U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352
DEC 2 2 2006

06-ESQ-174

Ms. Jane Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Mr. Richard Albright, Director
Waste and Chemicals Management
U.S. Environmental Protection Agency
Region 10
Office of Waste and Chemicals Management (WCM-127)
1200 Sixth Avenue
Seattle, Washington 98101

Addressees:

MILESTONE M-62-03, DELISTING PETITION FOR IMMOBILIZED HIGH-LEVEL WASTE (IHLW)

This letter transmits the Petition to delist IHLW generated at the Hanford Tank Waste Treatment and Immobilization Plant (WTP) required by Hanford Federal Facility Agreement and Consent Order (HFFACO) Milestone M-62-03 (Attachment). HFFACO Milestone M-62-03, "Submit DOE Petition for RCRA Delisting of Vitrified HLW," is due December 31, 2006.

When M-62-03 was agreed upon, submittal of the delisting petition was scheduled for one year prior to hot commissioning of the WTP. Since operation of the WTP has been delayed until approximately 2019, the U.S. Department of Energy, Office of River Protection (ORP) recognizes this submittal of the delisting petition is earlier than anticipated in the project life. ORP recognizes the possibility that the Environmental Protection Agency and the Washington State Department of Ecology may not view this petition as ready for decision-making. ORP, however, is submitting this petition to fulfill its HFFACO milestone commitment.

If you have any questions, please contact me, or your staff may contact Lori A. Huffman, Office of Environmental Safety and Quality, (509) 376-0104.

Sincerely,

Roy J. Schepens, Manager
Office of River Protection

ESQ:LAH

Attachment

cc w/CD attach:
W. S. Elkins, BNI
B. Becker-Khaleel, Ecology
J. W. Yokel, Ecology
D. Bartus, EPA
N. Ceto, EPA
Administrative Record (WTP H-0-8)
Environmental Portal, LMSI

cc w/o attach:
F. Marcinowski, EM-10
L. Bostic, BNI
B. G. Erlandson, BNI
J. Cox, CTUIR
S. Harris, CTUIR
L. Cusack, Ecology
S. L. Dahl, Ecology
G. P. Davis, Ecology
S. A. Thompson, FHI
G. Bohnee, NPT
K. Niles, Oregon Energy
A. C. McKarns, RL
R. Jim, YN

Attachment
06-ESQ-174

Petition to Delist Immobilized High-Level Waste Generated at the Hanford Tank Waste Treatment and Immobilization Plant

ISSUED BY
RPP-WTP PDC

R10742743

Document title: **Petition to Delist Immobilized High-Level Waste Generated at the Hanford Tank Waste Treatment and Immobilization Plant**

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Department:	Environmental and Nuclear Safety
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Principal author signature:	David Blumenkranz
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Date of issue:	22 December 2006
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Approved by:	P Peistrup
Approver's position:	Environmental Manager
Approver signature:	

River Protection Project
Waste Treatment Plant
2435 Stevens Center Place
Richland, WA 99354
United States of America
Tel: 509 371 2000

History Sheet

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DOE/ORP-2006-03
Revision 0

Petition to Delist Immobilized High-Level Waste Generated at the Waste Treatment and Immobilization Plant

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Office of River Protection

P.O. Box 450
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/ORP-2006-03
Revision 0

Petition to Delist Immobilized High-Level Waste Generated at the Waste Treatment and Immobilization Plant

Date Published
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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

[redacted]

P.O. Box 450
Richland, Washington 99352

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Release Approval Date

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Executive Summary

The Hanford Site, in southeastern Washington State, is owned by the US Government and operated by the US Department of Energy (DOE). Currently, 177 underground storage tanks are being managed by the DOE Office of River Protection (ORP). Of these, 149 are single-shell tanks (SSTs) and 28 are double-shell tanks (DSTs). These tanks contain low-level, low-activity, transuranic, and high-level wastes (LLW, LAW, TRU, and HLW). For reasons of consistency and conservatism, DOE has historically chosen to manage all of the tanks as if they contain HLW. Consequently, when the terms "HLW" or "HLW feed" are used herein, they are used in a generic sense and do not necessarily include other types of waste, e.g., TRU, which may be addressed in a different manner.

These tanks contain mixed waste, that is, the waste contains source, special nuclear, or by-product material regulated by DOE under the AEA; and a hazardous component regulated by the Washington State Department of Ecology (Ecology) under the authorities provided in the *Resource Conservation and Recovery Act* (RCRA) and the *Washington State Hazardous Waste Management Act* (HWMA) and their implementing regulations. DOE asserts that it has sole authority to regulate the radioactive component of mixed waste. Accordingly, although the delisting petition refers to and describes actions involving the radioactive component of mixed waste, that information is presented to provide complete information and to enhance understanding of the process described therein. The Hanford Site operated for nearly 50 years as a nuclear weapon production facility. Mixed wastes resulting from historical weapon production activities are stored in underground storage tanks on the Hanford Site. The Hanford Site is no longer involved in weapon production activities; primary activities involve management and cleanup of previously generated wastes.

The Hanford Tank Waste Treatment and Immobilization Plant (WTP), a future treatment and storage facility, is being constructed to treat the Hanford Site tank waste in preparation for final storage or disposal. A portion of those treated wastes, vitrified, or "immobilized" HLW (IHLW), is planned to be disposed of in the proposed geologic repository at Yucca Mountain, Nevada (National Geologic Repository). The National Geologic Repository will be licensed by the Nuclear Regulatory Commission, but will not be a RCRA permitted facility. Therefore, IHLW to be disposed of at the National Geologic Repository will need to be excluded from regulation as a hazardous waste under RCRA and analogous state statutes.

The purpose of this petition is to provide the regulatory and technical basis, with supporting documentation, to obtain approval to exclude IHLW from regulation as a hazardous waste under RCRA.

The WTP will receive slurried waste from the Hanford waste tank system. The waste slurry will contain supernatant and suspended solids that will be separated into low-activity and high-level fractions (LAW and HLW feed streams). The two waste fractions will be separated in the WTP pretreatment (PT) facility using a combination of processes such as concentrating waste through evaporation, removing HLW constituents from the LAW fraction through ultra-filtration, and ion exchange. Additionally, LAW feed containing strontium and TRU above feed specification limits will be subjected to a precipitation process so that precipitated strontium and TRU can be removed from the LAW feed stream and combined with the HLW feed stream. Secondary waste streams such as evaporator condensate, ion exchange eluates, and rinse solutions will be generated as a byproduct of pretreatment. These streams will be recycled into the pretreatment process and combined with LAW or HLW. Throughout the pretreatment process, critical operating parameters and feed constituent concentrations will be monitored to ensure adequate

process control. Constituent concentration anomalies will be detected during pretreatment, and the process will be adjusted to produce a final waste form that meets applicable requirements. Using this approach, the pretreatment unit operations can be extended or shortened, and recycle stream additions can be adjusted so that the WTP maintains processing flexibility such that waste feeds of dramatically varied composition can be treated. After pretreatment, the waste feed will be transferred to the appropriate vitrification facility (LAW or HLW), where the content of the pretreated feed will be verified by process sampling just before glass forming chemicals (GFCs) are added. Variations in pretreatment can be tolerated since GFC addition can be used to compensate for feed variability, and an appropriate glass formulation can be produced on a batch-by-batch basis. The combined waste feed and GFCs will be blended and fed to one of two HLW glass melters (LAW is also vitrified, but it is not the subject of this petition). Under the intense heat of the melter, volatile and unstable waste constituents will be volatilized or destroyed. Inorganic metals and radionuclides remaining in the melter will oxidize in the melt pool, forming molten glass with the GFCs. The molten HLW glasses will be discharged from the melters into metal containers, where it will cool to form solid IHLW. During this process, waste constituents will be bound as part of a glass matrix through iono-covalent bonding. The resultant IHLW will significantly reduce the potential threat to human health and the environment by immobilizing remaining hazardous and radioactive constituents into a durable form.

The data in this petition demonstrate that the WTP vitrification process will produce IHLW that will meet the criteria for delisting by immobilizing hazardous constituents of concern such that they will not leach from the vitrified waste form at levels that would exceed health-based delisting limits. The data in this petition clearly show that properly vitrified HLW no longer meets the criteria for which it was originally listed as a hazardous waste.

Framework for Delisting Petitions

For ease of reference, the US Environmental Protection Agency (EPA) checklist identifiers from the *RCRA Delisting Program Guidance Manual for the Petitioner*, Appendix A, "Framework for Delisting Petitions" (EPA 2000) appear in brackets after the section headings and subheadings. A checklist in this section of this petition indicates the location of the requested information as stated in EPA's guidance, referenced by the checklist identifiers. This cross-referencing simplifies review in instances where the chapters are not organized in the same manner as the guidance. Several reports are provided as standalone documents in the appendices and supplements to this petition.

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
Part 1: Delisting Administration Information	1
1) Name of Petitioner a. Name of individual or firm sending petition. b. Mailing address of individual or firm (Street/P.O. Box, City, State, Zip Code, Telephone No., Fax No.)	1.1
2) People to Contact for Additional Information Pertaining to this Petition. a. Name, Title, Telephone No. b. Mailing Address of contact(s) if different from petitioner (Street/P.O. Box, City, State, Zip Code)	1.2
3) Facility Responsible for Generating Petitioned Waste. a. Name of Facility: b. Location of Facility (Street, City, State, Zip Code) c. RCRA ID Number	1.3
4) Location of Petitioned Waste. Same as facility name and address given in item 3; or a. Name of Facility b. Location of Facility (Street, City, State, Zip Code) c. RCRA ID Number	1.4
5) Describe the proposed delisting action.	1.5
6) Provide a statement of the need and justification for the proposed action.	1.6

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
7) Signed Certification Statement I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for getting the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for sending false information, including the possibility of fine and imprisonment. Signed by Authorized Representative* (Signature, Typed Name, Title) *Note: An "authorized representative" is a person responsible for the overall operation of a facility or an operational unit (i.e., part of the facility), for example, a plant manager, superintendent, or person of equivalent responsibility. Consultants or other outside parties should not sign the certification statement.	1.7
Part 2: Delisting Waste and Waste Management Information	2
1) Which of the following scenarios best describes the petitioned waste? (Choose the most appropriate scenario and provide the information requested for the chosen scenario.)	2.1
a. Petitioned waste is not a mixture of two or more listed hazardous wastes (Common Name of Petitioned Waste, EPA Hazardous Waste Number, Hazardous Waste Description).	N/A
b. Petitioned waste is a mixture of two or more listed hazardous wastes (Common Name of Mixture). For all listed wastes provide: EPA Hazardous Waste Number, Hazardous Waste description, Common Name.	N/A
c. Petitioned waste is a mixture of one or more solid non-hazardous wastes and one or more listed hazardous wastes, as described in 40 CFR 2631.3 (a) (2) (iii-iv) (Common name of mixture, Solid waste(s) common name(s)). For all listed wastes provide: EPA Hazardous Waste Number, Hazardous waste description, Common name).	N/A
d. Petitioned waste is generated from the treatment, storage, or disposal of one or more listed hazardous wastes (or solid non-hazardous and listed hazardous waste mixture), as described in 40 CFR 261.3 (c) (2) (i) (Description of petitioned waste, Common name of petitioned waste, Solid waste(s) common name(s)). For all listed wastes provide: EPA Hazardous Waste Number, Hazardous waste description, Common name.	2.1
2) Describe the physical form of the petitioned waste (e.g., solid, liquid).	2.2

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
3) If the physical form is sludge or liquid, estimate based on waste analysis the percentage of solids (e.g., provide a range).	2.4
HISTORY OF WASTE GENERATION	2.5
4) Which of the following describes the generation of the petitioned waste: (Indicate those that apply and provide the information requested for each item.)	2.5
a. Waste has been generated in the past. (Provide the year when waste was first generated, provide the year when waste generation ended [if applicable]).	2.5.1
b. Waste is presently being generated. (Provide the year when waste was first generated)	2.5.2
c. Waste will be generated in the future.	2.5.3
VOLUME OF PETITIONED WASTE	
5) Is the petition for a waste of fixed quantity (e.g., a discrete volume of waste contained in a unit)? YES (Answer item 5a), NO (Answer item 5b)	2.6
a. Petitioned waste is/will be a fixed quantity. (Estimated volume, Quantity, Unit of Measurement). Describe the method of volume estimation.	N/A
b. Petitioned waste is/will be generated on a routine or continuous basis. (Monthly and Annual Volume of Average Quantity, Maximum Quantity, Unit of Measurement). Describe the method of volume estimation.	2.6
HISTORY OF WASTE MANAGEMENT	2.7
6) As appropriate, describe the present, past, and proposed waste management methods for the petitioned waste.	2.7
a. Present waste management methods, and off-site facility or facilities used (name, address, and waste management method).	2.7.1
b. Past waste management methods, if different from present, and off-site facility or facilities used (name, address, and waste management method).	2.7.2
c. Proposed waste management methods if delisting petition is granted, and off-site facility or facilities to be used (name, address, and waste management method).	2.7.3
Part 3: Delisting Process Information — General Operation at the Generating Facility	3.1
1) Describe facility business area(s) and operations. Include SIC code(s).	3.1.1

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
2) List and describe products manufactured at the facility.	3.1.2
3) List and describe all wastes (including all hazardous wastes) generated at the facility.	3.1.3
4) Describe your manufacturing and waste treatment areas and waste management units. Attach schematic showing the layout of the facility.	3.1.4
5) Describe the regulatory status of all on-site waste treatment, storage, and disposal units. Include a list of all hazardous waste permits and other permits issued under Federal and State environmental statutes. Include the permit numbers in this list.	3.1.5
CONTRIBUTING MANUFACTURING PROCESSES	3.2
6) Describe and include schematics of all "pre-process" steps used to prepare materials for processing before primary manufacturing operation, including surface and equipment preparation operations. Identify all pre-process material inputs and outputs in your descriptions and schematics.	3.2.1
7) Provide a step-by-step description and schematic of each manufacturing process contributing to the petitioned waste. Include each process step, reactions occurring, flow rated, and material inputs and outputs, as well as reaction intermediates and byproducts. Identify and describe waste inputs and outputs on the schematic(s) and show how each waste is managed.	3.2.2
8) Describe, and identify on the schematic, exactly where the petitioned waste is generated (if generated by a manufacturing process).	3.2.3
9) List and describe all process equipment, including the function of each unit and the ranges of the operating parameters.	3.2.4
10) Describe all of your operating cycles (batch cycles, versus continuous operation, start-up, shut-down, maintenance, cleaning) on a daily, weekly, or other period basis, as appropriate. Identify periods when process wastes are not generated (e.g., plant shut-downs or routine equipment maintenance).	3.2.4
11) Assess the extent that all contributing manufacturing processes, operations process materials, or generated wastes have varied in the past or may vary in the future.	3.2.5
12) Describe how the composition and generation rate of the petitioned waste may periodically vary due to any aspect of manufacturing process variability.	3.2.6
13) Does a waste treatment process contribute to the petitioned waste? YES (continue to item 14), NO (skip to item 22)	3.3.1

