Composition Control System (PCCS) models for use during the processing of the coupled flowsheet or that leads to the refinements of or modifications to the models that are needed so that they may be used during the processing of the coupled flowsheet.

Peeler, Edwards, and Jantzen (2014a) issued a Task Technical and Quality Assurance Plan (TTQAP) that addressed SRNL's work scope to be performed in support of this task. The TTQAP was issued in response to the SRR Task Technical Request (Holtzscheiter (2014a)). SRNL's initial focus was an investigation into the compositional region for the DWPF glass waste-form anticipated by the integration of SWPF into the DWPF flowsheet. Under guidance from SRR (Fellinger, Holtzscheiter, and Shah (2014)), SRNL modified the projections for future sludge-only batches from SRR's Systems Plan Revision 19 (Chew and Hamm (2014)) to reflect coupled operations at DWPF and developed candidate frit compositions that would support the processing of these coupled projections in a manner that would meet SRR's operational goals as described in the guidance document. The results from this investigation were summarized by Peeler, Edwards, and Jantzen (2014b) and used to develop the glass waste-form compositional region of interest for this study (Peeler and Edwards (2014a)). From these efforts, Peeler and Edwards (2014b) developed a test matrix of 50 glass compositions that is to serve as the basis for the completion of the activities associated with this task.

SRR's Statement of Work (SOW) for ES-VSL (Holtzscheiter (2014b)) covers several activities that ES-VSL is to complete including:

- ◆ ES-VSL is to batch and fabricate the study glasses.
- ◆ ES-VSL is to measure the chemical compositions of these study glasses in accordance with an analytical plan, which is to be provided by SRNL.
- ◆ ES-VSL is to conduct a DWPF centerline canister cooled heat treatment for each of the study glasses in addition to the quenched version for each glass.
- ◆ ES-VSL is to subject samples of both heat treatments of each study glass to the ASTM Product Consistency Test (PCT) Method A (ASTM C1285 (2014)) for durability testing. The solutions resulting from this testing are to be subjected to chemical analyses by ES-VSL. These activities are to be conducted in accordance with an analytical plan, which is to be provided by SRNL.
- ◆ ES-VSL is to measure the liquidus temperature and viscosity for each study glass. No analytical plans are needed to support these measurements.

The purpose of this technical report is to provide the two analytical plans supporting these activities. Section 2 provides the description and background for the plan supporting the measurement of the chemical compositions of the study glasses. Appendix A repeats the portions of this chemical composition plan that may be supplied to the laboratory technicians and other appropriate staff to help in the completion of these measurements. Section 3 provides the description and background for the plan supporting the measurement of the solutions resulting from the PCT evaluations of the study glasses. Appendix B repeats the portions of the PCT plan that may be supplied to the laboratory technicians and other appropriate staff to help in the completion of the measurement of the PCTs.

The measurements generated by VSL are to be provided to SRR and SRNL for data reduction and evaluation. The results along with the other property measurements (i.e., liquidus temperature and viscosity) are to be incorporated into a final report by ES-VSL as a deliverable to SRR and SRNL in support of the SWPF gap analysis at DWPF.

## 2.0 Analytical Plan for the Measurement of Glass Compositions

The analytical plan needed by ES-VSL to support the measurement of the chemical compositions of the study glasses is outlined in the sub-sections that follow. The plan covers fifty (50) glasses containing thorium oxide and depleted uranium oxide that were identified by SRNL (Peeler and Edwards (2014b)).

### 2.1 Naming Conventions for Study Glasses and Prepared Samples

To provide a level of separation between the targeted compositions of the study glasses and the measurements of the study glasses during the analytical process, the naming convention provided in Table 2-1 is to be used to establish the identifiers for the samples that are to be submitted for laboratory analysis.

**Table 2-1. VSL Identifiers (IDs) for the Study Glasses Linked to the Sample IDs.**

Glass ID	Sample ID	Glass ID	Sample ID	Glass ID	Sample ID	Glass ID	Sample ID
SWPF-01	GAP-15	SWPF-14	GAP-12	SWPF-27	GAP-24	SWPF-40	GAP-48
SWPF-02	GAP-22	SWPF-15	GAP-14	SWPF-28	GAP-50	SWPF-41	GAP-04
SWPF-03	GAP-43	SWPF-16	GAP-26	SWPF-29	GAP-32	SWPF-42	GAP-27
SWPF-04	GAP-31	SWPF-17	GAP-05	SWPF-30	GAP-16	SWPF-43	GAP-28
SWPF-05	GAP-33	SWPF-18	GAP-29	SWPF-31	GAP-30	SWPF-44	GAP-01
SWPF-06	GAP-38	SWPF-19	GAP-35	SWPF-32	GAP-09	SWPF-45	GAP-08
SWPF-07	GAP-21	SWPF-20	GAP-46	SWPF-33	GAP-40	SWPF-46	GAP-39
SWPF-08	GAP-37	SWPF-21	GAP-41	SWPF-34	GAP-36	SWPF-47	GAP-45
SWPF-09	GAP-44	SWPF-22	GAP-20	SWPF-35	GAP-03	SWPF-48	GAP-25
SWPF-10	GAP-47	SWPF-23	GAP-23	SWPF-36	GAP-11	SWPF-49	GAP-02
SWPF-11	GAP-10	SWPF-24	GAP-42	SWPF-37	GAP-07	SWPF-50	GAP-18
SWPF-12	GAP-34	SWPF-25	GAP-17	SWPF-38	GAP-13		
SWPF-13	GAP-19	SWPF-26	GAP-06	SWPF-39	GAP-49		

### 2.2 Sample Preparation for Chemical Composition Analyses

Two methods are to be used to conduct the measurement of the chemical compositions of the study glasses: X-ray fluorescence spectroscopy (XRF) and Direct Coupled Plasma Atomic Emission Spectroscopy (DCP). Each of the study glasses is to be prepared by VSL in duplicate for each of these two measurement methods. The preparation of a single study glass for XRF analysis involves grinding a sample of the glass to less than 200 mesh and sealing each of two samples of the resultant glass in a different vial in sufficient quantities for subsequent XRF analysis. A labeling scheme for these vials that are to be submitted for XRF is provided in Table 2-2. The groupings and sequencing of these glasses that are indicated in this table also guide the glass fabrication process in that the glasses must be batched and melted before the activities of Table 2-2 may be pursued. Thus, the study glasses are to be batched and fabricated in the order as indicated by Table 2-2.

**Table 2-2. XRF Preparation Blocks and Sequencing along with Sample Identifiers**

XRF Preparation Block 1		XRF Preparation Block 2		XRF Preparation Block 3	
GAP-15xrf-1	GAP-15xrf-2	GAP-44xrf-1	GAP-44xrf-2	GAP-26xrf-1	GAP-26xrf-2
GAP-22xrf-1	GAP-22xrf-2	GAP-47xrf-1	GAP-47xrf-2	GAP-05xrf-1	GAP-05xrf-2
GAP-43xrf-1	GAP-43xrf-2	GAP-10xrf-1	GAP-10xrf-2	GAP-29xrf-1	GAP-29xrf-2
GAP-31xrf-1	GAP-31xrf-2	GAP-34xrf-1	GAP-34xrf-2	GAP-35xrf-1	GAP-35xrf-2
GAP-33xrf-1	GAP-33xrf-2	GAP-19xrf-1	GAP-19xrf-2	GAP-46xrf-1	GAP-46xrf-2
GAP-38xrf-1	GAP-38xrf-2	GAP-12xrf-1	GAP-12xrf-2	GAP-41xrf-1	GAP-41xrf-2
GAP-21xrf-1	GAP-21xrf-2	GAP-14xrf-1	GAP-14xrf-2	GAP-20xrf-1	GAP-20xrf-2
GAP-37xrf-1	GAP-37xrf-2				
XRF Preparation Block 4		XRF Preparation Block 5		XRF Preparation Block 6	
GAP-23xrf-1	GAP-23xrf-2	GAP-16xrf-1	GAP-16xrf-2	GAP-07xrf-1	GAP-07xrf-2
GAP-42xrf-1	GAP-42xrf-2	GAP-30xrf-1	GAP-30xrf-2	GAP-13xrf-1	GAP-13xrf-2
GAP-17xrf-1	GAP-17xrf-2	GAP-09xrf-1	GAP-09xrf-2	GAP-49xrf-1	GAP-49xrf-2
GAP-06xrf-1	GAP-06xrf-2	GAP-40xrf-1	GAP-40xrf-2	GAP-48xrf-1	GAP-48xrf-2
GAP-24xrf-1	GAP-24xrf-2	GAP-36xrf-1	GAP-36xrf-2	GAP-04xrf-1	GAP-04xrf-2
GAP-50xrf-1	GAP-50xrf-2	GAP-03xrf-1	GAP-03xrf-2	GAP-27xrf-1	GAP-27xrf-2
GAP-32xrf-1	GAP-32xrf-2	GAP-11xrf-1	GAP-11xrf-2	GAP-28xrf-1	GAP-28xrf-2
XRF Preparation Block 7					
GAP-01xrf-1	GAP-01xrf-2				
GAP-08xrf-1	GAP-08xrf-2				
GAP-39xrf-1	GAP-39xrf-2				
GAP-45xrf-1	GAP-45xrf-2				
GAP-25xrf-1	GAP-25xrf-2				
GAP-02xrf-1	GAP-02xrf-2				
GAP-18xrf-1	GAP-18xrf-2				

In addition to the grinding and sieving steps used to prepare samples for XRF, the preparation of samples for DCP analysis involves a chemical dissolution step. Thus, once a sample of a study glass has been ground to less than 200 mesh, two samples of the ground glass are to be prepared for subsequent XRF analysis, and, in addition an adequate quantity (to be determined by VSL) of the ground glass is to be placed in a separate vial for subsequent duplicate preparation for analysis by DCP. That is, duplicate samples from each of the vials are to be subjected to microwave-assisted total acid dissolution in Teflon vessels according to VSL standard operating procedures. Typically, a mixture of concentrated HF:HNO<sub>3</sub> is used to conduct the digestions with each digestion leading to a 50 mL solution. The resulting solutions are further diluted to 200 mL before DCP analysis. The 200 mL solutions are to be labeled as indicated in Table 2-3. The groupings of Table 2-3 are established in a manner that indicates that all of the batching and preliminary preparations (i.e., grinding) of the glasses are to be completed before the dissolution activities of Table 2-3 are initiated. Each block of Table 2-3 represents a microwave batch and the sequence provides an order for sample weighing.

In addition to the study glasses, a standard reference glass (to be selected by VSL) is to be prepared once for repeated analysis by XRF (see Section 2.3.1), and similarly, samples of this standard glass are to be prepared (i.e., dissolved for DCP analysis) to provide sufficient quantities to allow aliquots of the resulting solutions to be submitted for DCP analysis along with the prepared samples of the study glasses (see Section 2.3.2). It is anticipated that two or more preparations of the standard glass (Std-dcp) may be needed and, thus, one has been included in each of the preparation blocks of Table 2-3. If aliquots of more than one dissolution of the Std-dcp standard are needed to support the DCP analyses of Section 2.3.2, this should be noted as part of the information provided to SRNL along with the reported measurements.

**Table 2-3. DCP Preparation Blocks and Sequencing along with Sample Identifiers for the 200 mL Solutions**

DCP Preparation Block 1	DCP Preparation Block 2	DCP Preparation Block 3	DCP Preparation Block 4	DCP Preparation Block 5
GAP-33dcp-1	GAP-12dcp-1	GAP-24dcp-1	GAP-03dcp-1	GAP-28dcp-1
GAP-15dcp-1	GAP-26dcp-1	GAP-42dcp-1	GAP-40dcp-1	GAP-04dcp-1
GAP-38dcp-1	GAP-14dcp-1	GAP-24dcp-2	GAP-07dcp-1	Std-dcp
GAP-21dcp-1	GAP-35dcp-1	GAP-42dcp-2	GAP-36dcp-1	GAP-27dcp-1
GAP-33dcp-2	GAP-29dcp-1	Std-dcp	GAP-03dcp-2	GAP-28dcp-2
GAP-15dcp-2	GAP-26dcp-2	GAP-23dcp-1	GAP-36dcp-2	GAP-04dcp-2
GAP-37dcp-1	GAP-35dcp-2	GAP-41dcp-1	GAP-40dcp-2	GAP-27dcp-2
Std-dcp	GAP-14dcp-2	GAP-17dcp-1	GAP-07dcp-2	GAP-08dcp-1
GAP-38dcp-2	GAP-34dcp-1	GAP-32dcp-1	GAP-13dcp-1	GAP-02dcp-1
GAP-21dcp-2	GAP-46dcp-1	GAP-17dcp-2	Std-dcp	GAP-25dcp-1
GAP-37dcp-2	GAP-34dcp-2	GAP-32dcp-2	GAP-11dcp-1	GAP-39dcp-1
GAP-43dcp-1	GAP-05dcp-1	GAP-20dcp-1	GAP-13dcp-2	GAP-02dcp-2
GAP-31dcp-1	GAP-10dcp-1	GAP-23dcp-2	GAP-30dcp-1	GAP-08dcp-2
GAP-47dcp-1	GAP-19dcp-1	GAP-41dcp-2	GAP-11dcp-2	GAP-39dcp-2
GAP-43dcp-2	GAP-10dcp-2	GAP-20dcp-2	GAP-49dcp-1	GAP-01dcp-1
GAP-31dcp-2	Std-dcp	GAP-50dcp-1	GAP-30dcp-2	GAP-25dcp-2
GAP-47dcp-2	GAP-46dcp-2	GAP-06dcp-1	GAP-48dcp-1	GAP-01dcp-2
GAP-44dcp-1	GAP-05dcp-2	GAP-16dcp-1	GAP-09dcp-1	GAP-18dcp-1
GAP-22dcp-1	GAP-12dcp-2	GAP-50dcp-2	GAP-49dcp-2	GAP-45dcp-1
GAP-44dcp-2	GAP-29dcp-2	GAP-06dcp-2	GAP-48dcp-2	GAP-18dcp-2
GAP-22dcp-2	GAP-19dcp-2	GAP-16dcp-2	GAP-09dcp-2	GAP-45dcp-2

## 2.3 Measurement of Chemical Compositions

Once samples of the study glasses and standard glass have been prepared they are to be submitted for chemical analysis by one of the two methods: XRF or DCP. The resulting measurements are to be provided to SRNL in elemental weight percent. A measurement below its detection limit should be indicated in this table by a less than sign (“<”) followed by the detection limit.

### 2.3.1 Composition Measurement by XRF

Measurements for the following elements of interest, including elements that are minor components and whose concentrations may be below detection, are to be acquired by VSL using XRF: aluminum (Al), barium (Ba), calcium (Ca), cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), copper (Cu), iron (Fe), potassium (K), lanthanum (La), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), lead (Pb), sulfur (S), silicon (Si), thorium (Th), titanium (Ti), uranium (U), zinc (Zn), and zirconium (Zr) concentrations. Once again, it should be noted that some of the elements listed above are minor components of the study glasses and may be below the detection limits of the analytical procedure. It should also be noted that this is a complete list of elements of interest for this glass study with the exception of boron (B) and lithium (Li); the measurement of these elements is addressed in the next section.

Blocking and randomizing the glass samples of Table 2-2 that are to be submitted for XRF measurement are primary concerns in the development of the analytical plan. It is anticipated that the day-to-day

variations of the XRF instrumentation may be a minor source of uncertainty for the analytical procedures used to determine the elemental concentrations for the submitted glass samples. However, to provide the data necessary to confirm this, the duplicate samples of each of the study glasses are to be analyzed by XRF on one day and then the pair of samples is to be analyzed on a subsequent day. A randomized plan that incorporates this approach in measuring the elemental concentrations of the glass samples prepared for XRF analysis is provided in Table 2-4. A PANalytical Axios mAX-Advanced or other equivalent wavelength dispersive XRF spectrometer is to be used for this purpose. The spectrometer is calibrated over a range of glass compositions using standard reference materials traceable to the National Institute of Standards and Technology (NIST), as well as waste glasses including the Argonne National Laboratory – Low Activity Reference Material (ANL-LRM), the Defense Waste Processing Facility – Environmental Assessment (DWPF-EA) glass, and Waste Treatment Plant (WTP) High-Level Waste (HLW) and Low-Activity Waste (LAW) glasses. A single sample of a reference glass, that is to be selected by VSL to be a matrix-match for this study and that is to be labeled as “Std-xrf”, is to be submitted repeatedly for measurement along with the samples of the study glasses as indicated in Table 2-4. The “known” composition of this reference glass is to be provided to SRNL along with the measured compositions from Table 2-4. These compositions are to be provided to SRNL as weight percent (wt%) elemental concentrations.

The sample identifiers in Table 2-4 have been modified to provide a labeling scheme for the measurements that are to be generated by these XRF determinations. Specifically, a suffix has been added to the label for the sample of the standard glass, Std-xrf, to indicate the XRF block (i.e., a 1 through 7), the measurement set (i.e., 1 (first) or 2 (second)), and its position (i.e., 1, 2, or 3) in the set. Finally, a suffix has been added to the sample identifier for the study glasses that indicates the measurement set (i.e., a 1 or 2).