Framework for Delisting Petitions **(see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)**	**Petition Location / Section Number**
CONTRIBUTING WASTE TREATMENT PROCESSES	3.3
14) Provide a step-by-step description and schematic of each waste treatment process contributing to the petitioned waste. Include process steps, reactions occurring, flow rates, material inputs, and waste inputs and outputs.	3.3.2
15) Describe, and identify on the schematic, exactly where the petitioned waste is generated (if applicable).	3.3.3
16) Identify and describe waste inputs and outputs on the schematic(s) and show how each waste is managed.	3.3.4
17) Describe all non-process wastes entering the waste treatment processes, including composition, rate of inputs, and source.	3.3.5
18) List and describe all process equipment, including the function of each unit and the ranges of the operating parameters.	3.3.6
19) Describe all of your operating cycles (batch cycles versus continuous operation, start-up, shut-down, maintenance, cleaning) on a daily, weekly, or other period basis, as appropriate. Identify periods when treatment wastes are not generated (e.g., plant shutdowns, or routine equipment maintenance).	3.3.7
20) Assess the extent that all contributing treatment processes, operations, process materials, or generated wastes have varied in the past or may vary in the future.	3.3.8
21) Describe how the composition and generation rate of the petitioned waste may periodically vary due to any aspect of treatment process variability.	3.3.8
22) Has the petitioned waste been managed in a land-based unit? YES (continue with item 23), NO (skip to item 25)	3.4.1
WASTE MANAGEMENT OPERATIONS	3.4
23) Provide the following information (items 23a through 23g) for each unit that is (or was) used to manage the petitioned waste: (If the petitioned waste is managed in more than one unit, assign a number to each unit (e.g., Unit #1, Unit #2, etc. and use the unit number to associate a description with a specific unit.) a. Unit location/address (show if on- or off-site) b. Description of unit construction (current design and materials). c. History of unit design (e.g., chronological summary of any changes to original construction). d. Purpose and description of any unit design and operating changes. e. Estimated surface area.	N/A

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
f. Estimated unit capacity volume. g. Listing of waste and material inputs which have occurred throughout the life of the unit, if known.	
24) Provide detailed schematic(s) of the waste unit(s) showing (as appropriate) unit dimensions, influent point(s), effluent point(s), and waste thickness.	N/A
PROCESS MATERIALS	3.5
25) List all materials used in the operations that contribute to the petitioned waste. This list should include: a. The name of the material(s). b. The process/operation in which it is used (i.e., manufacturing process, treatment process, waste management operations). c. Function of each material in the process. d. Approximate annual quantities used.	3.5.1
26) Provide Material Safety Data Sheets (MSDS) and any other compositional information for trade name and non-elemental materials. Include raw materials, cleaners, oils, solvents, strippers and any by-products generated by the process.	3.5.2
27) Specify the source, quality (i.e., recycled or virgin), and quantity of oil, grease, and hydraulic fluids entering the processes.	3.5.3
SPECIAL INFORMATION	3.6
28) Are you requesting an upfront exclusion for a waste that is not currently generated but will be in the future? YES (continue with item 29), NO (skip to item 32)	3.6.1
29) Explain how the bench-scale or pilot-scale process demonstration adequately models the proposed full-scale process.	3.6.2 3.6.3
30) Explain any real or potential differences between the two processes.	3.6.4
31) Describe the impact of those differences on the character of the petitioned waste.	3.6.5
32) Are you requesting an exclusion for a waste generated by a multiple waste treatment facility (MWTF)? YES (continue with item 33), NO (skip to Part 4)	3.6.6
33) Describe your procedure for prescreening clients and wastes and how this procedure will be carried out should your waste be excluded.	N/A
34) Describe the procedures by which you will make sure that: (1) treatment levels needed by an exclusion are maintained and (2) a hazardous waste is not disposed improperly as non-hazardous.	N/A

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
Part 4: Delisting Analytical Plan Development	4
1) Provide a complete list of the constituents and parameters of concern identified for your petitioned waste based on appropriate waste constituent analyses and the results of an engineering analysis. Identify those constituents quantitated by laboratory analysis and those quantitated using mass balance demonstrations.	4.1
2) Provide mass balance demonstrations for those constituents of concern in your list for which analyses were not conducted. Provide all calculations and assumptions.	4.2
3) Explain why any other delisting constituent of concern is not on the constituent of concern list for your petitioned waste.	4.3
4) Explain why your petitioned waste does not exhibit any hazardous waste characteristic for which analysis was not conducted.	4.4
Part 5: Delisting Sample and Analysis Information	5.0
1) Has a draft sampling and analysis plan been submitted to EPA for review before petition preparation? YES (Answer items 1a and 1b), NO (skip to item 2) a. Submittal date of sampling and analysis plan b. Log number assigned by EPA to your draft submittal	5.1
WASTE SAMPLING INFORMATION	5.2
2) Were all sampling-related activities performed by in-house staff?	5.2
a. Name and address of the organization(s) or company(s) responsible for designing the sampling strategy and collecting the samples (name, street, city, state, zip code, telephone).	5.2.1
b. For each individual person (in-house and otherwise) who designed the sampling plan, the quality control plan, and/or participated in sample collection, please provide a resume of qualifications and the following information (name, affiliation, title)	5.2.1
SAMPLING STRATEGY	5.3
3) Provide the following information (items 3a through 3f) on the sampling strategy you followed to make sure that the samples were representative.	5.3
a. Identify which process point discharges, containment areas (e.g., lagoons), or other areas (e.g., soil) were sampled and why these areas were selected for sample collection.	5.3.2.1

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
b. Describe the techniques and guidelines used to select waste sampling points (e.g., random sampling procedure or fixed transect and offset sampling procedure).	5.3.2.2
c. Describe the sampling and subsampling (i.e., transferring of sample aliquots into containers specific to certain analyses) procedures used during the sample collection process, including the particular days and times selected for sample collection, the number of grab samples collected for each composite sample, and why these procedures were used.	5.3.2.3
d. Describe the sampling devices used for sample collection and the basis for selecting the devices.	5.3.2.4
e. Identify and discuss any deviations from your original sampling plan and strategy and the impact of these deviations on waste characterization.	5.3.3
f. Explain why you believe the samples collected are non-biased and sufficiently represent the petitioned waste. In this explanation, fully address the potential for waste uniformity or spatial and temporal variability and how the strategy ensured collection of representative samples.	5.3.4
SAMPLE SPECIFIC INFORMATION	5.4
4) How many samples of the petitioned waste were collected? Is the number of samples taken different from the number of samples agreed upon during the pre-petition scoping meeting? Explain the deviation.	5.4.1
5) For each individual sample collected, please provide the following sample-specific information (items 5a through 5g).	
a. For each sample included in item 4, provide the sample identification number (as it appears in your field logbook and other records), the date that the sample was taken, an indication as to what type of sample it is (waste sample versus quality control sample and whether or not it is a composite sample).	5.4.2
b. Describe how each sample was collected, and its point of collection from the petitioned waste. If a sample is a composite of grabs, provide the number of grab samples collected for the composite sample, the sampling location for each grab sample, the volume of each grab sample, and the volume of the composite sample.	5.4.3
c. Describe the general sampling location (e.g., which quadrant of a surface impoundment) and the specific sampling points (e.g., specific location in the quadrant). You may refer to numbered sampling points shown in a diagram.	5.4.4

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
d. Describe how each sample was composited (e.g., equipment used and manner of mixing).	5.4.5
e. Provide a physical description of each sample at time of collection (e.g., color, odor, whether phase separation occurred soon after collection).	5.4.6
f. For each composite sample, specify the time and date when the grab samples were collected and the time and date when the sample was composited, as applicable.	5.4.7
g. Describe the handling and preparation techniques used for each sample (including types of containers used and techniques employed for container preparation) and types and amounts of preservatives used.	5.4.8
OTHER GENERAL INFORMATION	5.5
6) Describe the weather conditions during sampling (if conducted outdoors).	5.5.1
7) Describe any facility activities separate from sampling that occurred at the same time and might have affected sample representativeness.	5.5.2
8) Describe sampling device decontamination; and note when disposable devices were used for sample collection.	5.5.3
9) Were the chain-of-custody procedures specified in SW-846 followed? YES (Skip to item 11), NO (Continue with item 10)	5.5.4
10) Provide a description of the quality control procedures and documentation system used to track sample location and maintain sample integrity during transportation to the laboratory. Copies of the chain-of-custody forms may be provided, but are not needed.	5.5.5
LOCALIZED AREA OF CONTAMINATION	5.6
11) Have you collected samples to characterize a localized area of contamination (a "hot spot") within the petitioned waste? YES (Continue with item 12), NO (Skip to item 16)	N/A
12) Discuss your basis for believing a hot spot may or does exist (e.g., records of a one-time discharge of a concentrated material at a specific location).	N/A
13) Describe the known or predicted location (on a diagram) and the dimensions (e.g., depth, width and length) of the hot spot.	N/A
14) Identify the samples specifically collected to characterize the hot spot.	N/A
15) Explain why the samples sufficiently represent the hot spot.	N/A

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
MULTIPLE WASTE TREATMENT FACILITY	5.7
16) Have you collected samples to characterize a waste generated by a multiple waste treatment facility (MWTF)? YES (Continue with item 17), NO (Skip to item 21)	N/A
17) List and describe the untreated wastes that were treated and are represented by the treatment residue samples collected during the sampling period.	N/A
18) Provide the percentage of total wastes treated annually that was represented by the sampling period.	N/A
19) List and briefly describe the untreated wastes that also are treated at the facility but were not represented by the sampling period.	N/A
20) Explain why the wastes not represented by the sampling period are not expected to contain any other hazardous constituents of concern, different levels of constituents of concern, or other different characteristics than that represented by the sampling period.	N/A
WASTE ANALYSIS INFORMATION	5.8
21) Was sample analyses done by in-house staff? NO (Answer items 21a and 21b), YES (Answer item 21b)	5.8.1
a. Name and address of the organization(s) or company(s) responsible for sample analyses. (Name, Street, City, State, Zip Code, Telephone)	5.8.1.1
b. For each individual person (in-house and otherwise) who conducted analyses or was responsible for data reduction, validation, and laboratory quality control, please provide a resume of qualifications and the following information: Name, Affiliation, Title.	5.8.1.2
22) Provide your signed laboratory data reporting forms from all analyses, including results from quality control analyses.	5.8.2
23) Provide the following information on each sample and each analysis. a. Sample identification numbers as logged during collection and as assigned by the laboratory. b. Type of sample (e.g., waste sample, waste sample replicate, equipment blank, field blank). c. Date of sample receipt by the laboratory. d. The sample workup or preparation method and reference for the method (e.g., SW-846 Method 3500). e. The date of sample workup or preparation. f. The name of the person conducting the analysis. g. The date of extraction and analysis.	5.8.3

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
h. The test method used and the source of the test method (e.g., SW-846 Method 8020). i. The specific constituent, parameter, or hazard for which analysis was conducted. j. The test results, expressed in appropriate units (e.g., mg/L, mg/kg). k. The basis for the analysis (e.g., wet/dry weight). l. The quantitation limits.	
24) Provide the names and model numbers of all equipment used during analysis.	5.8.4
25) Provide all other information necessary to fully interpret the test procedures or results.	5.8.5
26) For each quality control analysis that involved a matrix or a surrogate spike and spike duplicate analysis, provide the following information. a. The name of the spike analyte added. b. The concentration of the spike analyte in the unspiked sample. c. The amount of the spike analyte added. d. The measured amount of the spike in both spiked samples. e. The calculated percent recovery of the spike and method of calculation. f. The acceptance criterion for recovery of each matrix spike. g. The relative percent difference (RPD) between the duplicate results. h. The acceptance criterion for the RPD.	5.8.6
27) Identify whether the waste analytical data was corrected based on quality control results (e.g., blank analysis) and explain how the correction was made.	5.8.7
28) Explain any inconsistencies or deviations found in the reported analytical results. The discussion should include any observed analytical interferences and what actions were taken to resolve the problems.	5.8.8
29) If any calculations are necessary (i.e., in use of the Oily Waste Extraction Procedure, for the Mobile Metal Concentration), please include all calculation sheets.	5.8.9
PART 6: DELISTING GROUNDWATER MONITORING INFORMATION	6.0
1) Show which of the following describes the management of the petitioned waste.	6.0

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
a. The petitioned waste is currently managed in a land-based waste management unit (on-site or offsite), and ground-water monitoring is needed under 40 CFR Part 264 or 265 or authorized State equivalent, or other Federal, state, or local requirements; or if ground-water monitoring information is otherwise available for the unit. (Go to item 2)	N/A
b. The petitioned waste was once managed (but is no longer) in a land-based waste management unit (on-site or off-site) and ground-water monitoring was needed under 40 CFR Part 264 or 265 or authorized State equivalent, or other Federal, state, or local requirements; or if ground-water monitoring information is otherwise available for the unit. (Go to item 2)	N/A
c. The petitioned waste is currently managed, or was once managed, in a land-based waste management unit, but ground-water monitoring requirement has been waived. (Go to item 9)	N/A
d. The petitioned waste is currently managed, or was once managed, in one or more land-based waste management units containing also significant amounts of other wastes, and you consider ground-water data from these non-dedicated units are immaterial in evaluating the petitioned waste's impact on ground-water quality. (Go to item 10)	N/A
e. None of the above management scenarios apply. (Go to item 11)	6.0
2) Has the appropriate responsible party previously submitted ground-water monitoring information for the subject units to an EPA Regional office or an authorized State in response to 40 CFR Part 264 or 265 requirements (or authorized State equivalent)? YES (Continue with item 3), NO (Skip to item 5)	6.0
3) Do you wish that we directly get the ground-water monitoring information from the EPA Region or State? YES (Complete item 4 and continue with item 6), NO (Skip to item 5)	N/A
4) Indicate the EPA Regional or State contact for getting the ground-water monitoring information (include name of contact, affiliation, mailing address, and phone number). a. Name of contact: b. Affiliation: c. Title of report (if applicable): d. Street/P.O. Box, City, State, Zip Code e. Phone	N/A

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
5) Provide all available and relevant (e.g., for each unit used to manage the petitioned waste) ground-water monitoring information and reports which, at a minimum, should include:	N/A
a. A description of site geology and hydrology.	N/A
b. A description of the ground-water monitoring systems for the units in which the petitioned waste is (or was) managed.	
c. The results obtained from the analysis of ground-water samples.	
d. A discussion of sampling and analytical procedures followed in getting and analyzing the ground-water samples.	
e. Any additional information necessary to characterize the petitioned waste's impact on ground-water quality.	
f. An analysis and discussion of whether the above-listed information and data that show contamination of the ground-water is attributable to the petitioned waste.	
6) Is the unsaturated (vadose) zone monitored at any of the subject units? YES (Continue with item 7), NO (Skip to item 8)	N/A
7) Provide the following information on vadose zone monitoring (e.g., lysimeter information) in as much detail as possible (as requested for ground-water monitoring systems).	N/A
a. A description of regional, local, and unit-specific geology and hydrology, and soil characteristics.	N/A
b. A description of the monitoring system(s) (e.g., design and construction).	
c. A description of the sampling and analytical procedures followed.	
d. Analytical and QC data obtained from sample analysis.	
e. An interpretation of the information and data presented.	
8) Discuss whether ground-water contamination exists on the site and, if it does, identify the source. If the source is not the petitioned waste, explain, with supporting information, why the petitioned waste has not contributed to the contamination.	N/A
9) Provide documentation on the waiver or exemption of groundwater monitoring at the land-based waste management unit containing the petitioned waste.	N/A

Framework for Delisting Petitions (see Appendix A, *RCRA Delisting Program Guidance Manual for the Petitioner*)	**Petition Location / Section Number**
10) Identify the units in question, provide estimates of the relative volumes of the petitioned and other wastes disposed in the units, and discuss in detail why you consider ground-water data from these non-dedicated units are immaterial in evaluating the petitioned waste's impact on ground-water quality.	N/A
11) Describe why ground-water monitoring is not needed for your petitioned waste.	6.0

Acronyms and Abbreviations

ALARA	as low as reasonably achievable
AWF	Aging-Waste Facility
BOF	balance of facilities
CAS	Chemical Abstract Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	Code of Federal Regulations
COC	constituent of concern
COPC	constituent of potential concern
CRV	concentrate receipt vessel
CSB	Canister Storage Building
DAF	dilution attenuation factor
DOE	US Department of Energy
DOE-ORP	US Department of Energy, Office of River Protection
DOE-RW	US Department of Energy, Office of Civilian Radioactive Waste Management
DQO	data quality objective
DRAS	Delisting Risk Assessment Software
DST	double-shell tank
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
EQL	estimated quantitation limit
GFC	glass-forming chemical
HEME	high-efficiency mist eliminator
HEPA	high-efficiency particulate air
HLW	high-level waste
IHLW	immobilized high-level waste
ILAW	immobilized low-activity waste
ITS	in-tank solidification
LAW	low-activity waste
LCS	laboratory control sample
LDR	Land Disposal Restrictions
LERF	Liquid Effluent Retention Facility

MB	method blank
MCL	maximum contaminant level
MDL	method detection limit
MFPV	melter feed preparation vessel
MFV	melter feed vessel
MIC	material inventory control
MS	matrix spike
MSD	matrix spike duplicate
ND	not detected
NRC	US Nuclear Regulatory Commission
MCO	multicanister overpack
MTG/day	metric ton of glass per day
NCRW	neutralized cladding removal waste
PCT	product consistency test
PFP	Plutonium Finishing Plant
PT	Pretreatment (facility)
QA	quality assurance
PSPD/OSW	Permits and State Programs Division/Office of Solid Waste
PUREX	Plutonium/Uranium Extraction (facility)
RCRA	*Resource Conservation and Recovery Act of 1976*
RDQO	Regulatory Data Quality Objectives
REDOX	Reduction-Oxidation (facility)
RPP	River Protection Project
RPD	relative percent difference
RSD	relative standard deviation
SBS	submerged bed scrubber
SOW	statement of work
SST	single-shell tank
STL	Severn Trent Laboratory
TBP	tributyl phosphate
TC	toxicity characteristic
TCLP	Toxicity Characteristic Leaching Procedure
TEDF	Treated Effluent Disposal Facility

TFCOUP	*Tank Farm Contractor Operations and Utilization Plan*
TRU	transuranic element(s)
UCI	upper confidence interval
VSL	Vitreous State Laboratory
WAC	Washington Administrative Code
WASRD	*Waste Acceptance System Requirements Document*
WESF	Waste Encapsulation Storage Facility
WESP	wet electrostatic precipitator
WTP	Hanford Tank Waste Treatment and Immobilization Plant
WVDP	West Valley Demonstration Project

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1 Delisting Administration Information [Part 1]

1.1 Name of Petitioner [Part 1: 1]

US Department of Energy, Office of River Protection (DOE-ORP)
P.O. Box 450
Richland, Washington 99354
Telephone No.: (509) 376-6677
Fax No.: (509) 376-8142

1.2 People to Contact [Part 1: 2]

Name: R. J. Schepens
Title: Manager, Office of River Protection
Telephone No.: (509) 376-6677
Fax No.: (509) 376-8142

1.3 Petitioned Waste Generating Facility [Part 1: 3]

Hanford Tank Waste Treatment and Immobilization Plant
Hanford Facility, 200 East Area
Richland, Washington 99354
RCRA ID number: WA7890008967 (EPA and State Identification number for Hanford Facility)

1.4 Location of Petitioned Waste [Part 1: 4]

The immobilized high-level waste will initially be stored at the following location:

Interim Storage Location
Hanford Tank Waste Treatment and Immobilization Plant
Hanford Facility, 200 East Area
Richland, Washington 99354
RCRA ID number: WA7890008967 (EPA and State Identification number for Hanford Facility)

Routinely, the waste will be transferred to an interim storage location on the Hanford Site, pending transfer to a National Geologic Repository for permanent disposal:

Interim Storage Location
Canister Storage Building
Hanford Facility, 200 East Area
Richland, Washington 99354
RCRA ID number: WA7890008967 (EPA and State Identification number for Hanford Facility)

A future permanent location is planned as described below:

Disposal Location (Planned Future, Permanent)
First National Geologic Repository selected to be located at:

Yucca Mountain Facility
Nevada Test Site
Nye County, Nevada
RCRA ID number: The National Geologic Repository will not be permitted under RCRA.

1.5 Proposed Delisting Action [Part 1: 5]

This petition requests that, subject to the conditions specified below, after being treated using vitrification in the Hanford Tank Waste Treatment and Immobilization Plant (WTP), immobilized HLW (IHLW) originating in the Hanford Tank Farm be excluded from regulation as a hazardous waste. The Hanford tank system is permitted to receive a mixture of wastes resulting from the reprocessing of spent nuclear fuel and other activities. Some of the wastes in the mixture are listed hazardous/dangerous wastes under both Federal and State hazardous waste regulations (F001-F005 and F039 as derived from F001-F005), and some are also hazardous/dangerous wastes under both Federal and State Regulations because they exhibit one or more of the characteristics of ignitability, corrosivity, reactivity, and toxicity (D wastes). (Although the tanks have been permitted to contain listed waste F039, this waste has never been added to the tanks.)

The National Geologic Repository will be licensed by the Nuclear Regulatory Commission, but will not be permitted to accept hazardous waste. To qualify IHLW for permanent disposal in its intended destination, the National Geologic Repository, it is necessary to delist the waste. The state of Nevada also must delist the IHLW before it can be accepted at the National Geologic Repository.

The proposed action is an upfront, conditional exclusion for IHLW in accordance with the bases described in 40 CFR 260.22 and WAC 173-303-072(3), (4), and (6). This petition requests an upfront conditional exclusion for a waste that will be generated in the future from the treatment of existing wastes, but that is not currently generated. Research and bench-scale experiments with surrogate materials indicate that through control of glass composition, IHLW will be produced that does not meet any of the criteria for which F001-F005 and F039 wastes were listed (see Section 2.1), does not exhibit any of the hazardous waste characteristics, and does not exhibit any additional factors, including additional hazardous/dangerous waste constituents (40 CFR Part 261, Appendix VIII; Washington Administrative Code (WAC) 173-303-9905), which may cause the waste to be a hazardous waste. DOE-ORP proposes that delisting of IHLW be contingent upon the conditions listed in the suggested regulatory language provided below.

IHLW produced in accordance with the predictive and analytical procedures in conditions (2) and (3) is presumed to meet the criteria for delisting set forth in condition (1), without confirmatory sampling and TCLP analysis of the final waste form for any constituents of concern, including mercury, cyanide, organic, and inorganic constituents.

To simplify the descriptions below, Figure 1-3 and Figure 1-4 are provided to illustrate how WTP proposes to produce a waste form that will comply with the limits in condition (1) below.

Draft Proposed Exclusion Language:

Facility: Hanford Tank Waste Treatment and Immobilization Plant (WTP), 200 East Area, Hanford Site, Richland, Washington 99354.

Waste Description: Immobilized High-Level Waste (IHLW) from WTP treatment (vitrification) of wastes from Hanford tank system (D001, D002, D003, D004, D005, D006, D007, D008, D009, D010, D011, D018, D019, D022, D028, D029, D030, D033, D034, D035, D036, D038, D039, D040, D041, D043, F001, F002, F003, F004, F005, F039). The maximum annual volume is 765 cubic meters.

Delisting Conditions

(1) Constituents of Concern: Constituents that caused the Hanford tank waste to be listed or that cause the waste to exhibit a hazardous waste characteristic, and any additional constituent which may cause the waste to be a hazardous waste, must be removed, immobilized, and/or destroyed during the vitrification process such that they are not released at levels exceeding the delisting levels. The vitrification process removes or destroys organics and cyanides. Other constituents of concern are immobilized (and/or partially volatilized) to meet the delisting levels shown below.

Constituent of Concern	CAS Number	Delisting Level Limit (mg/L, TCLP)
Chromium	18540-29-9	4.95
Lead	7439-92-1	5.00
Mercury	7439-97-6	0.200
Nickel	7440-02-0	22.6
Silver	7440-22-4	3.07
Thallium	7440-28-0	0.282
Antimony	7440-36-0	0.659
Arsenic	7440-38-2	0.616
Barium	7440-39-3	100
Beryllium	7440-41-7	1.33
Cadmium	7440-43-9	0.480
Copper	7440-50-8	29,200
Vanadium	7440-62-2	16.9
Zinc	7440-66-6	225
Selenium	7782-49-2	1.00

CAS = Chemical Abstract Service
TCLP = Toxicity Characteristic Leaching Procedure

(2) In advance or upon receipt of Hanford tank waste, the DOE-ORP shall project the IHLW composition to be produced using Hanford tank farm analytical data, available unit process and mass

balance information, and bench-scale testing of surrogate waste. The projected glass composition will be subject to the conditions below, and subject to provisions of condition (8) below.

(a) In cases where the projected glass composition thallium (III) oxide (chemical abstract number 1314-32-5) loading exceeds 0.50 weight-percent, the permissible IHLW thallium (III) oxide loading shall be based on surrogate test results such that thallium will not leach from the IHLW at levels exceeding limits in condition (1) above. A crucible scale surrogate waste product shall be developed representing the projected IHLW composition. The surrogate waste product shall be leached according to the Toxic Characteristic Leaching Procedure (EPA SW-846 Method 1311) (TCLP), and analyzed for constituents of concern identified in condition (1), for comparison to limits in condition (1), to demonstrate a compliant waste form.

(b) In cases where the projected glass composition cadmium oxide (chemical abstract number 1306-19-0) loading exceeds 0.10 weight-percent, the permissible IHLW cadmium oxide loading shall be based on surrogate test results or predictive model results as stipulated in condition (2)(c) below, such that cadmium will not leach from the IHLW at levels exceeding limits in condition (1) above.

(c) The DOE-ORP shall maintain a predictive glass property-composition model in order to provide a prediction of the TCLP response for cadmium oxide concentrations in excess of those specified in condition (2)(b) above (henceforth termed "TCLP response-glass composition model"). The TCLP response-glass composition model shall be used to interpolate an estimated cadmium TCLP response for the projected glass composition to ensure compliance with limits for cadmium from condition (1) above prior to IHLW production. If the projected glass composition to be produced lies beyond the valid range of glass compositions described by the TCLP response-glass composition model, condition (2)(c)(i) or (2)(c)(ii) shall apply.

(i) A crucible scale surrogate waste product shall be developed representing the projected IHLW composition. The surrogate waste product shall be leached according to the TCLP, and analyzed for comparison to limits in condition (1), to demonstrate a compliant waste form.

(ii) The TCLP response-glass composition model shall be revised to adequately bound the projected glass composition prior to IHLW production. Surrogates representing a range of potential IHLW compositions shall be developed and tested to provide data for model revision. Revisions to the TCLP response-glass composition model are subject to condition (7) below.

(d) Results of surrogate testing shall be maintained in the operating record.

(3) In advance of IHLW production, the waste staged in the melter feed preparation vessels shall be analyzed for glass-form-affecting constituents to provide information to confirm or revise the projected IHLW composition. Glass-form-affecting constituents will be prepared for analysis using laser ablation, digestion, and/or fusion methods (or other appropriate sample preparation techniques) and will be analyzed using inductively coupled plasma atomic emissions spectroscopy and/or mass spectroscopy. Target analytes and analytical methods will be subject to provisions of condition (8) below. The following conditions shall apply to the IHLW composition, as determined by analysis of melter feed (waste, and/or waste and glass formers), to be produced during production operations:

(a) If the confirmed/revised projected IHLW composition contains less than 0.50 weight-percent thallium (III) oxide and 0.10 weight-percent cadmium oxide, IHLW production will proceed.

(b) If IHLW production (glass formulation) is based on a composition derived in accordance with condition (2)(a) or (2)(c)(i) above, the confirmed/revised projected IHLW composition shall be

equivalent to the composition tested by surrogate IHLW analysis or condition (3)(c) shall be required.

(c) If the confirmed/revised projected IHLW composition is within valid range of glass compositions described by the TCLP response-glass composition model, the TCLP response-glass composition model shall be used to interpolate an estimated TCLP response for the confirmed/revised projected IHLW composition to ensure compliance with condition (1) above prior to IHLW production. If the cadmium leachate concentration of the confirmed/revised projected IHLW composition as predicted by the TCLP response-glass composition model exceeds the delisting levels in condition (1) above, the glass composition shall be reformulated, as necessary, by glass former additions such that estimated cadmium response of the reformulated glass composition (to be produced) complies with condition (1) above.

(d) If the confirmed/revised projected IHLW composition fails to meet conditions (3)(a) or (3)(b), or is beyond the valid range of glass compositions described by the TCLP response-glass composition model in (3)(c), the glass composition shall be reformulated, as necessary, by glass former additions, and re-characterized, such that conditions (3)(a) or (3)(b) or (3)(c) are satisfied.

IHLW produced in accordance with condition (3) will meet the criteria for delisting.

(4) Analytical results, projected IHLW compositions, TCLP response-glass composition model results, and associated calculations, shall be maintained in the operational record, subject to provisions of condition (8) below.

(5) Frequency of Testing: The high-level waste feed as staged in the melter feed preparation vessel must be analyzed before each batch is sent to the high-level waste melter.

(6) Data Submittals: At least one week in advance of treating HLW waste, the DOE-ORP must notify the Section Chief, Variances Section (address below), when the full-scale system is on line and waste treatment will begin. Any data contrary to this petition obtained through the testing condition must be submitted to the Section Chief, Variances Section, Permits and State Programs Division/Office of Solid Waste (PSPD/OSW), (OS-343), U.S. EPA, 1200 Pennsylvania Ave, NW, Mail Code 5303W, Washington, DC 20460, within four weeks after the data are obtained. Failure to submit the required data within the specified time period will be considered by the agency sufficient basis to revoke the DOE-ORP's exclusion to the extent directed by EPA. The following certification statement must accompany all data:

"*Under civil and criminal penalty of law for the making or submission of false or fraudulent statements or representations (pursuant to the applicable provisions of the Federal Code which include, but may not be limited to, 18 U.S.C. 6928), I certify that the information contained in or accompanying this document is true, accurate and complete.*"

(7) Changes in Operating Conditions: If there are significant changes in the IHLW vitrification process (glass composition, TCLP-response glass composition model), EPA will be notified in writing. Any wastes generated during this time period will be stored until authorized by EPA for disposal (i.e., after review and verification of laboratory analyses and/or process parameters). After written approval, the immobilized high-level wastes generated will be managed as non-hazardous, if the waste meets the criteria for delisting levels set in condition (3) above.