**Table 2-4. XRF Analytical Blocks and Sequencing along with the Measurement Identifiers**

<b>XRF Block 1 First Set of Measurements</b>	<b>XRF Block 1 Second Set of Measurements</b>	<b>XRF Block 2 First Set of Measurements</b>	<b>XRF Block 2 Second Set of Measurements</b>	<b>XRF Block 3 First Set of Measurements</b>	<b>XRF Block 3 Second Set of Measurements</b>
Std-xrf-111	Std-xrf-121	Std-xrf-211	Std-xrf-221	Std-xrf-311	Std-xrf-321
GAP-22xrf-11	GAP-37xrf-12	GAP-10xrf-11	GAP-10xrf-22	GAP-29xrf-11	GAP-41xrf-12
GAP-38xrf-11	GAP-43xrf-22	GAP-12xrf-11	GAP-47xrf-22	GAP-20xrf-11	GAP-29xrf-22
GAP-31xrf-11	GAP-22xrf-22	GAP-34xrf-21	GAP-14xrf-12	GAP-29xrf-21	GAP-35xrf-22
GAP-33xrf-11	GAP-43xrf-12	GAP-44xrf-21	GAP-12xrf-22	GAP-05xrf-11	GAP-26xrf-22
GAP-15xrf-21	GAP-37xrf-22	GAP-34xrf-11	GAP-47xrf-12	GAP-20xrf-21	GAP-05xrf-22
GAP-38xrf-21	GAP-33xrf-12	GAP-14xrf-11	GAP-19xrf-22	GAP-26xrf-21	GAP-20xrf-12
GAP-37xrf-11	GAP-15xrf-12	GAP-47xrf-11	GAP-44xrf-12	GAP-26xrf-11	GAP-29xrf-12
GAP-15xrf-11	GAP-38xrf-12	Std-xrf-212	Std-xrf-222	Std-xrf-312	Std-xrf-322
Std-xrf-112	Std-xrf-122	GAP-47xrf-21	GAP-34xrf-12	GAP-35xrf-11	GAP-35xrf-12
GAP-43xrf-11	GAP-31xrf-22	GAP-44xrf-11	GAP-19xrf-12	GAP-41xrf-21	GAP-46xrf-22
GAP-33xrf-21	GAP-15xrf-22	GAP-14xrf-21	GAP-12xrf-12	GAP-05xrf-21	GAP-20xrf-22
GAP-37xrf-21	GAP-22xrf-12	GAP-10xrf-21	GAP-10xrf-12	GAP-46xrf-11	GAP-46xrf-12
GAP-21xrf-11	GAP-21xrf-22	GAP-19xrf-21	GAP-34xrf-22	GAP-41xrf-11	GAP-41xrf-22
GAP-31xrf-21	GAP-33xrf-22	GAP-19xrf-11	GAP-44xrf-22	GAP-46xrf-21	GAP-26xrf-12
GAP-22xrf-21	GAP-38xrf-22	GAP-12xrf-21	GAP-14xrf-22	GAP-35xrf-21	GAP-05xrf-12
GAP-21xrf-21	GAP-21xrf-12	Std-xrf-213	Std-xrf-223	Std-xrf-313	Std-xrf-323
GAP-43xrf-21	GAP-31xrf-12				
Std-xrf-113	Std-xrf-123				

**Table 2-4. XRF Analytical Blocks and Sequencing along with the Measurement Identifiers**  
(continued)

<b>XRF Block 4 First Set of Measurements</b>	<b>XRF Block 4 Second Set of Measurements</b>	<b>XRF Block 5 First Set of Measurements</b>	<b>XRF Block 5 Second Set of Measurements</b>	<b>XRF Block 6 First Set of Measurements</b>	<b>XRF Block 6 Second Set of Measurements</b>
Std-xrf-411	Std-xrf-421	Std-xrf-511	Std-xrf-521	Std-xrf-611	Std-xrf-621
GAP-24xrf-11	GAP-17xrf-12	GAP-36xrf-21	GAP-30xrf-22	GAP-13xrf-11	GAP-49xrf-22
GAP-06xrf-11	GAP-23xrf-22	GAP-30xrf-11	GAP-16xrf-22	GAP-48xrf-21	GAP-28xrf-12
GAP-32xrf-11	GAP-17xrf-22	GAP-11xrf-21	GAP-09xrf-22	GAP-13xrf-21	GAP-07xrf-22
GAP-23xrf-21	GAP-24xrf-12	GAP-03xrf-21	GAP-11xrf-22	GAP-27xrf-11	GAP-13xrf-22
GAP-17xrf-21	GAP-42xrf-22	GAP-36xrf-11	GAP-11xrf-12	GAP-07xrf-11	GAP-04xrf-12
GAP-50xrf-11	GAP-06xrf-12	GAP-09xrf-21	GAP-36xrf-22	GAP-04xrf-21	GAP-27xrf-12
GAP-24xrf-21	GAP-50xrf-12	GAP-40xrf-11	GAP-40xrf-22	GAP-27xrf-21	GAP-28xrf-22
Std-xrf-412	Std-xrf-422	Std-xrf-512	Std-xrf-522	Std-xrf-612	Std-xrf-622
GAP-06xrf-21	GAP-32xrf-22	GAP-11xrf-11	GAP-30xrf-12	GAP-04xrf-11	GAP-07xrf-12
GAP-17xrf-11	GAP-24xrf-22	GAP-16xrf-11	GAP-09xrf-12	GAP-48xrf-11	GAP-48xrf-12
GAP-32xrf-21	GAP-42xrf-12	GAP-03xrf-11	GAP-36xrf-12	GAP-28xrf-21	GAP-27xrf-22
GAP-42xrf-11	GAP-06xrf-22	GAP-09xrf-11	GAP-03xrf-12	GAP-28xrf-11	GAP-04xrf-22
GAP-42xrf-21	GAP-23xrf-12	GAP-16xrf-21	GAP-03xrf-22	GAP-07xrf-21	GAP-48xrf-22
GAP-23xrf-11	GAP-50xrf-22	GAP-40xrf-21	GAP-16xrf-12	GAP-49xrf-11	GAP-13xrf-12
GAP-50xrf-21	GAP-32xrf-12	GAP-30xrf-21	GAP-40xrf-12	GAP-49xrf-21	GAP-49xrf-12
Std-xrf-413	Std-xrf-423	Std-xrf-513	Std-xrf-523	Std-xrf-613	Std-xrf-623
<b>XRF Block 7 First Set of Measurements</b>	<b>XRF Block 7 Second Set of Measurements</b>				
Std-xrf-711	Std-xrf-721				
GAP-01xrf-21	GAP-02xrf-22				
GAP-39xrf-21	GAP-18xrf-12				
GAP-08xrf-21	GAP-25xrf-12				
GAP-01xrf-11	GAP-45xrf-12				
GAP-39xrf-11	GAP-25xrf-22				
GAP-45xrf-21	GAP-18xrf-22				
GAP-02xrf-11	GAP-02xrf-12				
Std-xrf-712	Std-xrf-722				
GAP-18xrf-21	GAP-39xrf-22				
GAP-45xrf-11	GAP-45xrf-22				
GAP-25xrf-11	GAP-08xrf-22				
GAP-02xrf-21	GAP-08xrf-12				
GAP-25xrf-21	GAP-01xrf-12				
GAP-18xrf-11	GAP-39xrf-12				
GAP-08xrf-11	GAP-01xrf-22				
Std-xrf-713	Std-xrf-723				

### 2.3.2 Composition Measurement by DCP

The samples prepared for chemical analysis by DCP are to be measured for their boron and lithium content. Each of the duplicate preparations of each study glass is to be measured twice by DCP, with a re-calibration of the instrument being performed between the two measurements. The groupings and sequencing of these samples are provided in Table 2-5. To repeat, each column of this table indicates a different calibration of the DCP instrumentation. In addition, the order of the samples in a column is the sequence in which the samples should be measured by DCP. Also, note the addition of aliquots of the prepared samples of the reference glass, Std-dcp, to these DCP analytical blocks. The “known” composition of this reference glass (anticipated to be the same standard as used for the XRF analyses) is

to be provided to SRNL along with the measured compositions from Table 2-5. These compositions are to be provided as weight percent (wt%) elemental concentrations.

The sample identifiers in Table 2-5 have been modified to provide a labeling scheme for the measurements that are to be generated by these DCP determinations. Specifically, a suffix has been added to the label for the standard, Std-dcp, to indicate the DCP block (i.e., 1 through 7) and the calibration set (i.e., 1 (first) or 2 (second)). Finally, a suffix has been added to the sample identifier that indicates the calibration set (i.e., a 1 or 2).

**Table 2-5. DCP Analytical Blocks and Sequencing along with the Measurement Identifiers**

DCP Block 1 First Calibration	DCP Block 1 Second Calibration	DCP Block 2 First Calibration	DCP Block 2 Second Calibration	DCP Block 3 First Calibration	DCP Block 3 Second Calibration
Std-dcp-111	Std-dcp-121	Std-dcp-211	Std-dcp-221	Std-dcp-311	Std-dcp-321
GAP-21dcp-11	GAP-38dcp-22	GAP-44dcp-11	GAP-44dcp-12	GAP-35dcp-11	GAP-34dcp-22
GAP-33dcp-11	GAP-22dcp-12	GAP-10dcp-21	GAP-12dcp-12	GAP-34dcp-21	GAP-16dcp-12
GAP-37dcp-11	GAP-43dcp-12	GAP-47dcp-21	GAP-47dcp-12	GAP-16dcp-11	GAP-06dcp-22
GAP-21dcp-21	GAP-21dcp-22	GAP-12dcp-21	GAP-19dcp-22	GAP-46dcp-21	GAP-26dcp-22
GAP-43dcp-11	GAP-15dcp-12	GAP-14dcp-11	GAP-14dcp-22	GAP-06dcp-11	GAP-46dcp-22
GAP-15dcp-11	GAP-31dcp-22	GAP-19dcp-11	GAP-05dcp-22	GAP-34dcp-11	GAP-06dcp-12
GAP-22dcp-21	GAP-15dcp-22	GAP-10dcp-11	GAP-19dcp-12	GAP-16dcp-21	GAP-26dcp-12
GAP-31dcp-21	GAP-22dcp-22	Std-dcp-212	Std-dcp-222	Std-dcp-312	Std-dcp-322
Std-dcp-112	Std-dcp-122	GAP-47dcp-11	GAP-10dcp-22	GAP-46dcp-11	GAP-16dcp-22
GAP-33dcp-21	GAP-31dcp-12	GAP-19dcp-21	GAP-05dcp-12	GAP-26dcp-11	GAP-35dcp-12
GAP-43dcp-21	GAP-33dcp-12	GAP-05dcp-21	GAP-12dcp-22	GAP-29dcp-11	GAP-29dcp-12
GAP-22dcp-11	GAP-38dcp-12	GAP-05dcp-11	GAP-14dcp-12	GAP-06dcp-21	GAP-29dcp-22
GAP-31dcp-11	GAP-21dcp-12	GAP-14dcp-21	GAP-44dcp-22	GAP-29dcp-21	GAP-35dcp-22
GAP-38dcp-11	GAP-33dcp-22	GAP-12dcp-11	GAP-47dcp-22	GAP-26dcp-21	GAP-34dcp-12
GAP-37dcp-21	GAP-37dcp-22	GAP-44dcp-21	GAP-10dcp-12	GAP-35dcp-21	GAP-46dcp-12
GAP-38dcp-21	GAP-37dcp-12	Std-dcp-213	Std-dcp-223	Std-dcp-313	Std-dcp-323
GAP-15dcp-21	GAP-43dcp-22				
Std-dcp-113	Std-dcp-123				

**Table 2-5. DCP Analytical Blocks and Sequencing along with the Measurement Identifiers**  
(continued)

DCP Block 4 First Calibration	DCP Block 4 Second Calibration	DCP Block 5 First Calibration	DCP Block 5 Second Calibration	DCP Block 6 First Calibration	DCP Block 6 Second Calibration
Std-dcp-411	Std-dcp-421	Std-dcp-511	Std-dcp-521	Std-dcp-611	Std-dcp-621
GAP-17dcp-21	GAP-17dcp-22	GAP-11dcp-11	GAP-03dcp-22	GAP-48dcp-21	GAP-04dcp-22
GAP-41dcp-11	GAP-32dcp-22	GAP-03dcp-11	GAP-50dcp-22	GAP-49dcp-11	GAP-02dcp-22
GAP-24dcp-21	GAP-20dcp-22	GAP-13dcp-11	GAP-13dcp-22	GAP-48dcp-11	GAP-48dcp-22
GAP-20dcp-11	GAP-23dcp-12	GAP-30dcp-11	GAP-09dcp-12	GAP-04dcp-21	GAP-49dcp-12
GAP-17dcp-11	GAP-17dcp-12	GAP-13dcp-21	GAP-07dcp-12	GAP-36dcp-11	GAP-49dcp-22
GAP-42dcp-21	GAP-42dcp-22	GAP-11dcp-21	GAP-07dcp-22	GAP-01dcp-11	GAP-02dcp-12
GAP-23dcp-11	GAP-32dcp-12	GAP-07dcp-11	GAP-11dcp-22	GAP-02dcp-21	GAP-36dcp-12
Std-dcp-412	Std-dcp-422	Std-dcp-512	Std-dcp-522	Std-dcp-612	Std-dcp-622
GAP-20dcp-21	GAP-42dcp-12	GAP-30dcp-21	GAP-11dcp-12	GAP-40dcp-11	GAP-40dcp-22
GAP-32dcp-11	GAP-24dcp-22	GAP-09dcp-11	GAP-09dcp-22	GAP-40dcp-21	GAP-04dcp-12
GAP-23dcp-21	GAP-20dcp-12	GAP-09dcp-21	GAP-03dcp-12	GAP-04dcp-11	GAP-40dcp-12
GAP-24dcp-11	GAP-41dcp-22	GAP-50dcp-21	GAP-30dcp-22	GAP-49dcp-21	GAP-36dcp-22
GAP-42dcp-11	GAP-23dcp-22	GAP-07dcp-21	GAP-50dcp-12	GAP-36dcp-21	GAP-01dcp-12
GAP-32dcp-21	GAP-24dcp-12	GAP-50dcp-11	GAP-30dcp-12	GAP-01dcp-21	GAP-01dcp-22
GAP-41dcp-21	GAP-41dcp-12	GAP-03dcp-21	GAP-13dcp-12	GAP-02dcp-11	GAP-48dcp-12
Std-dcp-413	Std-dcp-423	Std-dcp-513	Std-dcp-523	Std-dcp-613	Std-dcp-623
DCP Block 7 First Calibration	DCP Block 7 Second Calibration				
Std-dcp-711	Std-dcp-721				
GAP-08dcp-21	GAP-25dcp-22				
GAP-39dcp-11	GAP-45dcp-12				
GAP-27dcp-11	GAP-28dcp-22				
GAP-28dcp-21	GAP-08dcp-12				
GAP-39dcp-21	GAP-45dcp-22				
GAP-45dcp-11	GAP-27dcp-22				
GAP-18dcp-11	GAP-39dcp-12				
Std-dcp-712	Std-dcp-722				
GAP-08dcp-11	GAP-27dcp-12				
GAP-25dcp-11	GAP-08dcp-22				
GAP-18dcp-21	GAP-18dcp-22				
GAP-25dcp-21	GAP-25dcp-12				
GAP-45dcp-21	GAP-39dcp-22				
GAP-28dcp-11	GAP-18dcp-12				
GAP-27dcp-21	GAP-28dcp-12				
Std-dcp-713	Std-dcp-723				

Appendix A repeats the critical portions and tables supporting the laboratory's activities associated with the chemical composition analysis and reporting. The appendix is intended to provide a "detachable" work plan that may be provided to laboratory technicians.

### 3.0 Analytical Plan for the Measurement of PCT Solutions

A primary property of interest for the glasses of this study is durability as determined by the PCT, which is defined in ASTM C-1285 (latest revision). As stated above, the study glasses are to be subjected to two heat treatments. During their initial fabrication, the glasses are to be quenched. In a subsequent step, they are to be heat treated to simulate cooling along the centerline of a DWPF-type canister. This cooling



schedule is referred to as the centerline canister cooling (ccc) curve. Both heat treatments of each study glass will be subjected to the PCT. Comparisons between the durabilities of the resulting glasses will provide insight into the effects of thermal history on the product performance for these glasses.

Due to the large number of PCTs that are to be performed as part of this study, several oven runs are to be conducted with the grouping of study glasses in each of these runs detailed in this section. In addition to the study glasses, each oven run is to include triplicate PCTs of the Approved Reference Material – One (ARM-1) glass and triplicate PCTs of the EA glass. Two reagent blank samples are also to be included in each oven run. Each oven run is to contain 32 vessels with 8 vessels being needed for the standard and blank solutions. That leaves 24 vessels to support the study glasses in each oven run. With 6 vessels needed for a given study glass (3 for the quenched version and 3 for the ccc version), 4 study glasses can be included in each oven run. Thus, 13 oven runs are to be conducted to cover all of the PCTs needed to support this study. The activities involved in the completion of each oven run include labeling and grouping of the PCT solutions and of the solutions of the standards. These solutions are then to be grouped and ordered for analysis by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP) or DCP. While the primary interest of these analyses is the measured concentrations of boron (B), lithium (Li), sodium (Na), and silicon (Si), the measurements of other elements (e.g., aluminum, iron, thorium, uranium, etc.) may also be recorded by VSL in order to provide a more complete set of results for these analyses. The results are to be reported to SRNL in parts per million (ppm). A measurement below its detection limit should be indicated in this table by a less than sign (“<”) followed by the detection limit.

### 3.1 Grouping of Glasses for Oven Runs

Table 3-1 presents the identifying codes, GAP-pct-001 through GAP-pct-404, that are to be used to label the individual solutions for each of the 13 oven runs that are required to complete these PCTs. Labels are provided for the solutions of the study glasses and of the standards (EA, ARM-1, and blanks). These codes provide a naming convention that is to be established by the VSL technicians conducting the PCT oven runs and then used by the laboratory technicians conducting the ICP or DCP analyses.