(8) Data Records: Records of operating conditions and analytical data from conditions (2) through (4) above must be compiled, summarized, and maintained onsite for a minimum of 25 years. These records and data must be furnished upon request to EPA, the State of Washington, and the State of Nevada, and made available for inspection. Failure to maintain records or submit the required data will be considered by EPA, at its discretion, sufficient basis for revoking the exclusion to the extent directed by EPA. The following certification statement must accompany all data transmitted to EPA, the State of Washington, and the State of Nevada:

"Under civil and criminal penalty of law for making or submitting false or fraudulent statements or representations (pursuant to the applicable provisions of the Federal Code, which include, but may not be limited to, 18 U.S.C. 1001 and 42 U.S.C. 6928), I certify that the information contained in or accompanying this document is true, accurate and complete. As to the (those) identified section(s) of this document for which I cannot personally verify its (their) truth and accuracy, I certify as the official having supervisory responsibility for the persons who, acting under my direct instructions, made the verification, that this information is true, accurate and complete. In the event that any of this information is determined by EPA in its sole discretion to be false, inaccurate or incomplete, and upon conveyance of this fact to the DOE-ORP, I recognize and agree that this exclusion of waste will be void as if it never had effect or to the extent directed by EPA and that the DOE-ORP will be liable for DOE-ORP's reliance on the void exclusion."

(9) Reopener Language: (A) If it is discovered that a condition at the facility or an assumption related to the disposal of the excluded waste that was modeled or predicted in the petition does not occur as modeled or predicted, then any information relevant to that condition will be reported to the Regional Administrator within 10 days of discovery. (B) Upon receiving the information described in the previous sentence from any source, the Regional Administrator will make a preliminary determination as to whether the reported condition requires further action. Further action may include suspending or revoking the exclusion, modifying the exclusion, or other appropriate response necessary to protect human health and the environment. (C) If EPA determines that the reported information does require Agency action, EPA will notify DOE-ORP in writing of the action believed necessary to protect human health and the environment. The notice shall include a statement of the proposed action and a statement providing DOE-ORP with an opportunity to present information as to why the proposed action is not necessary. (D) DOE-ORP shall have 10 days from the date of EPA's notice to present such information. (E) Following the receipt of information from DOE-ORP as described in (9)(D) above, or if no such information is received from DOE-ORP within 10 days, EPA will issue a final written determination describing the Agency actions that are necessary to protect human health or the environment, given the information received. Any required action described in EPA's determination shall become effective immediately, unless EPA provides otherwise.

(10) Notification Requirements: A one-time written notification will be provided to any State Regulatory Agency to which or through which the delisted waste described above will be transported for disposal at least 60 days prior to commencement of such activity. The one-time notification must be updated if the waste is shipped to a different disposal facility. Failure to provide such notification will result in a violation of the exclusion and a possible revocation of the exclusion.

1.6 Need and Justification for Proposed Action [Part 1: 6]

Approximately 54 million gallons of mixed hazardous/dangerous[1] and high-level nuclear waste are currently stored in the 149 single-shell and 28 double-shell tanks at the Hanford Site. The waste currently stored in the Hanford tank system consists of a mixture of wastes resulting from the reprocessing of spent nuclear fuel and other activities. Some of the wastes in the mixture are listed hazardous/dangerous wastes under both Federal and State hazardous waste regulations (F001-F005 and F039 as derived from F001-F005) and some are also hazardous/dangerous wastes under both Federal and State regulations because they exhibit one or more of the characteristics of ignitability, corrosivity, reactivity, and toxicity (D-wastes). Because the wastes contain both radioactive materials subject to regulation under the Atomic Energy Act of 1954 and hazardous/dangerous wastes subject to the Resource Conservation and Recovery Act, the Washington Dangerous Waste Act, and the Nevada Revised Statutes for Disposal of Hazardous Waste, management and disposal of the IHLW must be conducted in compliance with multiple sets of State and Federal regulations. Federal and State hazardous/dangerous waste laws require the waste to be (1) treated before disposal to meet specified Land Disposal Restrictions (LDR) treatment standards, unless a variance is granted, and (2) disposed only in a permitted hazardous waste disposal facility, unless the waste has been delisted and no longer exhibits any characteristic of hazardous waste.

As a matter of national policy, Congress has determined that the high activity portion of mixed waste like that which is stored in the Hanford tanks must be treated and permanently disposed of in a deep geologic repository. In 2002, Congress approved commencement of the nuclear licensing process to establish the National Geologic Repository at Yucca Mountain. However, the National Geologic Repository at Yucca Mountain will not be permitted to accept listed hazardous/dangerous wastes for disposal. Therefore, to comply with the Nuclear Waste Policy Act and the Energy Policy Act of 1992, DOE-ORP needs to obtain delisting of the listed waste component of the IHLW, and show that the delisted waste will not itself exhibit any hazardous characteristic or exhibit any additional factors, including constituents, which may cause the waste to be a hazardous waste. The delisted waste also must comply with the LDR regulations.

Although the following factors ensure adequate protection of the environment when disposal of the IHLW portion of the tank wastes is finalized, they are not sufficient to delist it:

- The treatment provided by the vitrification facility will be the best available, and is the only treatment currently available for the HLW feed;
- The waste will be treated using the technology HLVIT as defined by 40 CFR 268.42, Table 1, "Technology Codes and Description of Technology-Based Standards";
- The vitrified waste will be disposed in a structurally sound, corrosion-resistant waste package.
- EPA has proposed site-specific public health and radiation protection standards for storage and disposal of radioactive material at the National Geologic Repository (70 FR 49014 [Aug. 22, 2005], to be codified at 40 CFR Part 197).
- The Nuclear Regulatory Commission (NRC) has proposed to amend its regulations governing the disposal of radioactive material at the National Geologic Repository to be consistent with EPA's proposed standards (70 FR 53313 [Sept. 8, 2005], to be codified at 10 CFR Part 63).

[1] "Dangerous" waste is the Washington State terminology for hazardous waste. "Hazardous" waste is defined under Federal Regulations at 40 CFR 261. "Dangerous" and "extremely hazardous" wastes are defined under the Washington Administrative Code at Chapter 173-303. "Mixed" wastes are both hazardous/dangerous and radioactive.

- The NRC will determine whether the National Geologic Repository has demonstrated compliance with the NRC's licensing regulations, which must be consistent with EPA's standards, prior to granting the necessary license to dispose of radioactive material at the National Geologic Repository.

The justification for delisting is that the waste, after vitrification, will not meet any of the criteria for which it was listed, and will not exhibit any characteristic or other factor (including additional constituents) that would justify retaining it in the hazardous waste management system. Residual inorganic materials are bound into the glass matrix in such a manner that they will not leach from the product at concentrations in excess of proposed delisting levels. Mercury, cyanide, and any listed organic constituents that may have been present in the feed are destroyed or removed by the heat associated with the vitrification process.

Furthermore, the treated waste will comply with land disposal restriction requirements for hazardous waste components (listed and characteristic). LDR compliance will be demonstrated separately from the proposed action by obtaining a site-specific treatability variance under 40 CFR 268.44(h).

Because of the high radiation levels associated with the treated waste, analysis of the glass product would potentially expose sampling and analytical personnel to a significant radiation dose. Therefore, directly demonstrating that the treated waste form meets proposed delisting levels is not a practical condition for delisting. The information presented in this petition demonstrates that vitrification is an effective treatment technology for the Hanford tank waste feed materials and that waste compositions can be controlled to produce an IHLW product that meets proposed delisting levels as determined using the TCLP.

EPA has separately determined (EPA 2003) that a vitrified material meets the delisting criteria for organic COCs and cyanides, based on an analysis of the vitrification process, and in particular, of the residence time and temperatures associated with producing a vitrified product (refer to Supplement 3 of this petition)[2].

[2] Melter system design changes that have occurred since January 2003 do not affect aspects of the system on which EPA relied for its findings. EPA reserves the right to re-evaluate these policy conclusions if there are substantial changes to the proposed melter system.

1.7 Certification Statement [Part 1: 7]

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature

12/21/06
Date

R. J. Schepens
Manager, Office of River Protection
US Department of Energy

Figure 1-1 Facility Location

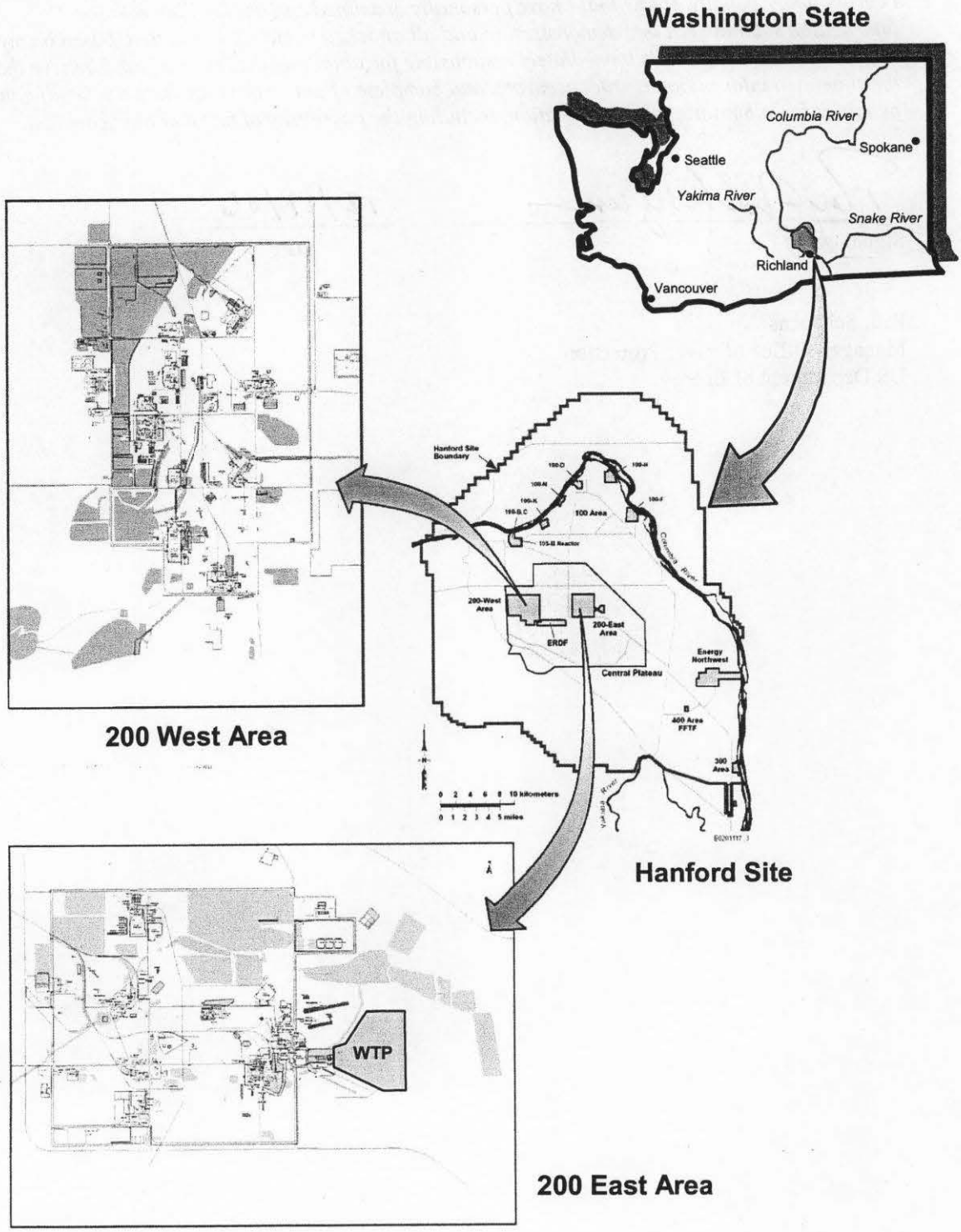


Figure 1-2 Tank Farms and WTP Facility Location

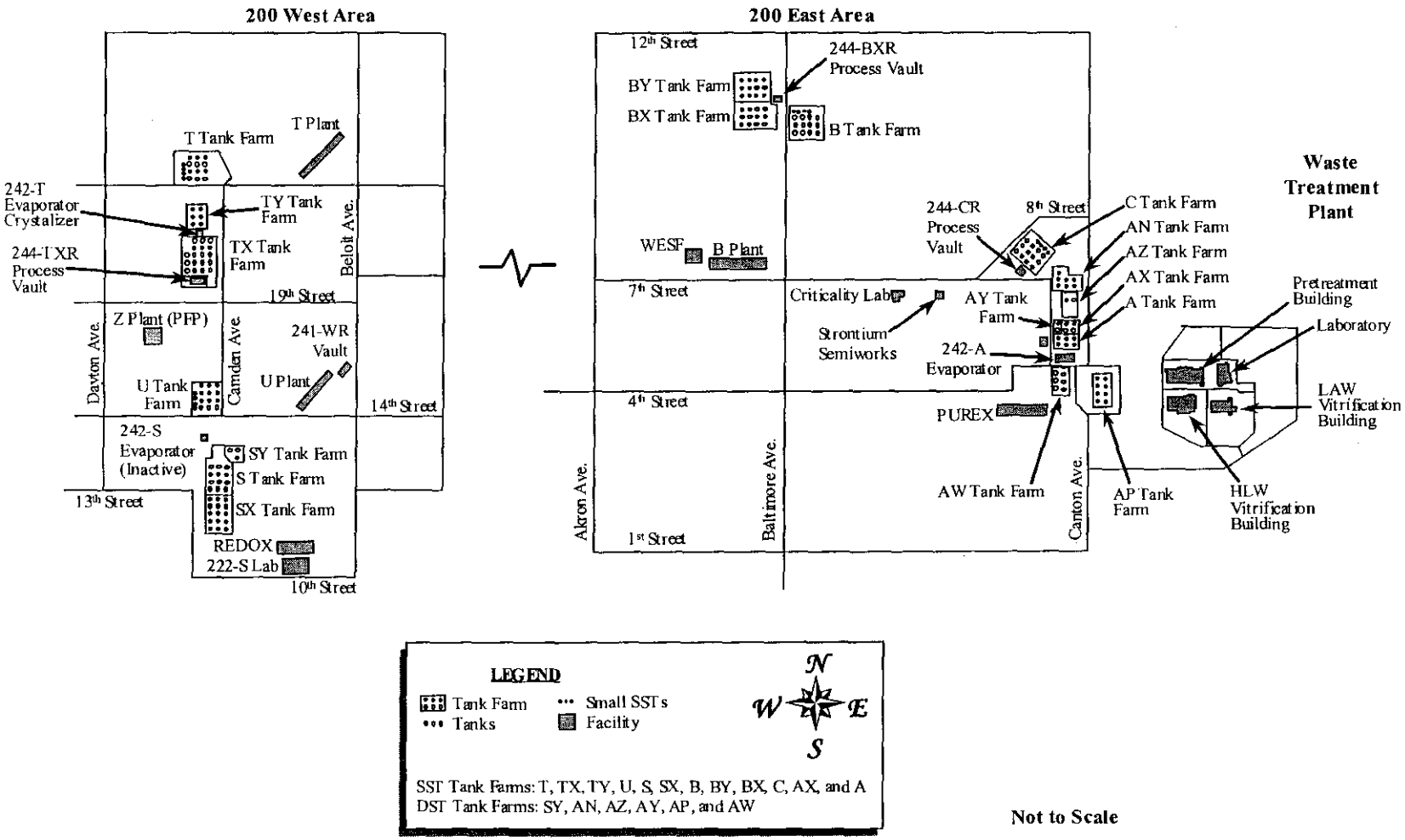


Figure 1-3 Flowchart of Proposed IHLW Formulation and Production Process (Pre-Production)