**Table 3-1. Groupings of Glasses for Oven Runs and the Labeling of the Corresponding PCT Solutions**

Oven Run 1 of 13		Oven Run 2 of 13		Oven Run 3 of 13		Oven Run 4 of 13		Oven Run 5 of 13	
Glass ID	Solution ID	Glass ID	Solution ID	Glass ID	Solution ID	Glass ID	Solution ID	Glass ID	Solution ID
ARM-1	GAP-pct-224	ARM-1	GAP-pct-131	ARM-1	GAP-pct-245	ARM-1	GAP-pct-086	ARM-1	GAP-pct-310
ARM-1	GAP-pct-283	ARM-1	GAP-pct-173	ARM-1	GAP-pct-132	ARM-1	GAP-pct-014	ARM-1	GAP-pct-402
ARM-1	GAP-pct-157	ARM-1	GAP-pct-019	ARM-1	GAP-pct-336	ARM-1	GAP-pct-108	ARM-1	GAP-pct-400
blank	GAP-pct-346	blank	GAP-pct-081	blank	GAP-pct-136	blank	GAP-pct-167	blank	GAP-pct-279
blank	GAP-pct-341	blank	GAP-pct-104	blank	GAP-pct-111	blank	GAP-pct-373	blank	GAP-pct-385
EA	GAP-pct-212	EA	GAP-pct-078	EA	GAP-pct-350	EA	GAP-pct-142	EA	GAP-pct-067
EA	GAP-pct-394	EA	GAP-pct-277	EA	GAP-pct-091	EA	GAP-pct-208	EA	GAP-pct-389
EA	GAP-pct-322	EA	GAP-pct-187	EA	GAP-pct-367	EA	GAP-pct-337	EA	GAP-pct-345
GAP-15	GAP-pct-015	GAP-21	GAP-pct-376	GAP-10	GAP-pct-316	GAP-12	GAP-pct-253	GAP-05	GAP-pct-239
GAP-15	GAP-pct-085	GAP-21	GAP-pct-010	GAP-10	GAP-pct-330	GAP-12	GAP-pct-140	GAP-05	GAP-pct-053
GAP-15	GAP-pct-116	GAP-21	GAP-pct-342	GAP-10	GAP-pct-334	GAP-12	GAP-pct-160	GAP-05	GAP-pct-403
GAP-15ccc	GAP-pct-112	GAP-21ccc	GAP-pct-287	GAP-10ccc	GAP-pct-105	GAP-12ccc	GAP-pct-134	GAP-05ccc	GAP-pct-387
GAP-15ccc	GAP-pct-180	GAP-21ccc	GAP-pct-381	GAP-10ccc	GAP-pct-114	GAP-12ccc	GAP-pct-051	GAP-05ccc	GAP-pct-166
GAP-15ccc	GAP-pct-327	GAP-21ccc	GAP-pct-251	GAP-10ccc	GAP-pct-365	GAP-12ccc	GAP-pct-198	GAP-05ccc	GAP-pct-288
GAP-22	GAP-pct-320	GAP-33	GAP-pct-197	GAP-34	GAP-pct-121	GAP-14	GAP-pct-029	GAP-29	GAP-pct-269
GAP-22	GAP-pct-315	GAP-33	GAP-pct-314	GAP-34	GAP-pct-098	GAP-14	GAP-pct-150	GAP-29	GAP-pct-030
GAP-22	GAP-pct-404	GAP-33	GAP-pct-307	GAP-34	GAP-pct-351	GAP-14	GAP-pct-007	GAP-29	GAP-pct-196
GAP-22ccc	GAP-pct-380	GAP-33ccc	GAP-pct-263	GAP-34ccc	GAP-pct-324	GAP-14ccc	GAP-pct-335	GAP-29ccc	GAP-pct-280
GAP-22ccc	GAP-pct-384	GAP-33ccc	GAP-pct-398	GAP-34ccc	GAP-pct-255	GAP-14ccc	GAP-pct-340	GAP-29ccc	GAP-pct-244
GAP-22ccc	GAP-pct-182	GAP-33ccc	GAP-pct-147	GAP-34ccc	GAP-pct-278	GAP-14ccc	GAP-pct-032	GAP-29ccc	GAP-pct-250
GAP-31	GAP-pct-073	GAP-37	GAP-pct-017	GAP-44	GAP-pct-297	GAP-19	GAP-pct-002	GAP-35	GAP-pct-082
GAP-31	GAP-pct-201	GAP-37	GAP-pct-199	GAP-44	GAP-pct-294	GAP-19	GAP-pct-052	GAP-35	GAP-pct-006
GAP-31	GAP-pct-353	GAP-37	GAP-pct-046	GAP-44	GAP-pct-213	GAP-19	GAP-pct-155	GAP-35	GAP-pct-055
GAP-31ccc	GAP-pct-285	GAP-37ccc	GAP-pct-379	GAP-44ccc	GAP-pct-308	GAP-19ccc	GAP-pct-071	GAP-35ccc	GAP-pct-127
GAP-31ccc	GAP-pct-011	GAP-37ccc	GAP-pct-188	GAP-44ccc	GAP-pct-184	GAP-19ccc	GAP-pct-370	GAP-35ccc	GAP-pct-237
GAP-31ccc	GAP-pct-090	GAP-37ccc	GAP-pct-281	GAP-44ccc	GAP-pct-185	GAP-19ccc	GAP-pct-189	GAP-35ccc	GAP-pct-065
GAP-43	GAP-pct-080	GAP-38	GAP-pct-252	GAP-47	GAP-pct-206	GAP-26	GAP-pct-130	GAP-46	GAP-pct-371
GAP-43	GAP-pct-054	GAP-38	GAP-pct-317	GAP-47	GAP-pct-227	GAP-26	GAP-pct-079	GAP-46	GAP-pct-107
GAP-43	GAP-pct-088	GAP-38	GAP-pct-356	GAP-47	GAP-pct-325	GAP-26	GAP-pct-043	GAP-46	GAP-pct-170
GAP-43ccc	GAP-pct-289	GAP-38ccc	GAP-pct-396	GAP-47ccc	GAP-pct-191	GAP-26ccc	GAP-pct-042	GAP-46ccc	GAP-pct-141
GAP-43ccc	GAP-pct-203	GAP-38ccc	GAP-pct-205	GAP-47ccc	GAP-pct-068	GAP-26ccc	GAP-pct-139	GAP-46ccc	GAP-pct-084
GAP-43ccc	GAP-pct-072	GAP-38ccc	GAP-pct-119	GAP-47ccc	GAP-pct-303	GAP-26ccc	GAP-pct-168	GAP-46ccc	GAP-pct-033

**Table 3-1. Groupings of Glasses for Oven Runs and the Labeling of the Corresponding PCT Solutions** *(continued)*

Oven Run 6 of 13		Oven Run 7 of 13		Oven Run 8 of 13		Oven Run 9 of 13		Oven Run 10 of 13	
Glass ID	Solution ID	Glass ID	Solution ID	Glass ID	Solution ID	Glass ID	Solution ID	Glass ID	Solution ID
ARM-1	GAP-pct-056	ARM-1	GAP-pct-122	ARM-1	GAP-pct-220	ARM-1	GAP-pct-223	ARM-1	GAP-pct-186
ARM-1	GAP-pct-329	ARM-1	GAP-pct-101	ARM-1	GAP-pct-305	ARM-1	GAP-pct-344	ARM-1	GAP-pct-075
ARM-1	GAP-pct-243	ARM-1	GAP-pct-162	ARM-1	GAP-pct-286	ARM-1	GAP-pct-236	ARM-1	GAP-pct-343
blank	GAP-pct-137	blank	GAP-pct-352	blank	GAP-pct-233	blank	GAP-pct-226	blank	GAP-pct-200
blank	GAP-pct-240	blank	GAP-pct-102	blank	GAP-pct-338	blank	GAP-pct-217	blank	GAP-pct-357
EA	GAP-pct-306	EA	GAP-pct-045	EA	GAP-pct-273	EA	GAP-pct-265	EA	GAP-pct-192
EA	GAP-pct-175	EA	GAP-pct-262	EA	GAP-pct-094	EA	GAP-pct-298	EA	GAP-pct-005
EA	GAP-pct-038	EA	GAP-pct-248	EA	GAP-pct-151	EA	GAP-pct-047	EA	GAP-pct-035
GAP-20	GAP-pct-282	GAP-06	GAP-pct-207	GAP-09	GAP-pct-215	GAP-03	GAP-pct-378	GAP-07	GAP-pct-290
GAP-20	GAP-pct-034	GAP-06	GAP-pct-313	GAP-09	GAP-pct-222	GAP-03	GAP-pct-399	GAP-07	GAP-pct-076
GAP-20	GAP-pct-156	GAP-06	GAP-pct-190	GAP-09	GAP-pct-110	GAP-03	GAP-pct-267	GAP-07	GAP-pct-218
GAP-20ccc	GAP-pct-339	GAP-06ccc	GAP-pct-115	GAP-09ccc	GAP-pct-296	GAP-03ccc	GAP-pct-368	GAP-07ccc	GAP-pct-361
GAP-20ccc	GAP-pct-257	GAP-06ccc	GAP-pct-209	GAP-09ccc	GAP-pct-354	GAP-03ccc	GAP-pct-177	GAP-07ccc	GAP-pct-089
GAP-20ccc	GAP-pct-284	GAP-06ccc	GAP-pct-319	GAP-09ccc	GAP-pct-063	GAP-03ccc	GAP-pct-024	GAP-07ccc	GAP-pct-064
GAP-23	GAP-pct-249	GAP-17	GAP-pct-390	GAP-16	GAP-pct-074	GAP-11	GAP-pct-153	GAP-13	GAP-pct-230
GAP-23	GAP-pct-087	GAP-17	GAP-pct-028	GAP-16	GAP-pct-214	GAP-11	GAP-pct-401	GAP-13	GAP-pct-020
GAP-23	GAP-pct-093	GAP-17	GAP-pct-397	GAP-16	GAP-pct-120	GAP-11	GAP-pct-118	GAP-13	GAP-pct-219
GAP-23ccc	GAP-pct-235	GAP-17ccc	GAP-pct-128	GAP-16ccc	GAP-pct-194	GAP-11ccc	GAP-pct-247	GAP-13ccc	GAP-pct-095
GAP-23ccc	GAP-pct-161	GAP-17ccc	GAP-pct-270	GAP-16ccc	GAP-pct-008	GAP-11ccc	GAP-pct-138	GAP-13ccc	GAP-pct-364
GAP-23ccc	GAP-pct-292	GAP-17ccc	GAP-pct-332	GAP-16ccc	GAP-pct-302	GAP-11ccc	GAP-pct-388	GAP-13ccc	GAP-pct-391
GAP-41	GAP-pct-301	GAP-24	GAP-pct-254	GAP-30	GAP-pct-123	GAP-36	GAP-pct-221	GAP-48	GAP-pct-234
GAP-41	GAP-pct-183	GAP-24	GAP-pct-044	GAP-30	GAP-pct-092	GAP-36	GAP-pct-293	GAP-48	GAP-pct-096
GAP-41	GAP-pct-077	GAP-24	GAP-pct-375	GAP-30	GAP-pct-366	GAP-36	GAP-pct-264	GAP-48	GAP-pct-229
GAP-41ccc	GAP-pct-165	GAP-24ccc	GAP-pct-261	GAP-30ccc	GAP-pct-133	GAP-36ccc	GAP-pct-377	GAP-48ccc	GAP-pct-274
GAP-41ccc	GAP-pct-025	GAP-24ccc	GAP-pct-179	GAP-30ccc	GAP-pct-144	GAP-36ccc	GAP-pct-003	GAP-48ccc	GAP-pct-021
GAP-41ccc	GAP-pct-382	GAP-24ccc	GAP-pct-242	GAP-30ccc	GAP-pct-372	GAP-36ccc	GAP-pct-210	GAP-48ccc	GAP-pct-311
GAP-42	GAP-pct-268	GAP-50	GAP-pct-266	GAP-32	GAP-pct-152	GAP-40	GAP-pct-083	GAP-49	GAP-pct-323
GAP-42	GAP-pct-158	GAP-50	GAP-pct-358	GAP-32	GAP-pct-149	GAP-40	GAP-pct-145	GAP-49	GAP-pct-309
GAP-42	GAP-pct-026	GAP-50	GAP-pct-369	GAP-32	GAP-pct-295	GAP-40	GAP-pct-069	GAP-49	GAP-pct-300
GAP-42ccc	GAP-pct-057	GAP-50ccc	GAP-pct-258	GAP-32ccc	GAP-pct-312	GAP-40ccc	GAP-pct-171	GAP-49ccc	GAP-pct-181
GAP-42ccc	GAP-pct-143	GAP-50ccc	GAP-pct-348	GAP-32ccc	GAP-pct-022	GAP-40ccc	GAP-pct-018	GAP-49ccc	GAP-pct-386
GAP-42ccc	GAP-pct-291	GAP-50ccc	GAP-pct-070	GAP-32ccc	GAP-pct-202	GAP-40ccc	GAP-pct-231	GAP-49ccc	GAP-pct-395

**Table 3-1. Groupings of Glasses for Oven Runs and the Labeling of the Corresponding PCT Solutions***(continued)*

Oven Run 11 of 13		Oven Run 12 of 13		Oven Run 13 of 13	
Glass ID	Solution ID	Glass ID	Solution ID	Glass ID	Solution ID
ARM-1	GAP-pct-066	ARM-1	GAP-pct-146	ARM-1	GAP-pct-275
ARM-1	GAP-pct-058	ARM-1	GAP-pct-174	ARM-1	GAP-pct-164
ARM-1	GAP-pct-050	ARM-1	GAP-pct-321	ARM-1	GAP-pct-039
blank	GAP-pct-041	blank	GAP-pct-178	blank	GAP-pct-163
blank	GAP-pct-113	blank	GAP-pct-393	blank	GAP-pct-001
EA	GAP-pct-326	EA	GAP-pct-023	EA	GAP-pct-172
EA	GAP-pct-027	EA	GAP-pct-062	EA	GAP-pct-299
EA	GAP-pct-260	EA	GAP-pct-276	EA	GAP-pct-271
GAP-01	GAP-pct-049	GAP-08	GAP-pct-246	GAP-02	GAP-pct-126
GAP-01	GAP-pct-154	GAP-08	GAP-pct-099	GAP-02	GAP-pct-012
GAP-01	GAP-pct-318	GAP-08	GAP-pct-383	GAP-02	GAP-pct-347
GAP-01ccc	GAP-pct-129	GAP-08ccc	GAP-pct-256	GAP-02ccc	GAP-pct-328
GAP-01ccc	GAP-pct-009	GAP-08ccc	GAP-pct-106	GAP-02ccc	GAP-pct-048
GAP-01ccc	GAP-pct-331	GAP-08ccc	GAP-pct-103	GAP-02ccc	GAP-pct-195
GAP-04	GAP-pct-159	GAP-39	GAP-pct-016	GAP-18	GAP-pct-169
GAP-04	GAP-pct-040	GAP-39	GAP-pct-349	GAP-18	GAP-pct-374
GAP-04	GAP-pct-004	GAP-39	GAP-pct-100	GAP-18	GAP-pct-117
GAP-04ccc	GAP-pct-355	GAP-39ccc	GAP-pct-125	GAP-18ccc	GAP-pct-037
GAP-04ccc	GAP-pct-216	GAP-39ccc	GAP-pct-211	GAP-18ccc	GAP-pct-360
GAP-04ccc	GAP-pct-228	GAP-39ccc	GAP-pct-148	GAP-18ccc	GAP-pct-363
GAP-27	GAP-pct-036	GAP-45	GAP-pct-059	GAP-25	GAP-pct-061
GAP-27	GAP-pct-109	GAP-45	GAP-pct-232	GAP-25	GAP-pct-362
GAP-27	GAP-pct-097	GAP-45	GAP-pct-135	GAP-25	GAP-pct-272
GAP-27ccc	GAP-pct-031	GAP-45ccc	GAP-pct-060	GAP-25ccc	GAP-pct-124
GAP-27ccc	GAP-pct-304	GAP-45ccc	GAP-pct-241	GAP-25ccc	GAP-pct-204
GAP-27ccc	GAP-pct-225	GAP-45ccc	GAP-pct-013	GAP-25ccc	GAP-pct-176
GAP-28	GAP-pct-238				
GAP-28	GAP-pct-259				
GAP-28	GAP-pct-333				
GAP-28ccc	GAP-pct-359				
GAP-28ccc	GAP-pct-392				
GAP-28ccc	GAP-pct-193				

### 3.2 Measurement of the PCT Solutions

A multi-element solution standard (denoted by “std-ij” where i = A, B, C, ..., U represents one of the twenty-one block letters and j = 1, 2, and 3 represents the position in the block) is to be added at the beginning, middle, and end of each of the nine ICP or DCP blocks by the VSL laboratory technicians. VSL is to provide SRNL the reference values in ppm for the elemental concentrations of the multi-element standard. The measurements of the standard may be useful in checking for bias in the concentration measurements arising from the ICP or DCP calibrations.

As the analyses are conducted by VSL, each sample group or block of Table 3-2 requires a different calibration of the ICP or DCP instrumentation. Each of the solution samples of Table 3-2 is to be analyzed only once for each of the elements of interest to VSL. However, the following elements are to be provided to SRNL for further evaluation: boron (B), lithium (Li), sodium (Na), and silicon (Si) concentrations. The measurements provided to SRNL are to be reported in ppm after accounting for all dilutions and other adjustments conducted during the measurement process.

**Table 3-2. ICP or DCP Calibration Blocks for the Leachate Measurements for the PCTs<sup>f</sup>**

PCT Solutions from Oven Runs 1 and 2			PCT Solutions from Oven Runs 3 and 4			PCT Solutions from Oven Runs 5 and 6		
Calibration Block A	Calibration Block B	Calibration Block C	Calibration Block D	Calibration Block E	Calibration Block F	Calibration Block G	Calibration Block H	Calibration Block I
std-A1	std-B1	std-C1	std-D1	std-E1	std-F1	std-G1	std-H1	std-I1
GAP-pct-201	GAP-pct-381	GAP-pct-197	GAP-pct-208	GAP-pct-336	GAP-pct-160	GAP-pct-279	GAP-pct-183	GAP-pct-165
GAP-pct-046	GAP-pct-317	GAP-pct-088	GAP-pct-086	GAP-pct-155	GAP-pct-198	GAP-pct-055	GAP-pct-084	GAP-pct-161
GAP-pct-080	GAP-pct-384	GAP-pct-104	GAP-pct-043	GAP-pct-111	GAP-pct-189	GAP-pct-235	GAP-pct-288	GAP-pct-339
GAP-pct-307	GAP-pct-116	GAP-pct-188	GAP-pct-297	GAP-pct-068	GAP-pct-029	GAP-pct-025	GAP-pct-243	GAP-pct-249
GAP-pct-398	GAP-pct-379	GAP-pct-187	GAP-pct-121	GAP-pct-098	GAP-pct-052	GAP-pct-127	GAP-pct-237	GAP-pct-034
GAP-pct-380	GAP-pct-199	GAP-pct-180	GAP-pct-340	GAP-pct-337	GAP-pct-213	GAP-pct-141	GAP-pct-371	GAP-pct-329
GAP-pct-287	GAP-pct-322	GAP-pct-119	GAP-pct-002	GAP-pct-253	GAP-pct-350	GAP-pct-239	GAP-pct-284	GAP-pct-065
GAP-pct-131	GAP-pct-078	GAP-pct-394	GAP-pct-365	GAP-pct-370	GAP-pct-334	GAP-pct-166	GAP-pct-282	GAP-pct-387
GAP-pct-320	GAP-pct-342	GAP-pct-263	GAP-pct-140	GAP-pct-108	GAP-pct-142	GAP-pct-269	GAP-pct-382	GAP-pct-077
GAP-pct-011	GAP-pct-090	GAP-pct-073	GAP-pct-150	GAP-pct-130	GAP-pct-042	GAP-pct-402	GAP-pct-268	GAP-pct-389
GAP-pct-085	GAP-pct-054	GAP-pct-224	GAP-pct-227	GAP-pct-294	GAP-pct-351	GAP-pct-175	GAP-pct-240	GAP-pct-038
std-A2	std-B2	std-C2	std-D2	std-E2	std-F2	std-G2	std-H2	std-I2
GAP-pct-341	GAP-pct-072	GAP-pct-376	GAP-pct-303	GAP-pct-032	GAP-pct-079	GAP-pct-280	GAP-pct-306	GAP-pct-403
GAP-pct-277	GAP-pct-353	GAP-pct-315	GAP-pct-367	GAP-pct-373	GAP-pct-206	GAP-pct-156	GAP-pct-030	GAP-pct-291
GAP-pct-289	GAP-pct-283	GAP-pct-285	GAP-pct-071	GAP-pct-324	GAP-pct-167	GAP-pct-301	GAP-pct-292	GAP-pct-137
GAP-pct-396	GAP-pct-081	GAP-pct-017	GAP-pct-316	GAP-pct-051	GAP-pct-335	GAP-pct-056	GAP-pct-057	GAP-pct-196
GAP-pct-010	GAP-pct-404	GAP-pct-015	GAP-pct-136	GAP-pct-325	GAP-pct-191	GAP-pct-093	GAP-pct-082	GAP-pct-006
GAP-pct-281	GAP-pct-173	GAP-pct-251	GAP-pct-168	GAP-pct-007	GAP-pct-014	GAP-pct-143	GAP-pct-087	GAP-pct-400
GAP-pct-356	GAP-pct-314	GAP-pct-019	GAP-pct-132	GAP-pct-114	GAP-pct-184	GAP-pct-257	GAP-pct-250	GAP-pct-033
GAP-pct-212	GAP-pct-205	GAP-pct-182	GAP-pct-278	GAP-pct-185	GAP-pct-105	GAP-pct-107	GAP-pct-310	GAP-pct-158
GAP-pct-157	GAP-pct-112	GAP-pct-252	GAP-pct-308	GAP-pct-139	GAP-pct-245	GAP-pct-345	GAP-pct-067	GAP-pct-170
GAP-pct-327	GAP-pct-346	GAP-pct-203	GAP-pct-134	GAP-pct-091	GAP-pct-255	GAP-pct-026	GAP-pct-053	GAP-pct-244
std-A3	GAP-pct-147	std-C3	std-D3	GAP-pct-330	std-F3	std-G3	GAP-pct-385	std-I3
	std-B3			std-E3			std-H3	

<sup>f</sup> Note that the PCT solutions from two oven runs are needed to support each set of 3 blocks: A-C, D-F, and G-I.

**Table 3-2. ICP or DCP Calibration Blocks for the Leachate Measurements for the PCTs<sup>f</sup>** *(continued)*

PCT Solutions from Oven Runs 7 and 8			PCT Solutions from Oven Runs 9 and 10			PCT Solutions from Oven Runs 11 and 12		
Calibration Block J	Calibration Block K	Calibration Block L	Calibration Block M	Calibration Block N	Calibration Block O	Calibration Block P	Calibration Block Q	Calibration Block R
std-J1	std-K1	std-L1	std-M1	std-N1	std-O1	std-P1	std-Q1	std-R1
GAP-pct-162	GAP-pct-179	GAP-pct-248	GAP-pct-177	GAP-pct-223	GAP-pct-293	GAP-pct-216	GAP-pct-148	GAP-pct-106
GAP-pct-273	GAP-pct-233	GAP-pct-094	GAP-pct-264	GAP-pct-021	GAP-pct-267	GAP-pct-041	GAP-pct-393	GAP-pct-027
GAP-pct-366	GAP-pct-266	GAP-pct-220	GAP-pct-300	GAP-pct-391	GAP-pct-386	GAP-pct-326	GAP-pct-304	GAP-pct-062
GAP-pct-270	GAP-pct-151	GAP-pct-348	GAP-pct-003	GAP-pct-069	GAP-pct-095	GAP-pct-333	GAP-pct-100	GAP-pct-225
GAP-pct-372	GAP-pct-209	GAP-pct-332	GAP-pct-236	GAP-pct-265	GAP-pct-368	GAP-pct-109	GAP-pct-113	GAP-pct-040
GAP-pct-286	GAP-pct-144	GAP-pct-194	GAP-pct-401	GAP-pct-309	GAP-pct-247	GAP-pct-211	GAP-pct-392	GAP-pct-318
GAP-pct-115	GAP-pct-092	GAP-pct-390	GAP-pct-361	GAP-pct-089	GAP-pct-343	GAP-pct-331	GAP-pct-023	GAP-pct-238
GAP-pct-028	GAP-pct-397	GAP-pct-312	GAP-pct-290	GAP-pct-221	GAP-pct-076	GAP-pct-349	GAP-pct-256	GAP-pct-246
GAP-pct-358	GAP-pct-101	GAP-pct-133	GAP-pct-388	GAP-pct-020	GAP-pct-344	GAP-pct-276	GAP-pct-009	GAP-pct-321
GAP-pct-242	GAP-pct-295	GAP-pct-319	GAP-pct-096	GAP-pct-229	GAP-pct-323	GAP-pct-099	GAP-pct-060	GAP-pct-036
GAP-pct-070	GAP-pct-352	GAP-pct-207	GAP-pct-145	GAP-pct-377	GAP-pct-234	GAP-pct-066	GAP-pct-260	GAP-pct-355
std-J2	std-K2	std-L2	std-M2	std-N2	std-O2	std-P2	std-Q2	std-R2
GAP-pct-375	GAP-pct-074	GAP-pct-149	GAP-pct-219	GAP-pct-138	GAP-pct-210	GAP-pct-031	GAP-pct-232	GAP-pct-193
GAP-pct-022	GAP-pct-302	GAP-pct-261	GAP-pct-364	GAP-pct-357	GAP-pct-298	GAP-pct-103	GAP-pct-049	GAP-pct-129
GAP-pct-313	GAP-pct-044	GAP-pct-214	GAP-pct-075	GAP-pct-217	GAP-pct-083	GAP-pct-154	GAP-pct-097	GAP-pct-013
GAP-pct-222	GAP-pct-262	GAP-pct-063	GAP-pct-226	GAP-pct-024	GAP-pct-200	GAP-pct-359	GAP-pct-050	GAP-pct-178
GAP-pct-008	GAP-pct-190	GAP-pct-215	GAP-pct-018	GAP-pct-181	GAP-pct-171	GAP-pct-004	GAP-pct-146	GAP-pct-125
GAP-pct-102	GAP-pct-202	GAP-pct-369	GAP-pct-378	GAP-pct-118	GAP-pct-230	GAP-pct-174	GAP-pct-228	GAP-pct-058
GAP-pct-120	GAP-pct-354	GAP-pct-122	GAP-pct-395	GAP-pct-231	GAP-pct-064	GAP-pct-059	GAP-pct-159	GAP-pct-016
GAP-pct-045	GAP-pct-110	GAP-pct-123	GAP-pct-047	GAP-pct-005	GAP-pct-035	GAP-pct-241	GAP-pct-383	GAP-pct-135
GAP-pct-296	GAP-pct-258	GAP-pct-254	GAP-pct-192	GAP-pct-399	GAP-pct-274	std-P3	GAP-pct-259	std-R3
GAP-pct-152	GAP-pct-305	GAP-pct-338	GAP-pct-311	GAP-pct-218	GAP-pct-153		std-Q3	
std-J3	GAP-pct-128	std-L3	std-M3	GAP-pct-186	std-O3			
	std-K3			std-N3				

<sup>f</sup> Note that the PCT solutions from two oven runs are needed to support each set of 3 blocks: J-L, M-O, and P-R.

**Table 3-2. ICP or DCP Calibration Blocks for the Leachate Measurements for the PCTs<sup>f</sup>** *(continued)*

PCT Solutions from Oven Run 13		
Calibration Block S	Calibration Block T	Calibration Block U
std-S1	std-T1	std-U1
GAP-pct-117	GAP-pct-275	GAP-pct-195
GAP-pct-176	GAP-pct-360	GAP-pct-169
GAP-pct-328	GAP-pct-048	GAP-pct-172
GAP-pct-362	GAP-pct-124	GAP-pct-163
GAP-pct-164	GAP-pct-126	GAP-pct-012
std-S2	std-T2	std-U2
GAP-pct-363	GAP-pct-299	GAP-pct-039
GAP-pct-001	GAP-pct-374	GAP-pct-061
GAP-pct-271	GAP-pct-272	GAP-pct-037
GAP-pct-347	std-T3	GAP-pct-204
std-S3		std-U3

Appendix B repeats the critical portions and tables supporting the laboratory’s activities in determining the PCT results and reporting the data to SRNL. The appendix is intended to provide a “detachable” work plan that may be provided to laboratory technicians.

## 4.0 Quality Assurance

Requirements for performing reviews of technical reports and the extent of review are established in manual E7 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.

## 5.0 Summary

SRR has issued scopes of work to both the SRNL and ES-VSL for glass formulation activities to support the integration of the SWPF into the DWPF flowsheet. Specifically, SRR has requested that the glass formulation team of SRNL and ES-VSL develop a technical basis that validates the current PCCS models for use during the processing of the coupled flowsheet or that leads to the refinements of or modifications to the models that are needed so that they may be used during the processing of the coupled flowsheet. SRNL has developed a matrix of test glasses that are to be batched and fabricated by ES-VSL as part of this effort. This document provides two analytical plans for use by ES-VSL: one plan is to guide the measurement of the chemical composition of the study glasses while the second is to guide the measurement of the durability of the study glasses based upon their PCT responses.

## 6.0 Path Forward

The measurements generated by VSL are to be provided to SRR and SRNL for data reduction and evaluation. The results along with the other property measurements (i.e., liquidus temperature and viscosity) are to be incorporated into a final report by ES-VSL as a deliverable to SRR and SRNL in support of the SWPF gap analysis at DWPF.

<sup>f</sup> Note that the PCT solutions from the final (13<sup>th</sup>) oven run support the final set of 3 blocks: S-U.

## 7.0 References

ASTM C1285. *Standard Test Methods for Determining Chemical Durability of Nuclear, Hazardous, and Mixed Waste Glasses and Multiphase Glass Ceramics: The Product Consistency Test (PCT)*, ASTM C1285-14, Annual Book of ASTM Standards, Vol. 12.01, West Conshohocken, PA, 2014.

Chew, D.P and B.A. Hamm, "Liquid Waste System Plan Revision 19," SRR-LWP-2009-00001, Rev. 19, May 2014.

Fellinger, T.L., E.W. Holtzscheiter, and H.B. Shah. 2014. *Engineering Position Paper on Input Assumptions for Incorporating Salt Waste Processing Facility (SWPF) Products Streams into the Defense Waste Processing Facility (DWPF)*, SRR-WSE-2014-00052, Savannah River Remediation, June 26, 2014.

Holtzscheiter, E.W. 2014a. *SWPF-Integration into DWPF - Glass Property / Models Impacts*, X-TTR-S-00012, Revision 1, Savannah River Remediation, Aiken, South Carolina.

Holtzscheiter, E.W. 2014b. *SWPF-DWPF Integration High Titanium Glass Property Measurements*, X-SOW-S-00007, Revision 0, Savannah River Remediation, Aiken, South Carolina.

Peeler, D.K., T.B. Edwards, and C.M. Jantzen. 2014a. *Task Technical and Quality Assurance Plan for SWPF Integration into the DWPF – Glass Property / Model Impacts*, SRNL-RP-2014-00348, Savannah River National Laboratory, Aiken, South Carolina.

Peeler, D.K., T.B. Edwards, and C.M. Jantzen. 2014b. *SWPF Integration into HLW Systems Plan (Rev 19): Current Status*, SRNL-STI-2014-00368, Savannah River National Laboratory, Aiken, South Carolina.



## Appendix A. Sample Preparation and Measurement of Glass Chemical Compositions<sup>f</sup>

Measurements for the following elements of interest, including elements that are minor components and whose concentrations are expected to be below detection, are to be acquired by VSL using X-ray fluorescence spectroscopy (XRF): aluminum (Al), barium (Ba), calcium (Ca), cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), copper (Cu), iron (Fe), potassium (K), lanthanum (La), magnesium (Mg), manganese (Mn), sodium (Na), nickel (Ni), lead (Pb), sulfur (S), silicon (Si), thorium (Th), titanium (Ti), uranium (U), zinc (Zn), and zirconium (Zr) concentrations. Once again, it should be noted that some of the elements listed above are minor components of the study glasses and may be below the detection limits of the analytical procedure.

Also, a single sample of a reference glass, that is to be selected by VSL to be a matrix-match for this study and that is to be labeled as “Std-xrf”, is to be submitted repeatedly for measurement along with the samples of the study glasses as indicated in Table A-1. These compositions are to be provided to SRNL as weight percent (wt%) elemental concentrations. Table A-2 provides a template for use by VSL in reporting these results. A value below its detection limit should be indicated in this table by a less than sign (“<”) followed by the detection limit.

**Table A-1. XRF Analytical Blocks and Sequencing along with the Measurement Identifiers**

<b>XRF Block 1 First Set of Measurements</b>	<b>XRF Block 1 Second Set of Measurements</b>	<b>XRF Block 2 First Set of Measurements</b>	<b>XRF Block 2 Second Set of Measurements</b>	<b>XRF Block 3 First Set of Measurements</b>	<b>XRF Block 3 Second Set of Measurements</b>
Std-xrf-111	Std-xrf-121	Std-xrf-211	Std-xrf-221	Std-xrf-311	Std-xrf-321
GAP-22xrf-11	GAP-37xrf-12	GAP-10xrf-11	GAP-10xrf-22	GAP-29xrf-11	GAP-41xrf-12
GAP-38xrf-11	GAP-43xrf-22	GAP-12xrf-11	GAP-47xrf-22	GAP-20xrf-11	GAP-29xrf-22
GAP-31xrf-11	GAP-22xrf-22	GAP-34xrf-21	GAP-14xrf-12	GAP-29xrf-21	GAP-35xrf-22
GAP-33xrf-11	GAP-43xrf-12	GAP-44xrf-21	GAP-12xrf-22	GAP-05xrf-11	GAP-26xrf-22
GAP-15xrf-21	GAP-37xrf-22	GAP-34xrf-11	GAP-47xrf-12	GAP-20xrf-21	GAP-05xrf-22
GAP-38xrf-21	GAP-33xrf-12	GAP-14xrf-11	GAP-19xrf-22	GAP-26xrf-21	GAP-20xrf-12
GAP-37xrf-11	GAP-15xrf-12	GAP-47xrf-11	GAP-44xrf-12	GAP-26xrf-11	GAP-29xrf-12
GAP-15xrf-11	GAP-38xrf-12	Std-xrf-212	Std-xrf-222	Std-xrf-312	Std-xrf-322
Std-xrf-112	Std-xrf-122	GAP-47xrf-21	GAP-34xrf-12	GAP-35xrf-11	GAP-35xrf-12
GAP-43xrf-11	GAP-31xrf-22	GAP-44xrf-11	GAP-19xrf-12	GAP-41xrf-21	GAP-46xrf-22
GAP-33xrf-21	GAP-15xrf-22	GAP-14xrf-21	GAP-12xrf-12	GAP-05xrf-21	GAP-20xrf-22
GAP-37xrf-21	GAP-22xrf-12	GAP-10xrf-21	GAP-10xrf-12	GAP-46xrf-11	GAP-46xrf-12
GAP-21xrf-11	GAP-21xrf-22	GAP-19xrf-21	GAP-34xrf-22	GAP-41xrf-11	GAP-41xrf-22
GAP-31xrf-21	GAP-33xrf-22	GAP-19xrf-11	GAP-44xrf-22	GAP-46xrf-21	GAP-26xrf-12
GAP-22xrf-21	GAP-38xrf-22	GAP-12xrf-21	GAP-14xrf-22	GAP-35xrf-21	GAP-05xrf-12
GAP-21xrf-21	GAP-21xrf-12	Std-xrf-213	Std-xrf-223	Std-xrf-313	Std-xrf-323
GAP-43xrf-21	GAP-31xrf-12				
Std-xrf-113	Std-xrf-123				

<sup>f</sup> Copies of this appendix may be provided to the laboratory technicians at VSL who are to conduct the sample dissolutions required to prepare the glass samples for DCP analysis, to those who are to conduct the XRF analyses, and to those that are to conduct the DCP analyses to facilitate these activities.