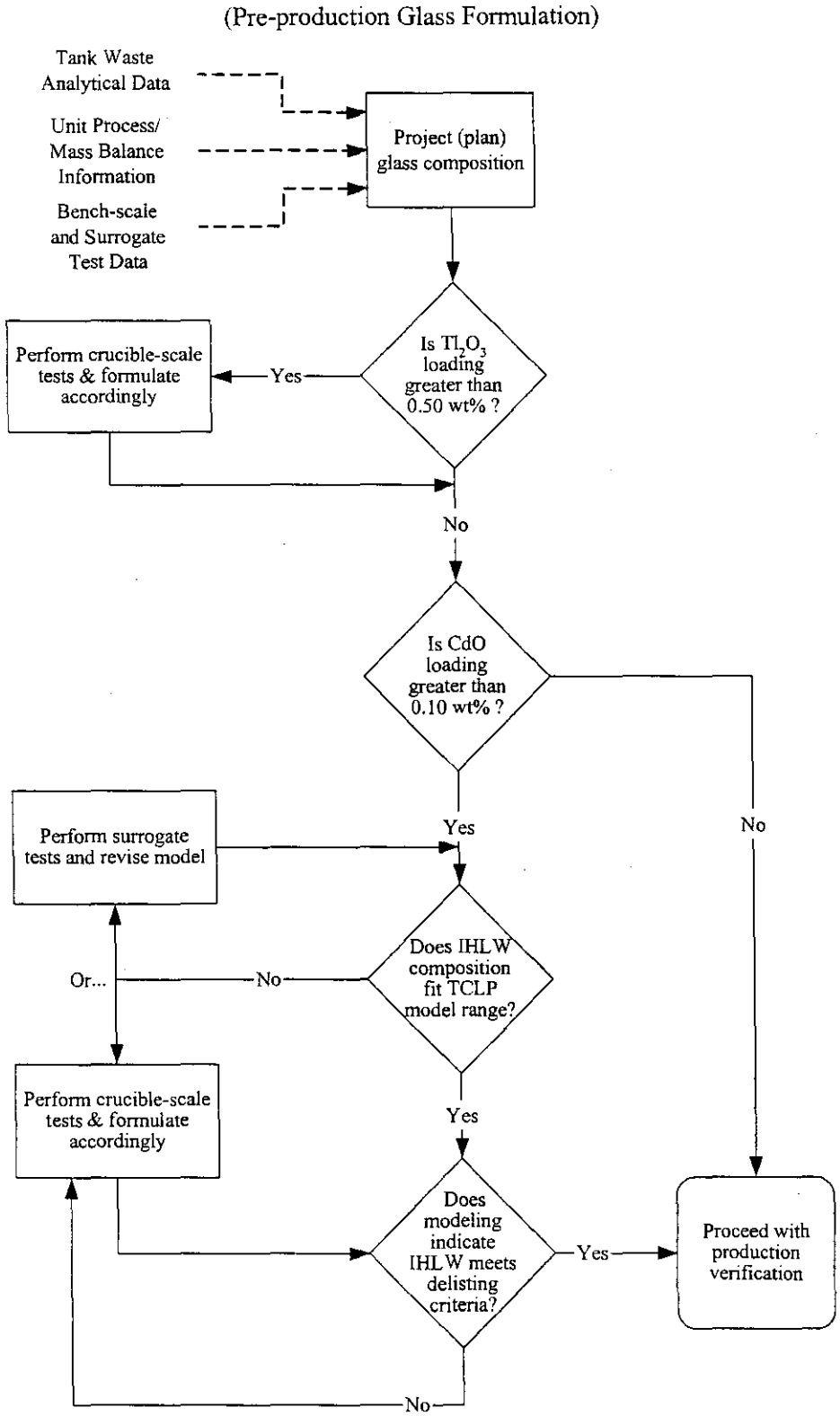
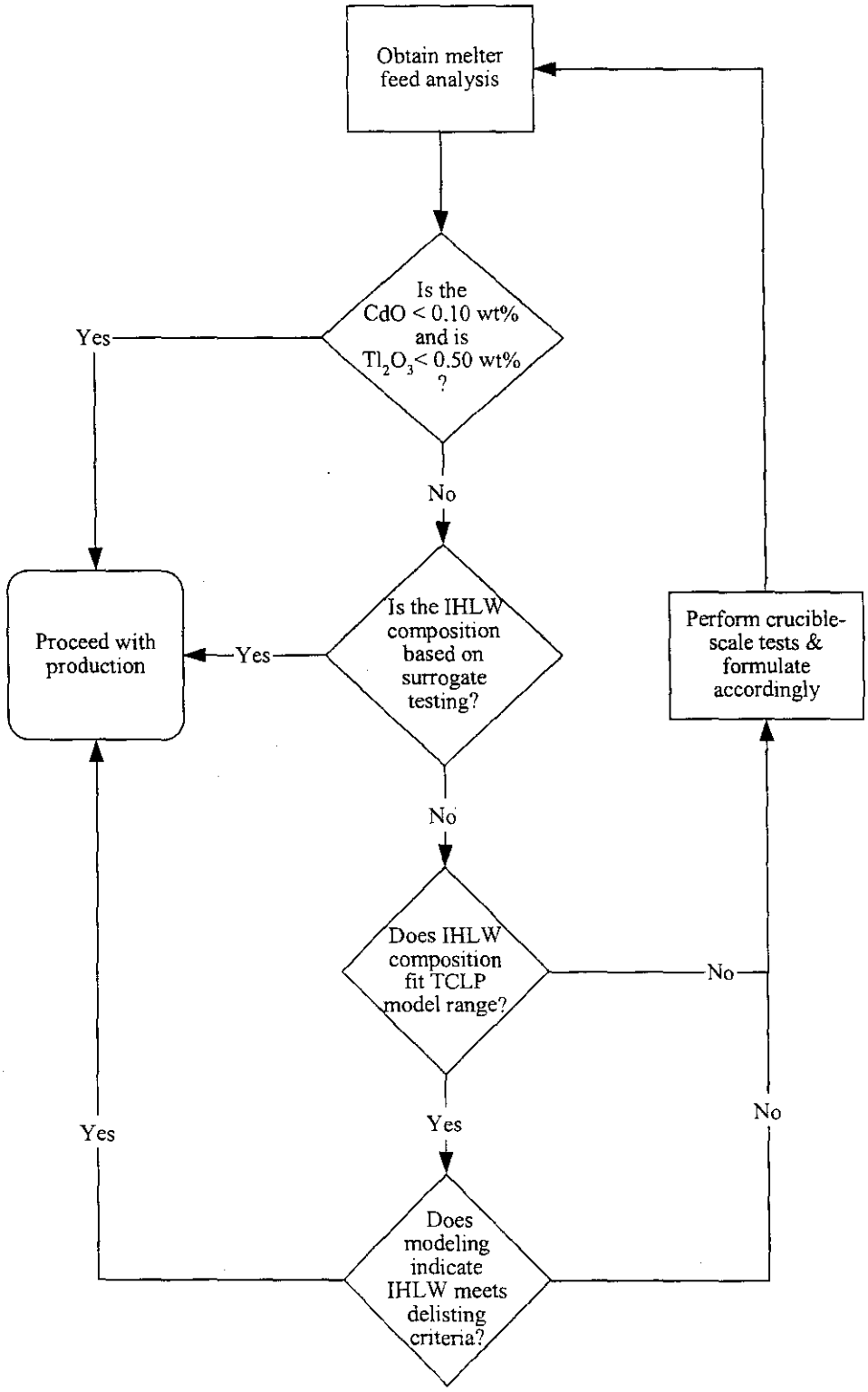


Figure 1-4 Flowchart of Proposed IHLW Formulation and Production Process (Verification)

(Production Verification)



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2 Delisting Waste and Waste Management Information [Part 2]

This section discusses the basis for the petitioned waste listing, a history of the waste feed generation processes, the approach for managing the treated waste product, and volume of the petitioned treated waste product.

2.1 Petitioned Waste Scenario [Part 2: 1]

The petitioned waste, to be generated in the future, will consist of vitrified solid material, generated by treating the HLW fraction of the Hanford tank wastes. It is commonly referred to as immobilized high-level waste (IHLW). Because the Hanford tank wastes contain listed dangerous/hazardous wastes, the IHLW, which results from treatment of such listed dangerous/hazardous wastes, must be characterized as listed dangerous/hazardous waste (40 CFR 261.3(c)(2)(i)), unless it is delisted. Upon receipt at the WTP, the Hanford tank wastes will be designated with some or all of the waste codes listed in Table 2-1. The waste codes for which this petition seeks delisting are F001-F005 and F039 (as derived from waste with codes F001-F005).

Hazardous and dangerous waste codes for the Hanford tank wastes (Table 2-1) (DOE-RL 1991), were generated using process knowledge, as described in the Hanford Facility permit, *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967) (Dangerous Waste Permit, Ecology 2001, as amended). Transfers have occurred to consolidate materials and to remove wastes from single-shell tanks (SSTs). Wastes have been transferred among tanks within the SST system and to the DST system to such an extent that the waste codes identified in Table 2-1 are appropriate for assignment to all SST and DST system wastes, although specific tanks of wastes may not exhibit all the characteristic waste codes.

2.2 Physical Form of Petitioned Waste [Part 2: 2]

The vitrified IHLW is a borosilicate glass, and is a primarily noncrystalline solid of relatively low porosity, composed primarily of silica, alumina, and oxides of alkali and alkaline earth elements. The glass matrix is a three-dimensional network consisting of tetrahedrally coordinated orthosilicate monomers (SiO_4^{4-}), oxides of alkali and alkaline earth elements, and ionically/covalently bonded cations. It is produced by fusing (or melting) crystalline and/or amorphous materials at elevated temperatures to produce molten glass. The molten glass is subsequently cooled to a solid phase without significant crystallization. The glass is amorphous; that is, there is no long-range molecular order, but it does exhibit short-range order. Most glasses contain a small portion of micro-crystalline phases.

The petitioned waste will be a monolithic, vitrified glass product. It will be generated through treatment of Hanford tank waste feed materials with the waste codes assigned to the Hanford tank waste in the site-wide RCRA permit (WA7890008967, Chapter 5, Attachment 35)(Ecology 2001) for the facility.

2.3 Chemical Composition and Reactivity of Petitioned Waste

2.3.1 Glass Composition and Chemical Structure

Understanding glass structure and its resulting properties is fundamental to understanding the advantages of vitrification as a treatment technology. This section provides an elementary overview of glass properties relative to IHLW, and describes "how" glass is used to immobilize hazardous constituents.

Glasses are composed of three-dimensional networks consisting primarily of tetrahedrally coordinated orthosilicate monomers (SiO_4^{4-}), each silicon atom bonded to four oxygen atoms. Some, or all four, of the oxygen atoms from the tetrahedron can be shared with other tetrahedra to form a three-dimensional network. Since the Si-O-Si bonds are random, the network remains irregular (amorphous) and non-crystalline. The shared oxygen atoms are called bridging oxygens. In pure silica glass, the ratio of silicon to oxygen is 1:2, and all oxygen atoms are bridging. Some atoms, such as sodium, are ionically bonded to oxygen when present in glass, and thus interrupt tetrahedral linking, and the continuity of the network. An oxygen atom that is not covalently bonded to another atom is "non-bridging."

Waste glass, such as IHLW, incorporates inorganic oxides into the silicate network. Vitrification immobilizes the hazardous constituents in IHLW by two main interactions within the glass matrix: chemical bonding and encapsulation. In most waste glass, the waste constituents are chemically bonded. In IHLW, certain inorganic constituents bond covalently with oxygen, becoming part of the network. Inorganics that react this way are network formers, since they essentially replace the silica in the glass network structure.

Other inorganic species in the waste become network modifiers by ionically bonding with oxygen or other elements in the glass network. This ionic bonding incorporates the inorganic constituent into the glass matrix, but disrupts the network's continuity by reducing the number of bridging oxygen atoms, thus changing the glass properties. Most monovalent and divalent cations fall into this category. However, as long as the number of R_2O or MO units ("R" being an alkali ion, "M" being an alkaline earth ion) is in a less than 1:1 ratio to the number of SiO_2 units, the silicon-oxygen network is preserved because each silicon-oxygen tetrahedron is linked to at least three other tetrahedra, and the glass-forming tendency of the mixture is retained. Figure 2-1 illustrates a glass network containing constituents as network modifiers and network formers.

Chemical composition plays an important role in all IHLW glass properties, including glass durability (e.g., resistance to leaching in acidic environments that may be encountered in a land disposal unit). In general, network modifiers tend to decrease glass durability since they reduce the availability of bridging oxygen atoms. However, these elements do reduce melting temperature and viscosity and, thus, are used as fluxing agents to improve the ability to process (EPA 1992).

In general, the following reactions occur as inorganic compounds are incorporated into the glass structure.

- Incorporation by monovalent network modifiers, R_2O (for example, Li_2O, Na_2O, K_2O, Cs_2O):

$$\sim Si - O - Si \sim \rightarrow \quad \sim Si - O^{-}R^{+} \quad R^{+}O^{-} - Si \sim$$

- Incorporation by divalent network modifiers, MO (for example, MgO, CaO, SrO, BaO, FeO, ZnO, PbO):

$$\sim Si - O - Si \sim \rightarrow \quad \sim Si - O^{-}M^{2+} \quad O^{-} - Si \sim$$

- Incorporation by trivalent network formers, A_2O_3 (for example, B_2O_3, Al_2O_3, Fe_2O_3), with charge compensation from R_2O and/or MO:

$$A_2O_3 + R_2O \rightarrow \quad 2AO_4^{-} + 2R^{+} \text{ and}$$
$$\sim Si - O^{-}R^{+} + \tfrac{1}{2} A_2O_3 \rightarrow \quad \sim Si - O - A^{-} \sim + R^{+}$$

Table 2-2 presents the COCs and primary GFCs in their oxide and predominant valance state (Lide 2003). The table indicates which constituents are likely to be present in IHLW as network modifiers or network formers. Elements such as arsenic, chromium, copper, nickel, silver, thallium and vanadium may have multiple valence states (Schreiber 1987); Table 2-2 presents the likely predominant valence state. COCs are incorporated into glass matrices and, in fact, some are often used to color glass in the commercial glass industry (e.g., cadmium produces red glass, copper produces blue/green glass, and lead is used in fine crystal glassware).

2.3.2 Glass Durability

Vitreous materials are relatively inert due to their high resistance to corrosion; however, they are subject to some chemical breakdown under severe conditions. There are two major forms of chemical attack on vitrified material: matrix dissolution and interdiffusion.