**Table A-1. XRF Analytical Blocks and Sequencing along with the Measurement Identifiers**  
(continued)

<b>XRF Block 4 First Set of Measurements</b>	<b>XRF Block 4 Second Set of Measurements</b>	<b>XRF Block 5 First Set of Measurements</b>	<b>XRF Block 5 Second Set of Measurements</b>	<b>XRF Block 6 First Set of Measurements</b>	<b>XRF Block 6 Second Set of Measurements</b>
Std-xrf-411	Std-xrf-421	Std-xrf-511	Std-xrf-521	Std-xrf-611	Std-xrf-621
GAP-24xrf-11	GAP-17xrf-12	GAP-36xrf-21	GAP-30xrf-22	GAP-13xrf-11	GAP-49xrf-22
GAP-06xrf-11	GAP-23xrf-22	GAP-30xrf-11	GAP-16xrf-22	GAP-48xrf-21	GAP-28xrf-12
GAP-32xrf-11	GAP-17xrf-22	GAP-11xrf-21	GAP-09xrf-22	GAP-13xrf-21	GAP-07xrf-22
GAP-23xrf-21	GAP-24xrf-12	GAP-03xrf-21	GAP-11xrf-22	GAP-27xrf-11	GAP-13xrf-22
GAP-17xrf-21	GAP-42xrf-22	GAP-36xrf-11	GAP-11xrf-12	GAP-07xrf-11	GAP-04xrf-12
GAP-50xrf-11	GAP-06xrf-12	GAP-09xrf-21	GAP-36xrf-22	GAP-04xrf-21	GAP-27xrf-12
GAP-24xrf-21	GAP-50xrf-12	GAP-40xrf-11	GAP-40xrf-22	GAP-27xrf-21	GAP-28xrf-22
Std-xrf-412	Std-xrf-422	Std-xrf-512	Std-xrf-522	Std-xrf-612	Std-xrf-622
GAP-06xrf-21	GAP-32xrf-22	GAP-11xrf-11	GAP-30xrf-12	GAP-04xrf-11	GAP-07xrf-12
GAP-17xrf-11	GAP-24xrf-22	GAP-16xrf-11	GAP-09xrf-12	GAP-48xrf-11	GAP-48xrf-12
GAP-32xrf-21	GAP-42xrf-12	GAP-03xrf-11	GAP-36xrf-12	GAP-28xrf-21	GAP-27xrf-22
GAP-42xrf-11	GAP-06xrf-22	GAP-09xrf-11	GAP-03xrf-12	GAP-28xrf-11	GAP-04xrf-22
GAP-42xrf-21	GAP-23xrf-12	GAP-16xrf-21	GAP-03xrf-22	GAP-07xrf-21	GAP-48xrf-22
GAP-23xrf-11	GAP-50xrf-22	GAP-40xrf-21	GAP-16xrf-12	GAP-49xrf-11	GAP-13xrf-12
GAP-50xrf-21	GAP-32xrf-12	GAP-30xrf-21	GAP-40xrf-12	GAP-49xrf-21	GAP-49xrf-12
Std-xrf-413	Std-xrf-423	Std-xrf-513	Std-xrf-523	Std-xrf-613	Std-xrf-623
<b>XRF Block 7 First Set of Measurements</b>	<b>XRF Block 7 Second Set of Measurements</b>				
Std-xrf-711	Std-xrf-721				
GAP-01xrf-21	GAP-02xrf-22				
GAP-39xrf-21	GAP-18xrf-12				
GAP-08xrf-21	GAP-25xrf-12				
GAP-01xrf-11	GAP-45xrf-12				
GAP-39xrf-11	GAP-25xrf-22				
GAP-45xrf-21	GAP-18xrf-22				
GAP-02xrf-11	GAP-02xrf-12				
Std-xrf-712	Std-xrf-722				
GAP-18xrf-21	GAP-39xrf-22				
GAP-45xrf-11	GAP-45xrf-22				
GAP-25xrf-11	GAP-08xrf-22				
GAP-02xrf-21	GAP-08xrf-12				
GAP-25xrf-21	GAP-01xrf-12				
GAP-18xrf-11	GAP-39xrf-12				
GAP-08xrf-11	GAP-01xrf-22				
Std-xrf-713	Std-xrf-723				

**Table A-2. Template for Reporting XRF Results**

Block Number	Measurement Group	Sample ID	Al	Ba	Ca	Ce	Co	Cr	Cs	Cu	Fe	K	La	Mg	Mn	Na	Ni	Pb	S	Si	Th	Ti	U	Zn	Zr
1	1	Std-xrf-111																							
1	1	GAP-22xrf-11																							
1	1	GAP-38xrf-11																							
1	1	GAP-31xrf-11																							
1	1	GAP-33xrf-11																							
1	1	GAP-15xrf-21																							
1	1	GAP-38xrf-21																							
1	1	GAP-37xrf-11																							
1	1	GAP-15xrf-11																							
1	1	Std-xrf-112																							
1	1	GAP-43xrf-11																							
1	1	GAP-33xrf-21																							
1	1	GAP-37xrf-21																							
1	1	GAP-21xrf-11																							
1	1	GAP-31xrf-21																							
1	1	GAP-22xrf-21																							
1	1	GAP-21xrf-21																							
1	1	GAP-43xrf-21																							
1	1	Std-xrf-113																							
1	2	Std-xrf-121																							
1	2	GAP-37xrf-12																							
1	2	GAP-43xrf-22																							
1	2	GAP-22xrf-22																							
1	2	GAP-43xrf-12																							
1	2	GAP-37xrf-22																							
1	2	GAP-33xrf-12																							
1	2	GAP-15xrf-12																							
1	2	GAP-38xrf-12																							
1	2	Std-xrf-122																							
1	2	GAP-31xrf-22																							
1	2	GAP-15xrf-22																							
1	2	GAP-22xrf-12																							
1	2	GAP-21xrf-22																							
1	2	GAP-33xrf-22																							
1	2	GAP-38xrf-22																							
1	2	GAP-21xrf-12																							
1	2	GAP-31xrf-12																							
1	2	Std-xrf-123																							
2	1	Std-xrf-211																							
2	1	GAP-10xrf-11																							
2	1	GAP-12xrf-11																							

Block Number	Measurement Group	Sample ID	Al	Ba	Ca	Ce	Co	Cr	Cs	Cu	Fe	K	La	Mg	Mn	Na	Ni	Pb	S	Si	Th	Ti	U	Zn	Zr
2	1	GAP-34xrf-21																							
2	1	GAP-44xrf-21																							
2	1	GAP-34xrf-11																							
2	1	GAP-14xrf-11																							
2	1	GAP-47xrf-11																							
2	1	Std-xrf-212																							
2	1	GAP-47xrf-21																							
2	1	GAP-44xrf-11																							
2	1	GAP-14xrf-21																							
2	1	GAP-10xrf-21																							
2	1	GAP-19xrf-21																							
2	1	GAP-19xrf-11																							
2	1	GAP-12xrf-21																							
2	1	Std-xrf-213																							
2	2	Std-xrf-221																							
2	2	GAP-10xrf-22																							
2	2	GAP-47xrf-22																							
2	2	GAP-14xrf-12																							
2	2	GAP-12xrf-22																							
2	2	GAP-47xrf-12																							
2	2	GAP-19xrf-22																							
2	2	GAP-44xrf-12																							
2	2	Std-xrf-222																							
2	2	GAP-34xrf-12																							
2	2	GAP-19xrf-12																							
2	2	GAP-12xrf-12																							
2	2	GAP-10xrf-12																							
2	2	GAP-34xrf-22																							
2	2	GAP-44xrf-22																							
2	2	GAP-14xrf-22																							
2	2	Std-xrf-223																							
3	1	Std-xrf-311																							
3	1	GAP-29xrf-11																							
3	1	GAP-20xrf-11																							
3	1	GAP-29xrf-21																							
3	1	GAP-05xrf-11																							
3	1	GAP-20xrf-21																							
3	1	GAP-26xrf-21																							
3	1	GAP-26xrf-11																							
3	1	Std-xrf-312																							
3	1	GAP-35xrf-11																							
3	1	GAP-41xrf-21																							
3	1	GAP-05xrf-21																							
3	1	GAP-46xrf-11																							
3	1	GAP-41xrf-11																							
3	1	GAP-46xrf-21																							

Block Number	Measurement Group	Sample ID	Al	Ba	Ca	Ce	Co	Cr	Cs	Cu	Fe	K	La	Mg	Mn	Na	Ni	Pb	S	Si	Th	Ti	U	Zn	Zr
3	1	GAP-35xrf-21																							
3	1	Std-xrf-313																							
3	2	Std-xrf-321																							
3	2	GAP-41xrf-12																							
3	2	GAP-29xrf-22																							
3	2	GAP-35xrf-22																							
3	2	GAP-26xrf-22																							
3	2	GAP-05xrf-22																							
3	2	GAP-20xrf-12																							
3	2	GAP-29xrf-12																							
3	2	Std-xrf-322																							
3	2	GAP-35xrf-12																							
3	2	GAP-46xrf-22																							
3	2	GAP-20xrf-22																							
3	2	GAP-46xrf-12																							
3	2	GAP-41xrf-22																							
3	2	GAP-26xrf-12																							
3	2	GAP-05xrf-12																							
3	2	Std-xrf-323																							
4	1	Std-xrf-411																							
4	1	GAP-24xrf-11																							
4	1	GAP-06xrf-11																							
4	1	GAP-32xrf-11																							
4	1	GAP-23xrf-21																							
4	1	GAP-17xrf-21																							
4	1	GAP-50xrf-11																							
4	1	GAP-24xrf-21																							
4	1	Std-xrf-412																							
4	1	GAP-06xrf-21																							
4	1	GAP-17xrf-11																							
4	1	GAP-32xrf-21																							
4	1	GAP-42xrf-11																							
4	1	GAP-42xrf-21																							
4	1	GAP-23xrf-11																							
4	1	GAP-50xrf-21																							
4	1	Std-xrf-413																							
4	2	Std-xrf-421																							
4	2	GAP-17xrf-12																							
4	2	GAP-23xrf-22																							
4	2	GAP-17xrf-22																							
4	2	GAP-24xrf-12																							
4	2	GAP-42xrf-22																							
4	2	GAP-06xrf-12																							
4	2	GAP-50xrf-12																							
4	2	Std-xrf-422																							
4	2	GAP-32xrf-22																							

Block Number	Measurement Group	Sample ID	Al	Ba	Ca	Ce	Co	Cr	Cs	Cu	Fe	K	La	Mg	Mn	Na	Ni	Pb	S	Si	Th	Ti	U	Zn	Zr
4	2	GAP-24xrf-22																							
4	2	GAP-42xrf-12																							
4	2	GAP-06xrf-22																							
4	2	GAP-23xrf-12																							
4	2	GAP-50xrf-22																							
4	2	GAP-32xrf-12																							
4	2	Std-xrf-423																							
5	1	Std-xrf-511																							
5	1	GAP-36xrf-21																							
5	1	GAP-30xrf-11																							
5	1	GAP-11xrf-21																							
5	1	GAP-03xrf-21																							
5	1	GAP-36xrf-11																							
5	1	GAP-09xrf-21																							
5	1	GAP-40xrf-11																							
5	1	Std-xrf-512																							
5	1	GAP-11xrf-11																							
5	1	GAP-16xrf-11																							
5	1	GAP-03xrf-11																							
5	1	GAP-09xrf-11																							
5	1	GAP-16xrf-21																							
5	1	GAP-40xrf-21																							
5	1	GAP-30xrf-21																							
5	1	Std-xrf-513																							
5	2	Std-xrf-521																							
5	2	GAP-30xrf-22																							
5	2	GAP-16xrf-22																							
5	2	GAP-09xrf-22																							
5	2	GAP-11xrf-22																							
5	2	GAP-11xrf-12																							
5	2	GAP-36xrf-22																							
5	2	GAP-40xrf-22																							
5	2	Std-xrf-522																							
5	2	GAP-30xrf-12																							
5	2	GAP-09xrf-12																							
5	2	GAP-36xrf-12																							
5	2	GAP-03xrf-12																							
5	2	GAP-03xrf-22																							
5	2	GAP-16xrf-12																							
5	2	GAP-40xrf-12																							
5	2	Std-xrf-523																							
6	1	Std-xrf-611																							
6	1	GAP-13xrf-11																							
6	1	GAP-48xrf-21																							
6	1	GAP-13xrf-21																							
6	1	GAP-27xrf-11																							

Block Number	Measurement Group	Sample ID	Al	Ba	Ca	Ce	Co	Cr	Cs	Cu	Fe	K	La	Mg	Mn	Na	Ni	Pb	S	Si	Th	Ti	U	Zn	Zr
6	1	GAP-07xrf-11																							
6	1	GAP-04xrf-21																							
6	1	GAP-27xrf-21																							
6	1	Std-xrf-612																							
6	1	GAP-04xrf-11																							
6	1	GAP-48xrf-11																							
6	1	GAP-28xrf-21																							
6	1	GAP-28xrf-11																							
6	1	GAP-07xrf-21																							
6	1	GAP-49xrf-11																							
6	1	GAP-49xrf-21																							
6	1	Std-xrf-613																							
6	2	Std-xrf-621																							
6	2	GAP-49xrf-22																							
6	2	GAP-28xrf-12																							
6	2	GAP-07xrf-22																							
6	2	GAP-13xrf-22																							
6	2	GAP-04xrf-12																							
6	2	GAP-27xrf-12																							
6	2	GAP-28xrf-22																							
6	2	Std-xrf-622																							
6	2	GAP-07xrf-12																							
6	2	GAP-48xrf-12																							
6	2	GAP-27xrf-22																							
6	2	GAP-04xrf-22																							
6	2	GAP-48xrf-22																							
6	2	GAP-13xrf-12																							
6	2	GAP-49xrf-12																							
6	2	Std-xrf-623																							
7	1	Std-xrf-711																							
7	1	GAP-01xrf-21																							
7	1	GAP-39xrf-21																							
7	1	GAP-08xrf-21																							
7	1	GAP-01xrf-11																							
7	1	GAP-39xrf-11																							
7	1	GAP-45xrf-21																							
7	1	GAP-02xrf-11																							
7	1	Std-xrf-712																							
7	1	GAP-18xrf-21																							
7	1	GAP-45xrf-11																							
7	1	GAP-25xrf-11																							
7	1	GAP-02xrf-21																							
7	1	GAP-25xrf-21																							
7	1	GAP-18xrf-11																							
7	1	GAP-08xrf-11																							
7	1	Std-xrf-713																							

Block Number	Measurement Group	Sample ID	Al	Ba	Ca	Ce	Co	Cr	Cs	Cu	Fe	K	La	Mg	Mn	Na	Ni	Pb	S	Si	Th	Ti	U	Zn	Zr
7	2	Std-xrf-721																							
7	2	GAP-02xrf-22																							
7	2	GAP-18xrf-12																							
7	2	GAP-25xrf-12																							
7	2	GAP-45xrf-12																							
7	2	GAP-25xrf-22																							
7	2	GAP-18xrf-22																							
7	2	GAP-02xrf-12																							
7	2	Std-xrf-722																							
7	2	GAP-39xrf-22																							
7	2	GAP-45xrf-22																							
7	2	GAP-08xrf-22																							
7	2	GAP-08xrf-12																							
7	2	GAP-01xrf-12																							
7	2	GAP-39xrf-12																							
7	2	GAP-01xrf-22																							
7	2	Std-xrf-723																							



Duplicate samples of each of the study glass vials are to be subjected to microwave-assisted total acid dissolution in Teflon vessels according to VSL standard operating procedures. Typically, a mixture of concentrated HF:HNO<sub>3</sub> is used to conduct the digestions with each digestion leading to a 50 ml solution. The resulting solutions are further diluted to 200 ml before DCP analysis. The 200 ml solutions are to be labeled as indicated in Table A-3. The groupings of Table A-3 are established in a manner that indicates that all of the batching and preliminary preparations (i.e., grinding) of the glasses are to be completed before the dissolution activities of Table A-3 are initiated. Each block of Table A-3 represents a microwave batch and the sequence provides an order for sample weighing. In addition to the study glasses, a sample of the standard reference glass selected by VSL to support this study is to be similarly prepared in a large enough quantity to allow aliquots of the resulting solution to be submitted for DCP analysis along with the prepared samples of the study glasses (see Table A-4). This standard glass (Std-dcp) has been included in each of the preparation blocks of Table A-3.