Matrix dissolution is characterized by alkali attack (exposure to a high pH). It begins with the hydration of the silica network, and may proceed to dissolution of the vitreous material (EPA 1992). The following reaction illustrates this process.

$$2\ NaOH + SiO_2 \rightarrow Na_2SiO_3 + H_2O$$

The alkali silicate (Na_2SiO_3) is water soluble, so as the silica network is attacked, it is broken down and other constituents are released. Matrix dissolution occurs at the surface of the vitrified material. The presence of insoluble constituents in the material can retard the reaction rate.

Interdiffusion involves the ionic exchange of hydronium ions in solution for ionically bonded network modifiers in the glass. Interdiffusion generally leaves the silica structure almost intact (EPA 1992). Although pH plays an important role in the interdiffusion rate, pH change has a stronger impact on matrix dissolution rates. Since the process is controlled predominantly by diffusion, the rate of leaching decreases as the thickness of the diffusion layer increases. However, this effect can be limited if the diffusion layer is dissolved, for example, by matrix dissolution.

Layer formation is favored in static or near-static conditions, and where silica is present, such as groundwater. Water can exhibit both acidic and alkaline reaction mechanisms because of readily formed hydronium and hydroxyl ions. The leaching of many glasses appears to be modified by the formation of surface layers. As matrix dissolution occurs, a surface layer composed of insoluble glass components forms. Initially, decomposition is dominated by interdiffusion (ionic exchange of alkali ions, such as sodium) as the network modifiers diffuse out of the glass and into solution, and the water diffuses into the surface of the glass. The concentration of alkali in most of the glass is unaffected (Doremus 1994).

During this process, the pH at the glass surface gradually increases (becomes more alkaline) due to the formation of alkali hydroxides in the solution. The result of the increase in pH is the onset of matrix dissolution and, eventually, the formation of a surface layer around the glass matrix. Within that surface layer, precipitation and adsorption of insoluble compounds occurs at the surface of the glass. These compounds are the more insoluble compounds (e.g., iron and manganese oxides), which remain as the more soluble constituents dissolve and move into solution. The surface layer can exert a strong limiting effect on the leaching of the glass underneath. Under static or near-static conditions, leaching may be reduced further, as silica concentrations build up in the leachate and approach saturation, which reduces the tendency of more silica in the glass to move into solution (EPA 1992). The primary reactions are summarized below:

- Interdiffusion:

$$\sim Si - O^-R^+ + H_2O \rightarrow \sim Si - OH + R^+ + OH^-$$

- Hydroxyl-Catalyzed Network Hydrolysis:

$$\sim Si - O - Si + OH^- \rightarrow \sim Si - OH + O^- - Si \sim$$
$$\sim Si - O^- + H_2O \rightarrow \sim Si - OH + OH^-$$

- Which, under higher pH, releases:

$$H_4SiO_4 \rightarrow H_3SiO_4^- + H^+ \rightarrow H_2SiO_4^{2-} + 2H^+$$

- Simultaneous with condensation:

$$\sim Si - OH \quad HO - Si \sim \qquad \sim Si - O - Si \sim + H_2O$$

Ultimately, solubility depends on pH. Diffusion gives rise to an increase in pH until saturation occurs, eventually resulting in the formation of a secondary phase of crystalline and amorphous precipitants at the glass surface.

Glass leaching is controlled by the following conditions:

- Moderation of the rise in pH
- Incorporation of low-solubility species, such as aluminum and iron
- Controlling the secondary phase formations

In formulating waste glasses, there is generally a trade-off between leachability and processability. Adding sodium and other modifiers decreases viscosity and alters other process variables, thus improving processability; however, this addition increases leachability.

It is important to note that IHLW is packaged in stainless steel canisters, with the only void space at the top of the glass, between the glass and the canister lid. Fill volume shall be equivalent to at least 87% of the volume of the empty canister (1.0 m3 [35 ft^3] of glass). The average fill volume over all the canisters shall be at least 95% of the volume of the empty canister (1.1 m^3 [39 ft^3] of glass) (24590-WTP-DB-ENG-01-001). A breach of the stainless steel canister would be required before environmental elements (e.g., groundwater) could intrude.

2.4 Percent Solids [Part 2: 3]

The physical form of the waste is a solid, not a sludge or liquid. Therefore, the material is a 100 % solid.

2.5 History of Waste Generation [Part 2]

The generation of the petitioned waste is presented in the following subsections.

2.5.1 Waste Generated in the Past [Part 2: 4a]

Petitioned waste has not been generated in the past. Therefore, this topic is not applicable.

2.5.2 Waste Presently Generated [Part 2: 4b]

Petitioned waste is not presently generated. Therefore, this topic is not applicable.

2.5.3 When Petitioned Waste is Generated [Part 2: 4c]

The petitioned vitrified waste form is forecasted to be generated beginning approximately in the year 2019.

2.6 Volume of Petitioned Waste [Part 2: 5]

IHLW will be produced at a nominal rate of 3.0 metric tons of glass (MTG) per day per melter, or 6 MTG/day from two HLW melters. The expected annual volume is 480 canisters of IHLW (24590-WTP-DB-ENG-01-001). Each canister has an interior volume of 1.16 m^3 (41 ft^3), making 557 m^3/yr (730 yd^3/yr). The expected operating life of the WTP is 40 years. The annual quantity of feed processed will depend on the variables involved in treating the waste, including the amount of GFCs required for a specific waste feed.

However, to increase conservatism when evaluating environmental risks posed by storage of IHLW at the National Geologic Repository, the annual volume was increased to 765 m^3 (1000 yd^3) when using the EPA's Delisting Risk Assessment Software[1] (DRAS) (EPA 2002a) to calculate delisting levels (Section 4.4). This petition also requests a delisting allowing up to 765 m^3 (1000 yd^3) of IHLW annually for 40 years to allow flexibility to increase WTP capacity, should it become necessary.

2.7 History of Waste Management [Part 2: 6]

The petitioned waste has not been generated; therefore, there is no history of waste management.

2.7.1 Present Waste Management Methods [Part 2: 6a]

The petitioned waste has not been generated and thus is not presently managed.

[1] The Delisting Risk Assessment Software (DRAS) is a computer program developed by the EPA to predict risks to human health and the environment from the disposal of wastes to a landfill or surface impoundment. The DRAS is used to calculate potential chemical releases, fate and transport of the chemicals, and to determine risk associated with exposure to the chemicals released.

2.7.2 Past Waste Management Methods [Part 2: 6b]

The petitioned waste has not been generated and thus was not managed in the past.

2.7.3 Proposed Waste Management Methods [Part 2: 6c]

IHLW will be poured from the IHLW melter(s) into waste canisters designed to meet DOE Office of Civilian Radioactive Waste Management's (DOE-RW) requirements for accepting IHLW for disposal by the federal geologic repository program. These requirements must be met before the IHLW product will be accepted by the DOE for onsite interim storage and in support of the later formal acceptance by DOE-RW for final disposal. IHLW canisters are described in Section 3.3.2.4.

Waste product as discussed in this petition is not currently being generated. After it is produced, the vitrified waste product will be stored on an interim basis in two facilities at the Hanford Site, permitted in the Hanford Facility RCRA permit (WA7890008967). First, the vitrified waste will be stored temporarily in the WTP. From the WTP, the vitrified waste will be transferred to the canister storage building in the 200 East Area, using nonpublic roads on the Hanford Site. These facilities are described in Section 3.4 of this petition.

In 2002, Congress approved commencement of the nuclear licensing process to establish a National Geologic Repository at Yucca Mountain, Nevada (Public Law 107-200). The vitrified product will remain in the canister storage building until the national repository is licensed, and shipping procedures to transfer it to the national repository are in place. Once the vitrified HLW product is transferred to a national repository, it will remain there permanently[2].

[2] The NRC regulations require that the DOE be able to retrieve waste for up to 50 years after the start of emplacement in case circumstances arise that necessitate waste removal from the disposal facility (e.g., catastrophic failure of waste containers or facility structures resulting in unacceptable threats to human health and the environment) (10 CFR 63.111(e)(1)). In such an event, the waste will be removed, placed into dry storage, and an alternate disposal facility identified in accordance with NRC regulations.

Table 2-1 Hanford Tank Waste Hazardous and Dangerous Waste Numbers

Characteristic Waste Codes			
Waste Code	**Chemical**	**Waste Code**	**Chemical**
D001	Ignitable	D033	Hexachlorobutadiene
D002	Corrosive	D034	Hexachloroethane
D003	Reactive	D035	Methyl ethyl ketone
D004	Arsenic	D036	Nitrobenzene
D005	Barium	D038	Pyridene
D006	Cadmium	D039	Tetrachloroethylene
D007	Chromium	D040	Trichloroethlyene
D008	Lead	D041	2,4,5-Trichlorophenol
D009	Mercury	D043	Vinyl chloride
D010	Selenium	WP01 [a]	Persistent dangerous waste – halogenated hydrocarbons (extremely hazardous waste)
D011	Silver		
D018	Benzene	WP02 [a]	Persistent dangerous waste – halogenated hydrocarbons
D019	Carbon tetrachloride		
D022	Chloroform	WT01 [a]	Toxic dangerous waste (extremely hazardous waste)
D028	1,2-Dichloroethane		
D029	1,1-Dichloroethylene	WT02 [a]	Toxic dangerous waste
D030	2,4-Dinitrotoluene		
Listed Waste Codes			
Waste Code	**Hazardous Waste Description**		**Chemical(s)**
F001	spent halogenated solvents used in degreasing: Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed inF002, F004, and F005;and still bottoms from the recovery of these spent solvents and spent solvent mixtures.		Carbon tetrachloride
			Methylene chloride
			Tetrachloroethylene
			1,1,1-Trichloroethane
			Trichloroethylene
			Trichloromonofluoromethane
			Trichloroethylene
			Trichloromonofluoromethane
F002	spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene,		Methylene chloride
			Tetrachloroethylene
			1,1,1-Trichloroethane

Table 2-1 Hanford Tank Waste Hazardous and Dangerous Waste Numbers

	trichlorofluoromethane, and 1,1,2- trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	Trichloroethylene
		Trichloromonofluoromethane
		Trichloroethylene
		Trichloromonofluoromethane
		Chlorobenzene
		o-Dichlorobenzene
		1,1,2-Trichloroethane
		1,1,2-Trichloro-1,2,2-trifluoroethane
		1,1,2-Trichloroethane
		1,1,2-Trichloro-1,2,2-trifluoroethane
		1,1,2-Trichloroethane
		1,1,2-Trichloro-1,2,2-trifluoroethane
F003	spent non-halogenated solvents: Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, only the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and, a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	Acetone
		n-Butyl alcohol
		Cyclohexanone
		Ethyl acetate
		Ethyl benzene
		Ethyl ether
		Methanol
		Methyl isobutyl ketone
F004	spent non-halogenated solvents: Cresols and cresylic acid, and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	o-Cresol
		m-Cresol
		p-Cresol
		Cresol-mixed isomers
		Nitrobenzene
F005	spent non-(I,T) halogenated solvents: Toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2- ethoxyethanol, and 2- nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	Benzene
		Carbon disulfide
		Isobutyl alcohol
		Methyl ethyl ketone
		Pyridine
		Toluene

Table 2-1 Hanford Tank Waste Hazardous and Dangerous Waste Numbers

F039 [b]	Leachate (liquids that have percolated through land disposed wastes) resulting from the disposal of more than one restricted waste classified as hazardous under subpart D of this part. (Leachate resulting from the disposal of one or more of the following EPA Hazardous Wastes and no other Hazardous Wastes retains its EPA Hazardous Waste Number(s): F020, F021, F022, F026, F027, and/or F028.).	Multi-source leachate

a Washington State criteria.

b Multi-source leachate (F039) is included as a waste derived from nonspecific source wastes F001 through F005. F039 is not included on the SST Form 3.

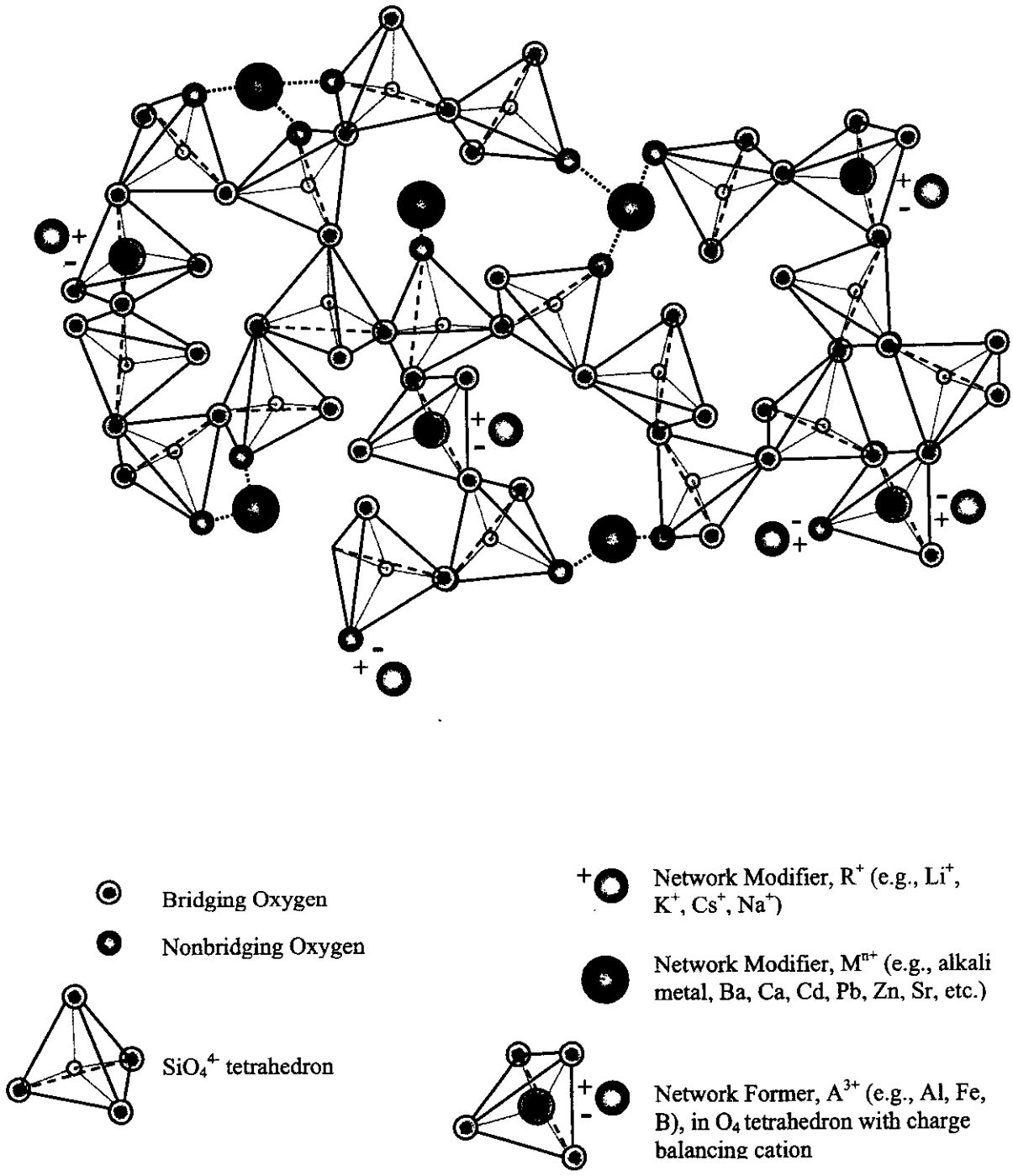
Ref: DOE-RL (1991), *Double-Shell Tank System Dangerous Waste Permit Application*, DOE/RL-90-39, as amended.

Table 2-2 Network Formers and Modifiers

COC or GFC		Element	Oxide	Predominant Valence[1] of Element	Likely Predominant Form: Network Former or Modifier
Constituent of Concern	Antimony	Sb	Sb_2O_3	III	Former
	Arsenic	As	As_2O_5	V	Former
	Barium	Ba	BaO	II	Modifier
	Beryllium	Be	BeO	II	Modifier
	Cadmium	Cd	CdO	II	Modifier
	Chromium	Cr	Cr_2O_3	III	Former
	Copper	Cu	CuO	II	Modifier
	Lead	Pb	PbO	II	Modifier
	Mercury	Hg	HgO	Not retained in glass - volatilized	
	Nickel	Ni	NiO	II	Modifier
	Selenium	Se	SeO_2	IV	Former
	Silver	Ag	Ag_2O	I	Modifier
	Thallium	Tl	Tl_2O	I	Modifier
	Vanadium	V	V_2O_5	V	Former
	Zinc	Zn	ZnO	II	Modifier
Major GFCs	Boric Acid	B	B_2O_3	III	Former
	Lithium Carbonate	Li	Li_2O	I	Modifier
	Silica	Si	SiO_2	IV	Former
	Sodium Carbonate	Na	Na_2O	I	Modifier
	Zinc Oxide	Zn	ZnO	II	Modifier
Minor GFCs	Alumina	Al	Al_2O_3	III	Former
	Wollastonite	Ca	CaO	II	Modifier
	Iron Oxide	Fe	Fe_2O_3	III	Former
	Olivine	Mg	MgO	II	Modifier
	Rutile-94	Ti	TiO_2	IV	Former
	Zirconium Oxide	Zr	ZrO_2	IV	Former

(1) Ref.: Lide DR 2003. *Handbook of Chemistry and Physics*, 84th Edition, Chemical Rubber Company, Boca Raton, Florida.

Figure 2-1 Glass Network



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3 Delisting Process Information [Part 3]

3.1 General Operations at the Generating Facility [Part 3]

The general operations information for the WTP is in Chapter 10 of the *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967), Attachment 51, "Waste Treatment and Immobilization Plant, Process Information," (refer to Supplement 1 of this petition). This information is summarized below.

3.1.1 Facility Business Areas [Part 3: 1]

The WTP will store and treat waste feed from the Hanford tank system, a waste storage complex that holds residual materials from the processing of nuclear fuels and other activities. The WTP Standard Industrial Classification Codes are in Table 3-1.

3.1.2 Products Manufactured [Part 3: 2]

The WTP will produce immobilized low-activity waste[1] (ILAW, not covered by this petition) and IHLW products. The IHLW will be borosilicate glass designed to meet requirements for disposal in the National Geologic Repository, as defined in the *Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document* (WASRD) (DOE 2002a) and other documents. The IHLW glass will be designed to meet criteria for delisting the waste, as described in this petition.

Feeds to be processed initially by the WTP are currently stored in DSTs 241-AY-102 (after addition of material from SST 241-C-106), 241-AY-101, 241-AZ-101, 241-AZ-102, and 241-SY-102. Material currently stored in SST 241-C-104 is to be added to DST 241-AY-101 before its waste is processed. Eventually, all of the HLW stored at the Hanford Site SST and DST systems will be treated. The IHLW will be subject to delisting.

3.1.3 Wastes Generated [Part 3: 3]

Secondary waste products will be produced in various forms (solid, liquid, and gaseous). Secondary waste types will be any non-glass waste streams, and include nonhazardous/nonradioactive waste, nonhazardous radioactive waste, mixed waste, and nonradioactive hazardous and dangerous secondary waste.

Secondary waste products include:

- Spent or failed equipment
- Spent, dewatered ion-exchange resins in the pretreatment plant
- Evaporator process condensate

[1] ILAW is vitrified waste slurry (supernatant and dissolved saltcake) that is separated from entrained solids in the pretreatment process and produced in a manner similar to IHLW. ILAW is planned for disposal in a RCRA facility, and thus, is not included in this petition. Refer to Section 3.3.2 for additional details on the separation of low-activity and high-activity waste streams.

- Offgas high-efficiency particulate air (HEPA) filters
- Melter consumables
- Analytical laboratory waste
- Spent melters
- Miscellaneous nonradioactive dangerous waste
- Other (nonhazardous radioactive waste)

The secondary waste products, and their permitted treatment processes, are described in the following documents:

- *Secondary Wastes Compliance Plan* (24590-WTP-PL-RT-03-003)
- Chapter 4, "Process Information," of Attachment 51 of Chapter 10 of the Hanford Facility RCRA Permit (WA7890008967)

These secondary wastes are outside the scope of this petition and are managed by the Hanford Site in accordance with applicable permits and licenses.

Secondary wastes associated with production of the IHLW are discussed in Section 3.3.4. Section 3.3.5 discusses streams that are recycled and contribute to the IHLW production through reincorporation into the pretreatment process.

3.1.4 Waste Treatment Areas [Part 3: 4]

The WTP will use four major process areas to produce the IHLW that is the subject of this petition: waste feed and pretreatment (PT), HLW vitrification, analytical laboratory, and the balance of facilities (BOF). A fifth process area will produce ILAW; however, ILAW is not the subject of this petition. The analytical laboratory and the BOF do not process HLW, but support HLW vitrification through the analysis of materials (laboratory) and utilities and infrastructure support (BOF).

The waste feed and pretreatment process area will receive wastes staged at and transferred from the DST system and separate the wastes into a high-activity fraction (high-level waste [HLW]) and a low-activity fraction (LAW). The HLW and LAW fractions are transferred to the HLW and LAW vitrification buildings, respectively, for processing into glass.

The HLW vitrification processes will combine pretreated HLW feeds with GFCs. The mixture will then be transferred to the HLW vitrification melters and heated into a molten glass mixture that will be poured into stainless steel canisters. After the hot glass mixture sufficiently cools and solidifies, lids will be welded on each container in preparation for storage and disposal (Sections 3.3 through 3.6). Figure 3-1 shows the WTP location; Figure 3-2 is a plan view of the facility. Figure 3-3 is an aerial photo of the WTP under construction. Figure 3-4 is a computer-generated isometric view of the completed WTP.

There are four types of dangerous waste management units in the WTP:

- Container storage areas
- Tank systems

- Containment buildings
- Miscellaneous treatment systems

Each waste management unit is discussed in Chapter 4, Process Information, of Attachment 51, "Waste Treatment and Immobilization Plant," of the Hanford Facility RCRA Permit (WA7890008967) (also see Supplement 1 of this petition).

3.1.5 Regulatory Status of Waste Treatment, Storage, and Disposal Units [Part 3: 5]

All waste treatment, storage, and disposal facilities at the Hanford Site are covered under the Hanford Facility RCRA permit (WA7890008967) or operate as interim status facilities subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998). Table 3-2 lists applicable hazardous waste permits and other permits issued for the WTP under federal and state environmental statutes.

3.2 Contributing Manufacturing Processes [Part 3]

The waste to be treated at the WTP was generated by manufacturing processes no longer in use, and by miscellaneous waste additions to the tanks. The Hanford Site's original mission was to produce plutonium by reprocessing nuclear fuels, which created the waste as it is now, stored in Hanford's DST and SST systems.

3.2.1 Pre-Process Steps to Prepare Materials for Processing [Part 3: 6]

The DOE ORP currently manages 177 underground storage tanks (waste tanks); 149 SSTs and 28 DSTs. Tank waste that will be treated at the WTP is the byproduct of producing plutonium and other defense-related materials. From 1944 through 1989, chemical processing facilities at the Hanford Site processed irradiated or spent nuclear fuel from defense reactors to separate and recover plutonium and other heavy elements for weapons production. The waste tanks received waste from all processing plants in the 200 (Chemical Separations) Areas, including the Plutonium/Uranium Extraction (PUREX) Plant (1956 to 1972 and 1983 to 1989); B Plant and T Plant (1944 to 1956); the Reduction-Oxidation (REDOX) Plant (1952 to 1966); Uranium (U) Plant (1952 to 1957); and smaller waste contributions from the Waste Encapsulation Storage Facility (WESF), Hot Semi-Works, Analytical Laboratories (222-S), and other waste treatment facilities in the separations areas (Figure 3-5). Other wastes stored in Hanford waste tanks included radiological, chemical, and liquid waste streams transported from the 300 Area by rail car.

As improved processing operations were developed, processing efficiency improved, and the waste compositions sent to the tanks for storage changed both chemically and radiologically. T and B Plants were the first separations facilities built at the Hanford Site. These plants recovered only plutonium; consequently, the remaining components of the dissolved fuel elements, including uranium, were sent to the waste tanks. Later, processes were developed to recover uranium, which was recycled back into the reactor fuel cycle. Many of the chemical processes associated with plutonium recovery from spent nuclear fuel involved dissolving the material in nitric acid. The resulting acidic waste streams were made alkaline by adding sodium hydroxide before transfer to the tanks. Sodium nitrate was also added to inhibit corrosion. These processing steps produced large volumes of sodium nitrate salts in the tanks. Table 3-3 lists the major processing facilities that served as sources of tank waste.

Waste numbers assigned to the waste described in the DST portion of the Part A Hanford Facility RCRA permit (Ecology 2001) apply to the WTP waste feed (waste codes on the DST Part A permit are inclusive of SST waste codes). These dangerous waste numbers are in Table 2-1.

The waste feed will carry the numbers for ignitable (D001) and reactive (D003) waste. However, based on past process knowledge, which includes the age, temperature, history, and chemical composition of the waste feed stored in Hanford waste tanks, the waste is not expected to exhibit the characteristics of ignitability or reactivity as defined in Washington Administrative Code (WAC) 173-303-090. After the waste feed has been received into the WTP, this process knowledge will be used to remove the dangerous waste numbers for ignitability and reactivity in accordance with Appendix 3A (Section 3.6) of Attachment 51 of Chapter 10 of the Hanford Facility RCRA Permit (WA7890008967).

The waste feed materials (to be vitrified) that contain the COCs will be derived from wastes stored in Hanford waste tanks. The Hanford waste tanks provide interim storage for liquid and solid wastes. More than 54 million gallons of waste are stored in the 149 SSTs and 28 DSTs at the Hanford Site. Feed materials to be processed into the petitioned waste form (vitrified glass) were first generated in approximately 1943 and were placed in SSTs. Wastes have been transferred extensively among both SSTs and DSTs, but all wastes to be treated by the WTP will be transferred from DSTs (the DST will serve as a staging location for both SST and DST waste prior to transfer to the WTP). The DSTs have received and will continue to receive waste from the SSTs as part of SST waste retrieval operations. Operations such as intertank transfers and evaporation to reduce waste volume still occur.

3.2.2 Processes Contributing to Petitioned Waste [Part 3: 7]

Wastes in any given DST have been placed there by a combination of the following events:

- Direct transfer from production operations or other miscellaneous activities in the 200 East and 200 West Areas.
- Transfer from the SST system.
- Transfer from other DSTs.
- Additions in the tanks (such as caustic to prevent corrosion).
- Miscellaneous transfers such as return of sample material after analysis in the laboratory, transfers from railroad tank cars and tank trucks, and transfer from smaller temporary tanks. A very small proportion of the waste is from these types of transfers.

Additional details of the original waste generation processes are in the *Hanford Facility Dangerous Waste Permit Application, Double-Shell Tank System* (DOE-RL 1991, as amended).

3.2.3 Description of Manufacturing Processes Generating Waste [Part 3: 8]

The following subsections summarize the historical waste generation processes and the processes required to prepare the waste for treatment to produce petitioned waste. Additional details about waste generation and tank systems are in *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* (DOE 1996).

3.2.3.1 Waste Production Processes

Several chemical separations processes were used to separate and recover plutonium and uranium from irradiated reactor fuels at the Hanford Site (DOE 1996). Common steps in the recovery processes included chemically removing the fuel element cladding, dissolving the fuel in nitric acid, chemically processing the fuel to separate the plutonium, and in some instances separating the uranium from the dissolved fuel mixture.

The first processing for plutonium recovery started in 1944 at T Plant and 1945 at B Plant using the bismuth phosphate process to precipitate plutonium from dissolved spent fuel solutions. The extraction waste was classified as a metal waste and contained 90 % of the fission products and 99 % of the uranium. This waste was sent to specific SST tank farms in the 200 East and 200 West Areas.

In January 1952, the REDOX Plant began operating as the world's first nuclear solvent extraction plant using the redox process, which extracted plutonium and uranium into a hexone solvent in a continuous solvent extraction process.

In 1956, the PUREX Plant began operating. The PUREX Plant used tributyl phosphate (TBP) in a kerosene base as a solvent to extract uranium and plutonium from the fuel elements that had been previously dissolved in a nitric acid solution. Both the redox and PUREX processes recovered plutonium, uranium, and neptunium from spent reactor fuel.

All of the acidic aqueous waste was made alkaline, primarily by adding sodium hydroxide before storing it in the underground storage tanks.

The Plutonium Finishing Plant (PFP) took the plutonium nitrate product from the PUREX and REDOX Plants and further refined it into plutonium metal. The PFP used a process similar to the PUREX Plant to further purify the plutonium and produce a finished plutonium product from the PUREX Plant output. The PFP sent waste to the tank farms that was low in radioactivity and high in metallic nitrates. Before PFP began operating, the plutonium nitrate product was transported to Los Alamos National Laboratory for processing.

During the B Plant and T Plant operations, uranium from the bismuth phosphate process was sent to tank farms. The U Plant was built and operated to recover the uranium from B and T Plant tank waste, which required reprocessing B and T Plant waste from the tank farms.

Midway through operations, the U Plant began precipitating cesium with ferrocyanide to remove the cesium from the liquid waste. The cesium precipitated in the tank waste as solids, allowing the liquid to be decanted and sent to the cribs (subsurface drain system). This practice allowed the discharge of clarified liquid and provided additional tank space. This process was completed in 1957.

B Plant was also operated as a waste fractionization plant in the 1960s to early 1980s. Cesium and strontium were recovered as waste byproduct, and the secondary waste that contained complexants (ethylenediaminetetraacetic acid [EDTA] and hydroxyethylenediaminetriacetic acid [HEDTA]) was sent to the tank farms.

Chemical processing generated approximately 1.5×10^9 L (4.0×10^8 gal) of waste. More than 1.1×10^9 L (3.0×10^8 gal) of waste was sent to underground SSTs and DSTs during the production period (that is, before in-tank precipitation, decanting and discharge).

3.2.3.2 Tank Farms Description

Tank farms are the source of waste feed proposed for treatment by the WTP to produce HLW glass that can be delisted. This section and subsections summarize these waste management processes.