**Table A-3. DCP Preparation Blocks and Sequencing along with Sample Identifiers for the 200 ml Solutions**

DCP Preparation Block 1	DCP Preparation Block 2	DCP Preparation Block 3	DCP Preparation Block 4	DCP Preparation Block 5
GAP-33dcp-1	GAP-12dcp-1	GAP-24dcp-1	GAP-03dcp-1	GAP-28dcp-1
GAP-15dcp-1	GAP-26dcp-1	GAP-42dcp-1	GAP-40dcp-1	GAP-04dcp-1
GAP-38dcp-1	GAP-14dcp-1	GAP-24dcp-2	GAP-07dcp-1	Std-dcp
GAP-21dcp-1	GAP-35dcp-1	GAP-42dcp-2	GAP-36dcp-1	GAP-27dcp-1
GAP-33dcp-2	GAP-29dcp-1	Std-dcp	GAP-03dcp-2	GAP-28dcp-2
GAP-15dcp-2	GAP-26dcp-2	GAP-23dcp-1	GAP-36dcp-2	GAP-04dcp-2
GAP-37dcp-1	GAP-35dcp-2	GAP-41dcp-1	GAP-40dcp-2	GAP-27dcp-2
Std-dcp	GAP-14dcp-2	GAP-17dcp-1	GAP-07dcp-2	GAP-08dcp-1
GAP-38dcp-2	GAP-34dcp-1	GAP-32dcp-1	GAP-13dcp-1	GAP-02dcp-1
GAP-21dcp-2	GAP-46dcp-1	GAP-17dcp-2	Std-dcp	GAP-25dcp-1
GAP-37dcp-2	GAP-34dcp-2	GAP-32dcp-2	GAP-11dcp-1	GAP-39dcp-1
GAP-43dcp-1	GAP-05dcp-1	GAP-20dcp-1	GAP-13dcp-2	GAP-02dcp-2
GAP-31dcp-1	GAP-10dcp-1	GAP-23dcp-2	GAP-30dcp-1	GAP-08dcp-2
GAP-47dcp-1	GAP-19dcp-1	GAP-41dcp-2	GAP-11dcp-2	GAP-39dcp-2
GAP-43dcp-2	GAP-10dcp-2	GAP-20dcp-2	GAP-49dcp-1	GAP-01dcp-1
GAP-31dcp-2	Std-dcp	GAP-50dcp-1	GAP-30dcp-2	GAP-25dcp-2
GAP-47dcp-2	GAP-46dcp-2	GAP-06dcp-1	GAP-48dcp-1	GAP-01dcp-2
GAP-44dcp-1	GAP-05dcp-2	GAP-16dcp-1	GAP-09dcp-1	GAP-18dcp-1
GAP-22dcp-1	GAP-12dcp-2	GAP-50dcp-2	GAP-49dcp-2	GAP-45dcp-1
GAP-44dcp-2	GAP-29dcp-2	GAP-06dcp-2	GAP-48dcp-2	GAP-18dcp-2
GAP-22dcp-2	GAP-19dcp-2	GAP-16dcp-2	GAP-09dcp-2	GAP-45dcp-2

The samples prepared for chemical analysis by DCP are to be measured for their boron and lithium content. Each of the duplicate preparations of each study glass is to be measured twice by DCP, with a re-calibration of the instrument being performed between the two measurements. The groupings and sequencing of these samples is provided in Table A-4. To repeat, each column of this table indicates a different calibration of the DCP instrumentation. In addition, the order of the samples in a column is the sequence in which the samples should be measured by DCP. Also, note the addition of aliquots of the prepared reference glass, Std-dcp, to these DCP analytical blocks. The “known” composition of this reference glass is to be provided to SRNL along with the measured compositions from Table A-4. These compositions are to be provided as weight percent (wt%) elemental concentrations.

**Table A-4. DCP Analytical Blocks and Sequencing along with the Measurement Identifiers**

<b>DCP Block 1 First Calibration</b>	<b>DCP Block 1 Second Calibration</b>	<b>DCP Block 2 First Calibration</b>	<b>DCP Block 2 Second Calibration</b>	<b>DCP Block 3 First Calibration</b>	<b>DCP Block 3 Second Calibration</b>
Std-dcp-111	Std-dcp-121	Std-dcp-211	Std-dcp-221	Std-dcp-311	Std-dcp-321
GAP-21dcp-11	GAP-38dcp-22	GAP-44dcp-11	GAP-44dcp-12	GAP-35dcp-11	GAP-34dcp-22
GAP-33dcp-11	GAP-22dcp-12	GAP-10dcp-21	GAP-12dcp-12	GAP-34dcp-21	GAP-16dcp-12
GAP-37dcp-11	GAP-43dcp-12	GAP-47dcp-21	GAP-47dcp-12	GAP-16dcp-11	GAP-06dcp-22
GAP-21dcp-21	GAP-21dcp-22	GAP-12dcp-21	GAP-19dcp-22	GAP-46dcp-21	GAP-26dcp-22
GAP-43dcp-11	GAP-15dcp-12	GAP-14dcp-11	GAP-14dcp-22	GAP-06dcp-11	GAP-46dcp-22
GAP-15dcp-11	GAP-31dcp-22	GAP-19dcp-11	GAP-05dcp-22	GAP-34dcp-11	GAP-06dcp-12
GAP-22dcp-21	GAP-15dcp-22	GAP-10dcp-11	GAP-19dcp-12	GAP-16dcp-21	GAP-26dcp-12
GAP-31dcp-21	GAP-22dcp-22	Std-dcp-212	Std-dcp-222	Std-dcp-312	Std-dcp-322
Std-dcp-112	Std-dcp-122	GAP-47dcp-11	GAP-10dcp-22	GAP-46dcp-11	GAP-16dcp-22
GAP-33dcp-21	GAP-31dcp-12	GAP-19dcp-21	GAP-05dcp-12	GAP-26dcp-11	GAP-35dcp-12
GAP-43dcp-21	GAP-33dcp-12	GAP-05dcp-21	GAP-12dcp-22	GAP-29dcp-11	GAP-29dcp-12
GAP-22dcp-11	GAP-38dcp-12	GAP-05dcp-11	GAP-14dcp-12	GAP-06dcp-21	GAP-29dcp-22
GAP-31dcp-11	GAP-21dcp-12	GAP-14dcp-21	GAP-44dcp-22	GAP-29dcp-21	GAP-35dcp-22
GAP-38dcp-11	GAP-33dcp-22	GAP-12dcp-11	GAP-47dcp-22	GAP-26dcp-21	GAP-34dcp-12
GAP-37dcp-21	GAP-37dcp-22	GAP-44dcp-21	GAP-10dcp-12	GAP-35dcp-21	GAP-46dcp-12
GAP-38dcp-21	GAP-37dcp-12	Std-dcp-213	Std-dcp-223	Std-dcp-313	Std-dcp-323
GAP-15dcp-21	GAP-43dcp-22				
Std-dcp-113	Std-dcp-123				
<b>DCP Block 4 First Calibration</b>	<b>DCP Block 4 Second Calibration</b>	<b>DCP Block 5 First Calibration</b>	<b>DCP Block 5 Second Calibration</b>	<b>DCP Block 6 First Calibration</b>	<b>DCP Block 6 Second Calibration</b>
Std-dcp-411	Std-dcp-421	Std-dcp-511	Std-dcp-521	Std-dcp-611	Std-dcp-621
GAP-17dcp-21	GAP-17dcp-22	GAP-11dcp-11	GAP-03dcp-22	GAP-48dcp-21	GAP-04dcp-22
GAP-41dcp-11	GAP-32dcp-22	GAP-03dcp-11	GAP-50dcp-22	GAP-49dcp-11	GAP-02dcp-22
GAP-24dcp-21	GAP-20dcp-22	GAP-13dcp-11	GAP-13dcp-22	GAP-48dcp-11	GAP-48dcp-22
GAP-20dcp-11	GAP-23dcp-12	GAP-30dcp-11	GAP-09dcp-12	GAP-04dcp-21	GAP-49dcp-12
GAP-17dcp-11	GAP-17dcp-12	GAP-13dcp-21	GAP-07dcp-12	GAP-36dcp-11	GAP-49dcp-22
GAP-42dcp-21	GAP-42dcp-22	GAP-11dcp-21	GAP-07dcp-22	GAP-01dcp-11	GAP-02dcp-12
GAP-23dcp-11	GAP-32dcp-12	GAP-07dcp-11	GAP-11dcp-22	GAP-02dcp-21	GAP-36dcp-12
Std-dcp-412	Std-dcp-422	Std-dcp-512	Std-dcp-522	Std-dcp-612	Std-dcp-622
GAP-20dcp-21	GAP-42dcp-12	GAP-30dcp-21	GAP-11dcp-12	GAP-40dcp-11	GAP-40dcp-22
GAP-32dcp-11	GAP-24dcp-22	GAP-09dcp-11	GAP-09dcp-22	GAP-40dcp-21	GAP-04dcp-12
GAP-23dcp-21	GAP-20dcp-12	GAP-09dcp-21	GAP-03dcp-12	GAP-04dcp-11	GAP-40dcp-12
GAP-24dcp-11	GAP-41dcp-22	GAP-50dcp-21	GAP-30dcp-22	GAP-49dcp-21	GAP-36dcp-22
GAP-42dcp-11	GAP-23dcp-22	GAP-07dcp-21	GAP-50dcp-12	GAP-36dcp-21	GAP-01dcp-12
GAP-32dcp-21	GAP-24dcp-12	GAP-50dcp-11	GAP-30dcp-12	GAP-01dcp-21	GAP-01dcp-22
GAP-41dcp-21	GAP-41dcp-12	GAP-03dcp-21	GAP-13dcp-12	GAP-02dcp-11	GAP-48dcp-12
Std-dcp-413	Std-dcp-423	Std-dcp-513	Std-dcp-523	Std-dcp-613	Std-dcp-623

**Table A-4. DCP Analytical Blocks and Sequencing along with the Measurement Identifiers**  
(continued)

<b>DCP Block 7 First Calibration</b>	<b>DCP Block7 Second Calibration</b>
Std-dcp-711	Std-dcp-721
GAP-08dcp-21	GAP-25dcp-22
GAP-39dcp-11	GAP-45dcp-12
GAP-27dcp-11	GAP-28dcp-22
GAP-28dcp-21	GAP-08dcp-12
GAP-39dcp-21	GAP-45dcp-22
GAP-45dcp-11	GAP-27dcp-22
GAP-18dcp-11	GAP-39dcp-12
Std-dcp-712	Std-dcp-722
GAP-08dcp-11	GAP-27dcp-12
GAP-25dcp-11	GAP-08dcp-22
GAP-18dcp-21	GAP-18dcp-22
GAP-25dcp-21	GAP-25dcp-12
GAP-45dcp-21	GAP-39dcp-22
GAP-28dcp-11	GAP-18dcp-12
GAP-27dcp-21	GAP-28dcp-12
Std-dcp-713	Std-dcp-723

Table A-5 provides a template for use by VSL in reporting the results from these DCP analyses. A value below its detection limit should be indicated in this table by a less than sign (“<”) followed by the detection limit.

**Table A-5. Template for Reporting DCP Results**

Block Number	Measurement Group	Sample ID	B	Li
1	1	Std-dcp-111		
1	1	GAP-21dcp-11		
1	1	GAP-33dcp-11		
1	1	GAP-37dcp-11		
1	1	GAP-21dcp-21		
1	1	GAP-43dcp-11		
1	1	GAP-15dcp-11		
1	1	GAP-22dcp-21		
1	1	GAP-31dcp-21		
1	1	Std-dcp-112		
1	1	GAP-33dcp-21		
1	1	GAP-43dcp-21		
1	1	GAP-22dcp-11		
1	1	GAP-31dcp-11		
1	1	GAP-38dcp-11		
1	1	GAP-37dcp-21		
1	1	GAP-38dcp-21		
1	1	GAP-15dcp-21		
1	1	Std-dcp-113		
1	2	Std-dcp-121		
1	2	GAP-38dcp-22		
1	2	GAP-22dcp-12		
1	2	GAP-43dcp-12		
1	2	GAP-21dcp-22		
1	2	GAP-15dcp-12		
1	2	GAP-31dcp-22		
1	2	GAP-15dcp-22		
1	2	GAP-22dcp-22		
1	2	Std-dcp-122		
1	2	GAP-31dcp-12		
1	2	GAP-33dcp-12		
1	2	GAP-38dcp-12		
1	2	GAP-21dcp-12		
1	2	GAP-33dcp-22		
1	2	GAP-37dcp-22		
1	2	GAP-37dcp-12		
1	2	GAP-43dcp-22		
1	2	Std-dcp-123		
2	1	Std-dcp-211		
2	1	GAP-44dcp-11		
2	1	GAP-10dcp-21		
2	1	GAP-47dcp-21		
2	1	GAP-12dcp-21		
2	1	GAP-14dcp-11		
2	1	GAP-19dcp-11		
2	1	GAP-10dcp-11		
2	1	Std-dcp-212		
2	1	GAP-47dcp-11		
2	1	GAP-19dcp-21		
2	1	GAP-05dcp-21		
2	1	GAP-05dcp-11		
2	1	GAP-14dcp-21		
2	1	GAP-12dcp-11		
2	1	GAP-44dcp-21		
2	1	Std-dcp-213		
2	2	Std-dcp-221		
2	2	GAP-44dcp-12		
2	2	GAP-12dcp-12		
2	2	GAP-47dcp-12		
2	2	GAP-19dcp-22		
2	2	GAP-14dcp-22		
2	2	GAP-05dcp-22		

Block Number	Measurement Group	Sample ID	B	Li
2	2	GAP-19dcp-12		
2	2	Std-dcp-222		
2	2	GAP-10dcp-22		
2	2	GAP-05dcp-12		
2	2	GAP-12dcp-22		
2	2	GAP-14dcp-12		
2	2	GAP-44dcp-22		
2	2	GAP-47dcp-22		
2	2	GAP-10dcp-12		
2	2	Std-dcp-223		
3	1	Std-dcp-311		
3	1	GAP-35dcp-11		
3	1	GAP-34dcp-21		
3	1	GAP-16dcp-11		
3	1	GAP-46dcp-21		
3	1	GAP-06dcp-11		
3	1	GAP-34dcp-11		
3	1	GAP-16dcp-21		
3	1	Std-dcp-312		
3	1	GAP-46dcp-11		
3	1	GAP-26dcp-11		
3	1	GAP-29dcp-11		
3	1	GAP-06dcp-21		
3	1	GAP-29dcp-21		
3	1	GAP-26dcp-21		
3	1	GAP-35dcp-21		
3	1	Std-dcp-313		
3	2	Std-dcp-321		
3	2	GAP-34dcp-22		
3	2	GAP-16dcp-12		
3	2	GAP-06dcp-22		
3	2	GAP-26dcp-22		
3	2	GAP-46dcp-22		
3	2	GAP-06dcp-12		
3	2	GAP-26dcp-12		
3	2	Std-dcp-322		
3	2	GAP-16dcp-22		
3	2	GAP-35dcp-12		
3	2	GAP-29dcp-12		
3	2	GAP-29dcp-22		
3	2	GAP-35dcp-22		
3	2	GAP-34dcp-12		
3	2	GAP-46dcp-12		
3	2	Std-dcp-323		
4	1	Std-dcp-411		
4	1	GAP-17dcp-21		
4	1	GAP-41dcp-11		
4	1	GAP-24dcp-21		
4	1	GAP-20dcp-11		
4	1	GAP-17dcp-11		
4	1	GAP-42dcp-21		
4	1	GAP-23dcp-11		
4	1	Std-dcp-412		
4	1	GAP-20dcp-21		
4	1	GAP-32dcp-11		
4	1	GAP-23dcp-21		
4	1	GAP-24dcp-11		
4	1	GAP-42dcp-11		
4	1	GAP-32dcp-21		
4	1	GAP-41dcp-21		
4	1	Std-dcp-413		
4	2	Std-dcp-421		
4	2	GAP-17dcp-22		
4	2	GAP-32dcp-22		

Block Number	Measurement Group	Sample ID	B	Li
4	2	GAP-20dcp-22		
4	2	GAP-23dcp-12		
4	2	GAP-17dcp-12		
4	2	GAP-42dcp-22		
4	2	GAP-32dcp-12		
4	2	Std-dcp-422		
4	2	GAP-42dcp-12		
4	2	GAP-24dcp-22		
4	2	GAP-20dcp-12		
4	2	GAP-41dcp-22		
4	2	GAP-23dcp-22		
4	2	GAP-24dcp-12		
4	2	GAP-41dcp-12		
4	2	Std-dcp-423		
5	1	Std-dcp-511		
5	1	GAP-11dcp-11		
5	1	GAP-03dcp-11		
5	1	GAP-13dcp-11		
5	1	GAP-30dcp-11		
5	1	GAP-13dcp-21		
5	1	GAP-11dcp-21		
5	1	GAP-07dcp-11		
5	1	Std-dcp-512		
5	1	GAP-30dcp-21		
5	1	GAP-09dcp-11		
5	1	GAP-09dcp-21		
5	1	GAP-50dcp-21		
5	1	GAP-07dcp-21		
5	1	GAP-50dcp-11		
5	1	GAP-03dcp-21		
5	1	Std-dcp-513		
5	2	Std-dcp-521		
5	2	GAP-03dcp-22		
5	2	GAP-50dcp-22		
5	2	GAP-13dcp-22		
5	2	GAP-09dcp-12		
5	2	GAP-07dcp-12		
5	2	GAP-07dcp-22		
5	2	GAP-11dcp-22		
5	2	Std-dcp-522		
5	2	GAP-11dcp-12		
5	2	GAP-09dcp-22		
5	2	GAP-03dcp-12		
5	2	GAP-30dcp-22		
5	2	GAP-50dcp-12		
5	2	GAP-30dcp-12		
5	2	GAP-13dcp-12		
5	2	Std-dcp-523		
6	1	Std-dcp-611		
6	1	GAP-48dcp-21		
6	1	GAP-49dcp-11		
6	1	GAP-48dcp-11		
6	1	GAP-04dcp-21		
6	1	GAP-36dcp-11		
6	1	GAP-01dcp-11		
6	1	GAP-02dcp-21		
6	1	Std-dcp-612		
6	1	GAP-40dcp-11		
6	1	GAP-40dcp-21		
6	1	GAP-04dcp-11		
6	1	GAP-49dcp-21		
6	1	GAP-36dcp-21		
6	1	GAP-01dcp-21		
6	1	GAP-02dcp-11		

Block Number	Measurement Group	Sample ID	B	Li
6	1	Std-dcp-613		
6	2	Std-dcp-621		
6	2	GAP-04dcp-22		
6	2	GAP-02dcp-22		
6	2	GAP-48dcp-22		
6	2	GAP-49dcp-12		
6	2	GAP-49dcp-22		
6	2	GAP-02dcp-12		
6	2	GAP-36dcp-12		
6	2	Std-dcp-622		
6	2	GAP-40dcp-22		
6	2	GAP-04dcp-12		
6	2	GAP-40dcp-12		
6	2	GAP-36dcp-22		
6	2	GAP-01dcp-12		
6	2	GAP-01dcp-22		
6	2	GAP-48dcp-12		
6	2	Std-dcp-623		
7	1	Std-dcp-711		
7	1	GAP-08dcp-21		
7	1	GAP-39dcp-11		
7	1	GAP-27dcp-11		
7	1	GAP-28dcp-21		
7	1	GAP-39dcp-21		
7	1	GAP-45dcp-11		
7	1	GAP-18dcp-11		
7	1	Std-dcp-712		
7	1	GAP-08dcp-11		
7	1	GAP-25dcp-11		
7	1	GAP-18dcp-21		
7	1	GAP-25dcp-21		
7	1	GAP-45dcp-21		
7	1	GAP-28dcp-11		
7	1	GAP-27dcp-21		
7	1	Std-dcp-713		
7	2	Std-dcp-721		
7	2	GAP-25dcp-22		
7	2	GAP-45dcp-12		
7	2	GAP-28dcp-22		
7	2	GAP-08dcp-12		
7	2	GAP-45dcp-22		
7	2	GAP-27dcp-22		
7	2	GAP-39dcp-12		
7	2	Std-dcp-722		
7	2	GAP-27dcp-12		
7	2	GAP-08dcp-22		
7	2	GAP-18dcp-22		
7	2	GAP-25dcp-12		
7	2	GAP-39dcp-22		
7	2	GAP-18dcp-12		
7	2	GAP-28dcp-12		
7	2	Std-dcp-723		

## **Appendix B. Measurement of PCT Solutions<sup>f</sup>**

The PCT solutions are to be measured by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP) or by DCP. A multi-element solution standard (denoted by “std-ij” where i = A, B, C, ..., U represents one of the 21 block letters and j = 1, 2, and 3 represents the position in the block) is to be added at the beginning, middle, and end of each of the twenty-one ICP or DCP blocks by the VSL laboratory technicians. As the analyses are conducted by VSL, each sample group or block of Table B-1 requires a different calibration of the ICP or DCP instrumentation. Each of the solution samples of Table B-1 is to be analyzed by VSL only once for each of the elements of interest to VSL. However, the following elements are to be provided to SRNL for further evaluation: boron (B), lithium (Li), sodium (Na), and silicon (Si) concentrations. The measurements provided to SRNL are to be reported in parts per million (ppm) after accounting for all dilutions and other adjustments conducted during the measurement process.

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<sup>f</sup> Copies of this appendix are to be provided to the laboratory technicians at VSL who are to conduct ICP or DCP analyses of the PCT solutions.



**Table B-1. ICP or DCP Calibration Blocks for the Leachate Measurements for the PCTs**

PCT Solutions from Oven Runs 1 and 2			PCT Solutions from Oven Runs 3 and 4			PCT Solutions from Oven Runs 5 and 6		
Calibration Block A	Calibration Block B	Calibration Block C	Calibration Block D	Calibration Block E	Calibration Block F	Calibration Block G	Calibration Block H	Calibration Block I
std-A1	std-B1	std-C1	std-D1	std-E1	std-F1	std-G1	std-H1	std-I1
GAP-pct-201	GAP-pct-381	GAP-pct-197	GAP-pct-208	GAP-pct-336	GAP-pct-160	GAP-pct-279	GAP-pct-183	GAP-pct-165
GAP-pct-046	GAP-pct-317	GAP-pct-088	GAP-pct-086	GAP-pct-155	GAP-pct-198	GAP-pct-055	GAP-pct-084	GAP-pct-161
GAP-pct-080	GAP-pct-384	GAP-pct-104	GAP-pct-043	GAP-pct-111	GAP-pct-189	GAP-pct-235	GAP-pct-288	GAP-pct-339
GAP-pct-307	GAP-pct-116	GAP-pct-188	GAP-pct-297	GAP-pct-068	GAP-pct-029	GAP-pct-025	GAP-pct-243	GAP-pct-249
GAP-pct-398	GAP-pct-379	GAP-pct-187	GAP-pct-121	GAP-pct-098	GAP-pct-052	GAP-pct-127	GAP-pct-237	GAP-pct-034
GAP-pct-380	GAP-pct-199	GAP-pct-180	GAP-pct-340	GAP-pct-337	GAP-pct-213	GAP-pct-141	GAP-pct-371	GAP-pct-329
GAP-pct-287	GAP-pct-322	GAP-pct-119	GAP-pct-002	GAP-pct-253	GAP-pct-350	GAP-pct-239	GAP-pct-284	GAP-pct-065
GAP-pct-131	GAP-pct-078	GAP-pct-394	GAP-pct-365	GAP-pct-370	GAP-pct-334	GAP-pct-166	GAP-pct-282	GAP-pct-387
GAP-pct-320	GAP-pct-342	GAP-pct-263	GAP-pct-140	GAP-pct-108	GAP-pct-142	GAP-pct-269	GAP-pct-382	GAP-pct-077
GAP-pct-011	GAP-pct-090	GAP-pct-073	GAP-pct-150	GAP-pct-130	GAP-pct-042	GAP-pct-402	GAP-pct-268	GAP-pct-389
GAP-pct-085	GAP-pct-054	GAP-pct-224	GAP-pct-227	GAP-pct-294	GAP-pct-351	GAP-pct-175	GAP-pct-240	GAP-pct-038
std-A2	std-B2	std-C2	std-D2	std-E2	std-F2	std-G2	std-H2	std-I2
GAP-pct-341	GAP-pct-072	GAP-pct-376	GAP-pct-303	GAP-pct-032	GAP-pct-079	GAP-pct-280	GAP-pct-306	GAP-pct-403
GAP-pct-277	GAP-pct-353	GAP-pct-315	GAP-pct-367	GAP-pct-373	GAP-pct-206	GAP-pct-156	GAP-pct-030	GAP-pct-291
GAP-pct-289	GAP-pct-283	GAP-pct-285	GAP-pct-071	GAP-pct-324	GAP-pct-167	GAP-pct-301	GAP-pct-292	GAP-pct-137
GAP-pct-396	GAP-pct-081	GAP-pct-017	GAP-pct-316	GAP-pct-051	GAP-pct-335	GAP-pct-056	GAP-pct-057	GAP-pct-196
GAP-pct-010	GAP-pct-404	GAP-pct-015	GAP-pct-136	GAP-pct-325	GAP-pct-191	GAP-pct-093	GAP-pct-082	GAP-pct-006
GAP-pct-281	GAP-pct-173	GAP-pct-251	GAP-pct-168	GAP-pct-007	GAP-pct-014	GAP-pct-143	GAP-pct-087	GAP-pct-400
GAP-pct-356	GAP-pct-314	GAP-pct-019	GAP-pct-132	GAP-pct-114	GAP-pct-184	GAP-pct-257	GAP-pct-250	GAP-pct-033
GAP-pct-212	GAP-pct-205	GAP-pct-182	GAP-pct-278	GAP-pct-185	GAP-pct-105	GAP-pct-107	GAP-pct-310	GAP-pct-158
GAP-pct-157	GAP-pct-112	GAP-pct-252	GAP-pct-308	GAP-pct-139	GAP-pct-245	GAP-pct-345	GAP-pct-067	GAP-pct-170
GAP-pct-327	GAP-pct-346	GAP-pct-203	GAP-pct-134	GAP-pct-091	GAP-pct-255	GAP-pct-026	GAP-pct-053	GAP-pct-244
std-A3	GAP-pct-147	std-C3	std-D3	GAP-pct-330	std-F3	std-G3	GAP-pct-385	std-I3
	std-B3			std-E3			std-H3	

**Table B-1. ICP or DCP Calibration Blocks for the Leachate Measurements for the PCTs** *(continued)*

PCT Solutions from Oven Runs 7 and 8			PCT Solutions from Oven Runs 9 and 10			PCT Solutions from Oven Runs 11 and 12		
Calibration Block J	Calibration Block K	Calibration Block L	Calibration Block M	Calibration Block N	Calibration Block O	Calibration Block P	Calibration Block Q	Calibration Block R
std-J1	std-K1	std-L1	std-M1	std-N1	std-O1	std-P1	std-Q1	std-R1
GAP-pct-162	GAP-pct-179	GAP-pct-248	GAP-pct-177	GAP-pct-223	GAP-pct-293	GAP-pct-216	GAP-pct-148	GAP-pct-106
GAP-pct-273	GAP-pct-233	GAP-pct-094	GAP-pct-264	GAP-pct-021	GAP-pct-267	GAP-pct-041	GAP-pct-393	GAP-pct-027
GAP-pct-366	GAP-pct-266	GAP-pct-220	GAP-pct-300	GAP-pct-391	GAP-pct-386	GAP-pct-326	GAP-pct-304	GAP-pct-062
GAP-pct-270	GAP-pct-151	GAP-pct-348	GAP-pct-003	GAP-pct-069	GAP-pct-095	GAP-pct-333	GAP-pct-100	GAP-pct-225
GAP-pct-372	GAP-pct-209	GAP-pct-332	GAP-pct-236	GAP-pct-265	GAP-pct-368	GAP-pct-109	GAP-pct-113	GAP-pct-040
GAP-pct-286	GAP-pct-144	GAP-pct-194	GAP-pct-401	GAP-pct-309	GAP-pct-247	GAP-pct-211	GAP-pct-392	GAP-pct-318
GAP-pct-115	GAP-pct-092	GAP-pct-390	GAP-pct-361	GAP-pct-089	GAP-pct-343	GAP-pct-331	GAP-pct-023	GAP-pct-238
GAP-pct-028	GAP-pct-397	GAP-pct-312	GAP-pct-290	GAP-pct-221	GAP-pct-076	GAP-pct-349	GAP-pct-256	GAP-pct-246
GAP-pct-358	GAP-pct-101	GAP-pct-133	GAP-pct-388	GAP-pct-020	GAP-pct-344	GAP-pct-276	GAP-pct-009	GAP-pct-321
GAP-pct-242	GAP-pct-295	GAP-pct-319	GAP-pct-096	GAP-pct-229	GAP-pct-323	GAP-pct-099	GAP-pct-060	GAP-pct-036
GAP-pct-070	GAP-pct-352	GAP-pct-207	GAP-pct-145	GAP-pct-377	GAP-pct-234	GAP-pct-066	GAP-pct-260	GAP-pct-355
std-J2	std-K2	std-L2	std-M2	std-N2	std-O2	std-P2	std-Q2	std-R2
GAP-pct-375	GAP-pct-074	GAP-pct-149	GAP-pct-219	GAP-pct-138	GAP-pct-210	GAP-pct-031	GAP-pct-232	GAP-pct-193
GAP-pct-022	GAP-pct-302	GAP-pct-261	GAP-pct-364	GAP-pct-357	GAP-pct-298	GAP-pct-103	GAP-pct-049	GAP-pct-129
GAP-pct-313	GAP-pct-044	GAP-pct-214	GAP-pct-075	GAP-pct-217	GAP-pct-083	GAP-pct-154	GAP-pct-097	GAP-pct-013
GAP-pct-222	GAP-pct-262	GAP-pct-063	GAP-pct-226	GAP-pct-024	GAP-pct-200	GAP-pct-359	GAP-pct-050	GAP-pct-178
GAP-pct-008	GAP-pct-190	GAP-pct-215	GAP-pct-018	GAP-pct-181	GAP-pct-171	GAP-pct-004	GAP-pct-146	GAP-pct-125
GAP-pct-102	GAP-pct-202	GAP-pct-369	GAP-pct-378	GAP-pct-118	GAP-pct-230	GAP-pct-174	GAP-pct-228	GAP-pct-058
GAP-pct-120	GAP-pct-354	GAP-pct-122	GAP-pct-395	GAP-pct-231	GAP-pct-064	GAP-pct-059	GAP-pct-159	GAP-pct-016
GAP-pct-045	GAP-pct-110	GAP-pct-123	GAP-pct-047	GAP-pct-005	GAP-pct-035	GAP-pct-241	GAP-pct-383	GAP-pct-135
GAP-pct-296	GAP-pct-258	GAP-pct-254	GAP-pct-192	GAP-pct-399	GAP-pct-274	std-P3	GAP-pct-259	std-R3
GAP-pct-152	GAP-pct-305	GAP-pct-338	GAP-pct-311	GAP-pct-218	GAP-pct-153		std-Q3	
std-J3	GAP-pct-128	std-L3	std-M3	GAP-pct-186	std-O3			
	std-K3			std-N3				

**Table B-1. ICP or DCP Calibration Blocks for the Leachate Measurements for the PCTs**  
(continued)

PCT Solutions from Oven Run 13		
Calibration Block S	Calibration Block T	Calibration Block U
std-S1	std-T1	std-U1
GAP-pct-117	GAP-pct-275	GAP-pct-195
GAP-pct-176	GAP-pct-360	GAP-pct-169
GAP-pct-328	GAP-pct-048	GAP-pct-172
GAP-pct-362	GAP-pct-124	GAP-pct-163
GAP-pct-164	GAP-pct-126	GAP-pct-012
std-S2	std-T2	std-U2
GAP-pct-363	GAP-pct-299	GAP-pct-039
GAP-pct-001	GAP-pct-374	GAP-pct-061
GAP-pct-271	GAP-pct-272	GAP-pct-037
GAP-pct-347	std-T3	GAP-pct-204
std-S3		std-U3

Table B-2 provides a template for use by VSL in reporting these results. A value below its detection limit should be indicated in this table by a less than sign (“<”) followed by the detection limit.

**Table B-2. Reporting Template for the Leachate Measurements for the PCTs**

Oven Runs	Calibration Block	Sample ID	B Boron(ppm)	Li Lithium(ppm)	Na Sodium(ppm)	Si Silicon(ppm)
1 and 2	A	std-A1				
1 and 2	A	GAP-pct-201				
1 and 2	A	GAP-pct-046				
1 and 2	A	GAP-pct-080				
1 and 2	A	GAP-pct-307				
1 and 2	A	GAP-pct-398				
1 and 2	A	GAP-pct-380				
1 and 2	A	GAP-pct-287				
1 and 2	A	GAP-pct-131				
1 and 2	A	GAP-pct-320				
1 and 2	A	GAP-pct-011				
1 and 2	A	GAP-pct-085				
1 and 2	A	std-A2				
1 and 2	A	GAP-pct-341				
1 and 2	A	GAP-pct-277				
1 and 2	A	GAP-pct-289				
1 and 2	A	GAP-pct-396				
1 and 2	A	GAP-pct-010				
1 and 2	A	GAP-pct-281				
1 and 2	A	GAP-pct-356				
1 and 2	A	GAP-pct-212				
1 and 2	A	GAP-pct-157				
1 and 2	A	GAP-pct-327				
1 and 2	A	std-A3				
1 and 2	B	std-B1				
1 and 2	B	GAP-pct-381				
1 and 2	B	GAP-pct-317				
1 and 2	B	GAP-pct-384				
1 and 2	B	GAP-pct-116				
1 and 2	B	GAP-pct-379				
1 and 2	B	GAP-pct-199				
1 and 2	B	GAP-pct-322				
1 and 2	B	GAP-pct-078				
1 and 2	B	GAP-pct-342				
1 and 2	B	GAP-pct-090				
1 and 2	B	GAP-pct-054				
1 and 2	B	std-B2				
1 and 2	B	GAP-pct-072				
1 and 2	B	GAP-pct-353				
1 and 2	B	GAP-pct-283				
1 and 2	B	GAP-pct-081				
1 and 2	B	GAP-pct-404				
1 and 2	B	GAP-pct-173				
1 and 2	B	GAP-pct-314				
1 and 2	B	GAP-pct-205				
1 and 2	B	GAP-pct-112				
1 and 2	B	GAP-pct-346				
1 and 2	B	GAP-pct-147				
1 and 2	B	std-B3				
1 and 2	C	std-C1				
1 and 2	C	GAP-pct-197				
1 and 2	C	GAP-pct-088				
1 and 2	C	GAP-pct-104				
1 and 2	C	GAP-pct-188				
1 and 2	C	GAP-pct-187				
1 and 2	C	GAP-pct-180				
1 and 2	C	GAP-pct-119				
1 and 2	C	GAP-pct-394				
1 and 2	C	GAP-pct-263				
1 and 2	C	GAP-pct-073				
1 and 2	C	GAP-pct-224				

Oven Runs	Calibration Block	Sample ID	B Boron(ppm)	Li Lithium(ppm)	Na Sodium(ppm)	Si Silicon(ppm)
1 and 2	C	std-C2				
1 and 2	C	GAP-pct-376				
1 and 2	C	GAP-pct-315				
1 and 2	C	GAP-pct-285				
1 and 2	C	GAP-pct-017				
1 and 2	C	GAP-pct-015				
1 and 2	C	GAP-pct-251				
1 and 2	C	GAP-pct-019				
1 and 2	C	GAP-pct-182				
1 and 2	C	GAP-pct-252				
1 and 2	C	GAP-pct-203				
1 and 2	C	std-C3				
3 and 4	D	std-D1				
3 and 4	D	GAP-pct-208				
3 and 4	D	GAP-pct-086				
3 and 4	D	GAP-pct-043				
3 and 4	D	GAP-pct-297				
3 and 4	D	GAP-pct-121				
3 and 4	D	GAP-pct-340				
3 and 4	D	GAP-pct-002				
3 and 4	D	GAP-pct-365				
3 and 4	D	GAP-pct-140				
3 and 4	D	GAP-pct-150				
3 and 4	D	GAP-pct-227				
3 and 4	D	std-D2				
3 and 4	D	GAP-pct-303				
3 and 4	D	GAP-pct-367				
3 and 4	D	GAP-pct-071				
3 and 4	D	GAP-pct-316				
3 and 4	D	GAP-pct-136				
3 and 4	D	GAP-pct-168				
3 and 4	D	GAP-pct-132				
3 and 4	D	GAP-pct-278				
3 and 4	D	GAP-pct-308				
3 and 4	D	GAP-pct-134				
3 and 4	D	std-D3				
3 and 4	E	std-E1				
3 and 4	E	GAP-pct-336				
3 and 4	E	GAP-pct-155				
3 and 4	E	GAP-pct-111				
3 and 4	E	GAP-pct-068				
3 and 4	E	GAP-pct-098				
3 and 4	E	GAP-pct-337				
3 and 4	E	GAP-pct-253				
3 and 4	E	GAP-pct-370				
3 and 4	E	GAP-pct-108				
3 and 4	E	GAP-pct-130				
3 and 4	E	GAP-pct-294				
3 and 4	E	std-E2				
3 and 4	E	GAP-pct-032				
3 and 4	E	GAP-pct-373				
3 and 4	E	GAP-pct-324				
3 and 4	E	GAP-pct-051				
3 and 4	E	GAP-pct-325				
3 and 4	E	GAP-pct-007				
3 and 4	E	GAP-pct-114				
3 and 4	E	GAP-pct-185				
3 and 4	E	GAP-pct-139				
3 and 4	E	GAP-pct-091				
3 and 4	E	GAP-pct-330				
3 and 4	E	std-E3				
3 and 4	F	std-F1				
3 and 4	F	GAP-pct-160				
3 and 4	F	GAP-pct-198				
3 and 4	F	GAP-pct-189				

Oven Runs	Calibration Block	Sample ID	B Boron(ppm)	Li Lithium(ppm)	Na Sodium(ppm)	Si Silicon(ppm)
3 and 4	F	GAP-pct-029				
3 and 4	F	GAP-pct-052				
3 and 4	F	GAP-pct-213				
3 and 4	F	GAP-pct-350				
3 and 4	F	GAP-pct-334				
3 and 4	F	GAP-pct-142				
3 and 4	F	GAP-pct-042				
3 and 4	F	GAP-pct-351				
3 and 4	F	std-F2				
3 and 4	F	GAP-pct-079				
3 and 4	F	GAP-pct-206				
3 and 4	F	GAP-pct-167				
3 and 4	F	GAP-pct-335				
3 and 4	F	GAP-pct-191				
3 and 4	F	GAP-pct-014				
3 and 4	F	GAP-pct-184				
3 and 4	F	GAP-pct-105				
3 and 4	F	GAP-pct-245				
3 and 4	F	GAP-pct-255				
3 and 4	F	std-F3				
5 and 6	G	std-G1				
5 and 6	G	GAP-pct-279				
5 and 6	G	GAP-pct-055				
5 and 6	G	GAP-pct-235				
5 and 6	G	GAP-pct-025				
5 and 6	G	GAP-pct-127				
5 and 6	G	GAP-pct-141				
5 and 6	G	GAP-pct-239				
5 and 6	G	GAP-pct-166				
5 and 6	G	GAP-pct-269				
5 and 6	G	GAP-pct-402				
5 and 6	G	GAP-pct-175				
5 and 6	G	std-G2				
5 and 6	G	GAP-pct-280				
5 and 6	G	GAP-pct-156				
5 and 6	G	GAP-pct-301				
5 and 6	G	GAP-pct-056				
5 and 6	G	GAP-pct-093				
5 and 6	G	GAP-pct-143				
5 and 6	G	GAP-pct-257				
5 and 6	G	GAP-pct-107				
5 and 6	G	GAP-pct-345				
5 and 6	G	GAP-pct-026				
5 and 6	G	std-G3				
5 and 6	H	std-H1				
5 and 6	H	GAP-pct-183				
5 and 6	H	GAP-pct-084				
5 and 6	H	GAP-pct-288				
5 and 6	H	GAP-pct-243				
5 and 6	H	GAP-pct-237				
5 and 6	H	GAP-pct-371				
5 and 6	H	GAP-pct-284				
5 and 6	H	GAP-pct-282				
5 and 6	H	GAP-pct-382				
5 and 6	H	GAP-pct-268				
5 and 6	H	GAP-pct-240				
5 and 6	H	std-H2				
5 and 6	H	GAP-pct-306				
5 and 6	H	GAP-pct-030				
5 and 6	H	GAP-pct-292				
5 and 6	H	GAP-pct-057				
5 and 6	H	GAP-pct-082				
5 and 6	H	GAP-pct-087				
5 and 6	H	GAP-pct-250				
5 and 6	H	GAP-pct-310				

Oven Runs	Calibration Block	Sample ID	B Boron(ppm)	Li Lithium(ppm)	Na Sodium(ppm)	Si Silicon(ppm)
5 and 6	H	GAP-pct-067				
5 and 6	H	GAP-pct-053				
5 and 6	H	GAP-pct-385				
5 and 6	H	std-H3				
5 and 6	I	std-I1				
5 and 6	I	GAP-pct-165				
5 and 6	I	GAP-pct-161				
5 and 6	I	GAP-pct-339				
5 and 6	I	GAP-pct-249				
5 and 6	I	GAP-pct-034				
5 and 6	I	GAP-pct-329				
5 and 6	I	GAP-pct-065				
5 and 6	I	GAP-pct-387				
5 and 6	I	GAP-pct-077				
5 and 6	I	GAP-pct-389				
5 and 6	I	GAP-pct-038				
5 and 6	I	std-I2				
5 and 6	I	GAP-pct-403				
5 and 6	I	GAP-pct-291				
5 and 6	I	GAP-pct-137				
5 and 6	I	GAP-pct-196				
5 and 6	I	GAP-pct-006				
5 and 6	I	GAP-pct-400				
5 and 6	I	GAP-pct-033				
5 and 6	I	GAP-pct-158				
5 and 6	I	GAP-pct-170				
5 and 6	I	GAP-pct-244				
5 and 6	I	std-I3				
7 and 8	J	std-J1				
7 and 8	J	GAP-pct-162				
7 and 8	J	GAP-pct-273				
7 and 8	J	GAP-pct-366				
7 and 8	J	GAP-pct-270				
7 and 8	J	GAP-pct-372				
7 and 8	J	GAP-pct-286				
7 and 8	J	GAP-pct-115				
7 and 8	J	GAP-pct-028				
7 and 8	J	GAP-pct-358				
7 and 8	J	GAP-pct-242				
7 and 8	J	GAP-pct-070				
7 and 8	J	std-J2				
7 and 8	J	GAP-pct-375				
7 and 8	J	GAP-pct-022				
7 and 8	J	GAP-pct-313				
7 and 8	J	GAP-pct-222				
7 and 8	J	GAP-pct-008				
7 and 8	J	GAP-pct-102				
7 and 8	J	GAP-pct-120				
7 and 8	J	GAP-pct-045				
7 and 8	J	GAP-pct-296				
7 and 8	J	GAP-pct-152				
7 and 8	J	std-J3				
7 and 8	K	std-K1				
7 and 8	K	GAP-pct-179				
7 and 8	K	GAP-pct-233				
7 and 8	K	GAP-pct-266				
7 and 8	K	GAP-pct-151				
7 and 8	K	GAP-pct-209				
7 and 8	K	GAP-pct-144				
7 and 8	K	GAP-pct-092				
7 and 8	K	GAP-pct-397				
7 and 8	K	GAP-pct-101				
7 and 8	K	GAP-pct-295				
7 and 8	K	GAP-pct-352				
7 and 8	K	std-K2				

Oven Runs	Calibration Block	Sample ID	B Boron(ppm)	Li Lithium(ppm)	Na Sodium(ppm)	Si Silicon(ppm)
7 and 8	K	GAP-pct-074				
7 and 8	K	GAP-pct-302				
7 and 8	K	GAP-pct-044				
7 and 8	K	GAP-pct-262				
7 and 8	K	GAP-pct-190				
7 and 8	K	GAP-pct-202				
7 and 8	K	GAP-pct-354				
7 and 8	K	GAP-pct-110				
7 and 8	K	GAP-pct-258				
7 and 8	K	GAP-pct-305				
7 and 8	K	GAP-pct-128				
7 and 8	K	std-K3				
7 and 8	L	std-L1				
7 and 8	L	GAP-pct-248				
7 and 8	L	GAP-pct-094				
7 and 8	L	GAP-pct-220				
7 and 8	L	GAP-pct-348				
7 and 8	L	GAP-pct-332				
7 and 8	L	GAP-pct-194				
7 and 8	L	GAP-pct-390				
7 and 8	L	GAP-pct-312				
7 and 8	L	GAP-pct-133				
7 and 8	L	GAP-pct-319				
7 and 8	L	GAP-pct-207				
7 and 8	L	std-L2				
7 and 8	L	GAP-pct-149				
7 and 8	L	GAP-pct-261				
7 and 8	L	GAP-pct-214				
7 and 8	L	GAP-pct-063				
7 and 8	L	GAP-pct-215				
7 and 8	L	GAP-pct-369				
7 and 8	L	GAP-pct-122				
7 and 8	L	GAP-pct-123				
7 and 8	L	GAP-pct-254				
7 and 8	L	GAP-pct-338				
7 and 8	L	std-L3				
9 and 10	M	std-M1				
9 and 10	M	GAP-pct-177				
9 and 10	M	GAP-pct-264				
9 and 10	M	GAP-pct-300				
9 and 10	M	GAP-pct-003				
9 and 10	M	GAP-pct-236				
9 and 10	M	GAP-pct-401				
9 and 10	M	GAP-pct-361				
9 and 10	M	GAP-pct-290				
9 and 10	M	GAP-pct-388				
9 and 10	M	GAP-pct-096				
9 and 10	M	GAP-pct-145				
9 and 10	M	std-M2				
9 and 10	M	GAP-pct-219				
9 and 10	M	GAP-pct-364				
9 and 10	M	GAP-pct-075				
9 and 10	M	GAP-pct-226				
9 and 10	M	GAP-pct-018				
9 and 10	M	GAP-pct-378				
9 and 10	M	GAP-pct-395				
9 and 10	M	GAP-pct-047				
9 and 10	M	GAP-pct-192				
9 and 10	M	GAP-pct-311				
9 and 10	M	std-M3				
9 and 10	N	std-N1				
9 and 10	N	GAP-pct-223				
9 and 10	N	GAP-pct-021				
9 and 10	N	GAP-pct-391				
9 and 10	N	GAP-pct-069				



Oven Runs	Calibration Block	Sample ID	B Boron(ppm)	Li Lithium(ppm)	Na Sodium(ppm)	Si Silicon(ppm)
9 and 10	N	GAP-pct-265				
9 and 10	N	GAP-pct-309				
9 and 10	N	GAP-pct-089				
9 and 10	N	GAP-pct-221				
9 and 10	N	GAP-pct-020				
9 and 10	N	GAP-pct-229				
9 and 10	N	GAP-pct-377				
9 and 10	N	std-N2				
9 and 10	N	GAP-pct-138				
9 and 10	N	GAP-pct-357				
9 and 10	N	GAP-pct-217				
9 and 10	N	GAP-pct-024				
9 and 10	N	GAP-pct-181				
9 and 10	N	GAP-pct-118				
9 and 10	N	GAP-pct-231				
9 and 10	N	GAP-pct-005				
9 and 10	N	GAP-pct-399				
9 and 10	N	GAP-pct-218				
9 and 10	N	GAP-pct-186				
9 and 10	N	std-N3				
9 and 10	O	std-O1				
9 and 10	O	GAP-pct-293				
9 and 10	O	GAP-pct-267				
9 and 10	O	GAP-pct-386				
9 and 10	O	GAP-pct-095				
9 and 10	O	GAP-pct-368				
9 and 10	O	GAP-pct-247				
9 and 10	O	GAP-pct-343				
9 and 10	O	GAP-pct-076				
9 and 10	O	GAP-pct-344				
9 and 10	O	GAP-pct-323				
9 and 10	O	GAP-pct-234				
9 and 10	O	std-O2				
9 and 10	O	GAP-pct-210				
9 and 10	O	GAP-pct-298				
9 and 10	O	GAP-pct-083				
9 and 10	O	GAP-pct-200				
9 and 10	O	GAP-pct-171				
9 and 10	O	GAP-pct-230				
9 and 10	O	GAP-pct-064				
9 and 10	O	GAP-pct-035				
9 and 10	O	GAP-pct-274				
9 and 10	O	GAP-pct-153				
9 and 10	O	std-O3				
11 and 12	P	std-P1				
11 and 12	P	GAP-pct-216				
11 and 12	P	GAP-pct-041				
11 and 12	P	GAP-pct-326				
11 and 12	P	GAP-pct-333				
11 and 12	P	GAP-pct-109				
11 and 12	P	GAP-pct-211				
11 and 12	P	GAP-pct-331				
11 and 12	P	GAP-pct-349				
11 and 12	P	GAP-pct-276				
11 and 12	P	GAP-pct-099				
11 and 12	P	GAP-pct-066				
11 and 12	P	std-P2				
11 and 12	P	GAP-pct-031				
11 and 12	P	GAP-pct-103				
11 and 12	P	GAP-pct-154				
11 and 12	P	GAP-pct-359				
11 and 12	P	GAP-pct-004				
11 and 12	P	GAP-pct-174				
11 and 12	P	GAP-pct-059				
11 and 12	P	GAP-pct-241				

Oven Runs	Calibration Block	Sample ID	B Boron(ppm)	Li Lithium(ppm)	Na Sodium(ppm)	Si Silicon(ppm)
11 and 12	P	std-P3				
11 and 12	Q	std-Q1				
11 and 12	Q	GAP-pct-148				
11 and 12	Q	GAP-pct-393				
11 and 12	Q	GAP-pct-304				
11 and 12	Q	GAP-pct-100				
11 and 12	Q	GAP-pct-113				
11 and 12	Q	GAP-pct-392				
11 and 12	Q	GAP-pct-023				
11 and 12	Q	GAP-pct-256				
11 and 12	Q	GAP-pct-009				
11 and 12	Q	GAP-pct-060				
11 and 12	Q	GAP-pct-260				
11 and 12	Q	std-Q2				
11 and 12	Q	GAP-pct-232				
11 and 12	Q	GAP-pct-049				
11 and 12	Q	GAP-pct-097				
11 and 12	Q	GAP-pct-050				
11 and 12	Q	GAP-pct-146				
11 and 12	Q	GAP-pct-228				
11 and 12	Q	GAP-pct-159				
11 and 12	Q	GAP-pct-383				
11 and 12	Q	GAP-pct-259				
11 and 12	Q	std-Q3				
11 and 12	R	std-R1				
11 and 12	R	GAP-pct-106				
11 and 12	R	GAP-pct-027				
11 and 12	R	GAP-pct-062				
11 and 12	R	GAP-pct-225				
11 and 12	R	GAP-pct-040				
11 and 12	R	GAP-pct-318				
11 and 12	R	GAP-pct-238				
11 and 12	R	GAP-pct-246				
11 and 12	R	GAP-pct-321				
11 and 12	R	GAP-pct-036				
11 and 12	R	GAP-pct-355				
11 and 12	R	std-R2				
11 and 12	R	GAP-pct-193				
11 and 12	R	GAP-pct-129				
11 and 12	R	GAP-pct-013				
11 and 12	R	GAP-pct-178				
11 and 12	R	GAP-pct-125				
11 and 12	R	GAP-pct-058				
11 and 12	R	GAP-pct-016				
11 and 12	R	GAP-pct-135				
11 and 12	R	std-R3				
13	S	std-S1				
13	S	GAP-pct-117				
13	S	GAP-pct-176				
13	S	GAP-pct-328				
13	S	GAP-pct-362				
13	S	GAP-pct-164				
13	S	std-S2				
13	S	GAP-pct-363				
13	S	GAP-pct-001				
13	S	GAP-pct-271				
13	S	GAP-pct-347				
13	S	std-S3				
13	T	std-T1				
13	T	GAP-pct-275				
13	T	GAP-pct-360				
13	T	GAP-pct-048				
13	T	GAP-pct-124				
13	T	GAP-pct-126				
13	T	std-T2				

Oven Runs	Calibration Block	Sample ID	B Boron(ppm)	Li Lithium(ppm)	Na Sodium(ppm)	Si Silicon(ppm)
13	T	GAP-pct-299				
13	T	GAP-pct-374				
13	T	GAP-pct-272				
13	T	std-T3				
13	U	std-U1				
13	U	GAP-pct-195				
13	U	GAP-pct-169				
13	U	GAP-pct-172				
13	U	GAP-pct-163				
13	U	GAP-pct-012				
13	U	std-U2				
13	U	GAP-pct-039				
13	U	GAP-pct-061				
13	U	GAP-pct-037				
13	U	GAP-pct-204				
13	U	std-U3				

**Distribution:**

*SRS Distribution*

S. L. Marra, 773-A  
T. B. Brown, 773-A  
D. H. McGuire, 999-W  
S. D. Fink, 773-A  
C. C. Herman, 773-A  
E. N. Hoffman, 999-W  
F. M. Pennebaker, 773-42A  
W. R. Wilmarth, 773-A  
Records Administration (EDWS)  
J. M. Bricker, 704-30S  
J. S. Contardi, 704-56H  
T. L. Fellingner, 766-H  
E. J. Freed, 704-S  
J. M. Gillam, 766-H  
B. A. Hamm, 766-H  
E. W. Holtzscheiter, 766-H  
J. F. Iaukea, 704-27S  
D. K. Peeler, 999-W  
J. W. Ray, 704-27S  
P. J. Ryan, 704-S  
H. B. Shah, 766-H  
D. C. Sherburne, 704-S  
M. E. Stone, 999-W  
V. Jain, 766-H  
A. R. Shafer, 704-27S  
P. R. Jackson, DOE-SR, 703-46A  
J. A. Crenshaw, 703-46A  
J. R. Vitali, 766-H  
M. A. Broome, 704-29S  
R. N. Hinds, 704-S  
W. A. Drown, 773-41  
W.B. Van Pelt, 766-H  
B.T. Geyer, 704-72S

*CUA/VSL Distribution*

Wing Kot, CUA/VSL  
Ian Pegg CUA/VSL

*ES Distribution*

Brad Bowen, ES  
Glenn Diener, ES