The tanks are grouped into "tank farms," each containing 2 to 18 tanks. The SST farms typically were interconnected in a series or cascade that allowed the waste to be pumped into the first tank, overflow into the next, and so on through the series. This allowed solid particles to settle into the first few tanks of a cascade and allowed the liquid in the last tank to be discharged into a crib. Tank waste is no longer discharged to cribs. The tanks are interconnected to one another, other tank farms, and various support structures and processing facilities. Underground pipes transfer the waste between tanks. Figure 3-6 and Figure 3-7 illustrate the tank farms and associated piping and show the individual tank numeric designations (e.g., 241-AZ-101; "241-AZ-" is omitted for brevity) and tank capacities. The figures were developed from information in *Hanford Tank Clean up: A Guide to Understanding the Technical Issues* (Gephart and Lundgren 1995) and TFCOUP (Kirkbride et al. 2003).

The tank waste is categorized as liquid, sludge, and saltcake. Liquid is made up of water and organic compounds that contain dissolved salts. The organics in liquid form, depending on the type, either are dissolved in the water or exist in separate phases. Liquid in the tanks is either free standing (relatively free of solid particles), or interstitial (contained in the voids surrounding the sludge and saltcake particles). Sludge is a mixture of insoluble (i.e., will not dissolve in tank liquid) metal salt compounds that have precipitated out of solution after the waste was made alkaline. Saltcake is primarily sodium and aluminum salt that crystallizes out of solution following evaporation.

These three types of waste exist in the tanks in numerous combinations and proportions, which result in complex combinations of waste with varied physical and chemical properties. Sludge ranges from mud to hardened clay. In some tanks, layers of organic compounds float on top of solid waste. Crusts have formed in some tanks where a layer of solid has formed on top of the liquid. Table 3-4 summarizes the waste forms in the SSTs and DSTs. Figure 3-8 and Figure 3-9 provide a tank-by-tank summary of tank contents as of March 2005. The figures also identify potential leaking tanks.

3.2.3.2.1 Single-Shell Tank Farm Facility Descriptions

Wastes originally placed in the SST system were primarily generated from three major chemical reprocessing operations: the bismuth-phosphate process, the REDOX process, and the PUREX process (DOE 1996). The resultant wastes were blended and concentrated by evaporation to reduce the volume for storage in large (up to 3790 kL [1,000,000 gal]) underground tanks. Acidic wastes were made basic by adding sodium hydroxide, to limit corrosion of the carbon steel tanks. As a result, the waste consists primarily of precipitated metal hydroxides (sludge), alkaline salt solutions (supernatant), and crystallized salts (saltcake). The SSTs also received miscellaneous waste transfers from Hanford Site supporting activities as described above for the DSTs.

The 149 SSTs are located on 12 separate tank farms. Of these tanks, 133 are 22.9 m (75 ft) in diameter, with nominal capacities of 2010 to 3790 kL (530,000 to 1,000,000 gal), and 16 are 6.1 m (20 ft) in diameter with capacities of 208 kL (55,000 gal) each. The tanks are reinforced concrete, cylindrical, dome-roofed, buried tanks with a single steel liner across the tank bottom and up the concrete tank wall (but not the domed top). A typical exterior reinforced concrete tank (Figure 3-10) consists of foundation, walls, and dome. The concrete tank is designed to sustain soil loads, dead loads, live loads

(vehicles/cranes), seismic loads, and loads caused by thermal gradients between the radioactive wastes and the surrounding soil. Figure 3-11 summarizes SST dimensions and capacities, and Figure 3-12 shows the actual construction of SSTs.

241-A Tank Farm Facilities (200 East Area)

The 241-A Tank Farm complex is directly north of the 241-AW Tank Farm, along the east boundary of the 200 East Area. The 241-A Tank Farm has six tanks rated at 3790 kL (1,000,000 gal) each, constructed during 1954 and 1955.

241-AX Tank Farm Facilities (200 East Area)

The 241-AX Tank Farm complex is located in the 200 East Area. The 241-AX Tank Farm has four tanks rated at 3790 kL (1,000,000 gal) each, constructed during 1963 and 1964. The tanks received waste from PUREX and B Plant, and double-shell slurry feed from the 242-A Evaporator.

241-B Tank Farm Facilities (200 East Area)

The 241-B Tank Farm complex is north of B Plant next to Baltimore Avenue in the 200 East Area. The 241-B Tank Farm, one of the first four tank farms constructed, was built from 1943 to 1944. The 241-B Tank Farm has 12 tanks rated at 2010 kL (530,000 gal) each, and four smaller tanks, each 6.1 m (20 ft) in diameter and rated at 208 kL (55,000 gal). The 241-B Tank Farm tanks were used to settle and store low-level waste from B Plant, primarily first- and second-cycle cladding removal waste and evaporator bottoms. Tanks 241-B-102, 241-B-103, 241-B-106, 241-B-108, 241-B-109, and 241-B-112 also accepted in-tank solidification (ITS) evaporator bottoms. Residual liquor was removed from four tanks (241-B-101, 241-B-105, 241-B-107, 241-B-110) when they were inactivated and pumped to tank 241-B-102.

241-BX Tank Farm Facilities (200 East Area)

Tanks in the 241-BX Tank Farm were built from 1946 to 1947 using the original tank design for the 241-B Tank Farm. The tanks were arranged in four cascades of three tanks each. Tanks in the 241-BX Tank Farm supported cross-site transfers and the 242-A Evaporator until the DST system became the only receiver of wastes. The 241-BX Tank Farm has twelve 2010 kL (530,000 gal) SSTs. Tanks 241-BX-101 through 241-BX-106 received B Plant metal waste until the two cascades were full in January 1950. Tanks 241-BX-107 through 241-BX-112 received B Plant first-cycle waste and Cell 23 concentrated waste. During the ITS-1 program, tank 241-BX-110 received evaporator bottoms. Several tanks served to stage the feed. The first two cascades also received TBP waste. Double-contained receiver tank 244-BX served the 241-B, 241-BX, and 241-BY Tank Farms for salt-well pumping activities.

241-BY Tank Farm Facilities (200 East Area)

The 241-BY Tank Farm was built from 1948 to 1949 using a modified 241-B Tank Farm design. The capacity of each of the 12 tanks is 2870 kL (758,000 gal); the riser pattern was modified to gain more uniform access to the tank interior. The 241-BY Tank Farm was initially operated to back up the 241-BX Tank Farm. Tanks 241-BY-101 through 241-BY-106 received B Plant metal wastes in cascade after the 241-BX Tank Farm was full. Tanks 241-BY-107 through 241-BY-110 received B Plant first-cycle waste and TBP waste; tanks 241-BY-111 and 241-BY-112 were used for the temporary storage of metal waste.

241-C Tank Farm Facilities (200 East Area)

The 241-C Tank Farm is north of the PUREX complex, just northwest of the 241-AN Tank Farm. The 241-C Tank Farm has twelve 2010 kL (530,000 gal) tanks (241-C-101 through 241-C-112) and four 208 kL (55,000 gal) tanks (241-C-201 through 241-C-204). These tanks were constructed during 1943 and 1944. Twelve of the tanks are 22.9 m (75 ft) in diameter, and four are 6.1 m (20 ft) in diameter. The 22.9 m (75 ft) diameter tanks are arranged in four cascades of three tanks each. The 6.1 m (20 ft) diameter tanks were also used to settle waste. The 241-C Tank Farm has been used to support several operations. The first cascade began in March 1946 to store metal waste from B Plant. Tanks 241-C-101 through 241-C-106 initially stored metal wastes, and tanks 241-C-107 through 241-C-112 received first-cycle B Plant decontamination waste. The first cascade (tanks 241-C-101 through 241-C-103) was pumped and converted to a TBP receiver in 1953. Several tanks acted as feed and receiver tanks for PUREX fission product waste processed in the 244-CR vault. The processing left a large amount of strontium in tank 241-C-106.

241-S Tank Farm Facilities (200 West Area)

This facility is on 13th Street, northwest of the REDOX Plant. The 241-S Tank Farm includes the following main facilities/buildings: 241-S Tank Farm, 242-S Evaporator/Crystallizer, and 244-S double-contained receiver tank. The 241-S Tank Farm has twelve 2870 kL (758,000 gal) SSTs constructed to the second-generation tank design (similar to the original 22.9 m (75 ft) diameter tanks but with increased operating depths). These tanks were constructed during 1950 and 1951. The 241-S Tank Farm received several types of REDOX Plant wastes in all four cascades (waste segregation was not practiced until 1955). In 1953, surface condensers were installed that self-concentrated the wastes in the first two cascades by disposing of vapor condensate via cribbing. Further concentration was achieved in most of the tanks during the 1970s using the 242-S Evaporator.

241-SX Tank Farm Facilities (200 West Area)

The 241-SX Tank Farm has 15 SSTs of third-generation tank design. Each can hold 3790 kL (1,000,000 gal). These tanks were constructed during 1953 and 1954. These were the first tanks designed for self-boiling waste. Original construction included underground duct headers connected to a common condenser-ventilation system. Tanks 241-SX-101 through 241-SX-106 vent through the system to tank 241-SX-109. Tanks 241-SX-107 through 241-SX-112 and tank 241-SX-114 are connected by an aboveground vent system. The first six tanks started operation in 1954, receiving REDOX Plant salt waste and first-cycle condensate. The salt waste tanks began boiling shortly after startup, but the condensate tanks took up to 2 years to start boiling. After the tanks had self-concentrated for several years, they served as receiver tanks for the 242-S Evaporator. The other nine tanks (241-SX-107 through 241-SX-115) were not released for use until late 1955. Self-concentration began very soon after startup. The heat load on the vent system increased as wastes self-concentrated, and in time condensate was refluxed (recycled) back to the tanks to maintain an even cooling rate (recycled condensate evaporates and removes heat). Airlift circulators were necessary to mix tank contents and prevent burping. Today, the airlift circulators are blanked and de-energized and do not work.

241-T Tank Farm Facilities (200 West Area)

The 241-T Tank Farm complex is directly west of the T Plant, in the 200 West Area. The 241-T Tank Farm was one of the first four tank farms built from 1943 to 1944. The 241-T Tank Farm has 16 SSTs. Twelve of the tanks are 22.9 m (75 ft) in diameter with capacities of 2010 kL (530,000 gal), and four are

6.1 m (20 ft) in diameter with 208 kL (55,000 gal) capacities. The 22.9 m (75 ft) diameter tanks are arranged in four cascades of three tanks each. The four 6.1 m (20 ft) diameter tanks were also used to settle waste, with the supernate overflowing into a crib (for soil disposal).

The first cascade began receiving metal waste from the T Plant bismuth phosphate process in 1944. The other cascades received decontamination-cycle wastes. Over several years, the tanks were emptied and used for ion-exchange wastes, 221-T Plant wastes, and TBP waste from the 244-CR vault (generated after the fourth cascade in the 241-C Tank Farm became full).

241-TX Tank Farm Facilities (200 West Area)

The 241-TX Tank Farm was constructed from 1947 to 1948 using a modified 241-B Tank Farm design that consisted of 18 tanks, each with a 2870 kL (758,000 gal) capacity, arranged in three cascades of four tanks each and two cascades of three tanks. Only half the tanks were used in cascade. The first two cascades (tanks 241-TX-101 through 241-TX-108) were filled with T Plant metal waste. During the 1950s six of the tanks were sluiced until empty, and began receiving redox waste. Tanks 241-TX-103 and 241-TX-108 were used for TBP waste after sluicing. The third cascade (tanks 241-T-109 through 241-T-112) stored first-cycle decontamination waste before being used with the 242-T Evaporator. The last six tanks were not used until the early 1950s and were used in combination with the 242-T Evaporator as feed, bottoms, and recycle tanks.

241-TY Tank Farm Facilities (200 West Area)

The 241-TY Tank Farm was built from 1951 to1952. All six tanks have a 3790 kL (1,000,000 gal) capacity and are of the same design as the tanks in the 241-S Tank Farm. Tanks in the 241-TY Tank Farm were used to settle and decant low-level wastes and were used as lag storage for the 242-T Evaporator feed.

241-U Tank Farm Facilities (200 West Area)

The 241-U Tank Farm, west of U Plant on Camden Avenue, was built from 1943 to 1944. Tanks in the 241-U Tank Farm received slurry from the 242-S Evaporator. Twelve of the tanks are 22.9 m (75 ft) in diameter with capacities of 2010 kL (530,000 gal), and four are 6.1 m (20 ft) in diameter with capacities of 208 kL (55,000 gal). The 22.9 m (75 ft) diameter tanks are arranged in four cascades of three tanks each; feed was pumped into the high tanks and overflowed into the lower tanks. The 6.1 m (20 ft) diameter tanks also were used to settle and decant waste. Tanks 241-U-101 through 241-U-109 received metal waste from T Plant and were subsequently sluiced back to the TBP recovery process in U Plant. Waste was received from various storage tanks for processing in the 242-T Evaporator. The last cascade (241-U-110 through 241-U-112) received self-evaporated first-cycle decontamination waste. All three tanks were then used for redox waste storage and evaporator feed. Tank 241-U-101 received solid waste items from 1969 to 1971, including experimental fuel elements, shroud tubes, and samarium balls.

3.2.3.2.2 Double-Shell Tank Farms and Systems

More specific data are available regarding the types of waste stored in DSTs than for SSTs. The waste stored in DSTs is reported by the kind of waste stored in individual tanks. Eight basic kinds of waste are associated with DSTs (DOE 1996):

- Concentrated Complexant Waste: concentrated product from evaporating dilute complexed waste. Liquid and solid alkaline waste containing high concentrations of organic complexants that retain transuranic elements ([TRU] e.g., plutonium) in solution; usually originated from strontium recovery in B Plant.
- Concentrated Phosphate Waste: waste originating from the decontamination of the N Reactor in the 100-N Area.
- Dilute Complexed Waste: liquid waste characterized by a high content of organic carbon including organic complexants. The main source is liquid-removal operations from the SSTs.
- Dilute Noncomplexed Waste: liquid waste containing low levels of radioactivity originating from T, B, REDOX and PUREX Plants, plus N Reactor (mostly sulfate waste), 300 Area, and PFP.
- Double-Shell Slurry: waste that exceeds the sodium aluminate saturation boundary in the evaporator without exceeding receiver tank composition limits. The waste is a thick liquid (mostly fine solids suspended in a liquid) formed from evaporation of SST waste. The resulting high-salt solutions (mostly sodium nitrate) were transferred to DSTs. Waste contains cesium, strontium, TRU, and low amounts of organic complexants. Dilute waste from reprocessing plants was also evaporated and classified as double-shell slurry.
- Neutralized Cladding Removal Waste (NCRW): thick sludge-like waste created when Zircaloy cladding was dissolved off the N Reactor fuel elements by reacting with liquid ammonium-fluoride ammonium nitrate solutions. This acid waste was then made strongly alkaline by adding sodium hydroxide. This resulted in a large volume of sludge, mostly zirconium hydroxide containing TRU, other fission products, and rare earth elements added to remove the TRU. This waste includes the solids portion of the PUREX Plant NCRW. This NCRW was sent to the tank farms as a slurry and is classified as TRU waste.
- PFP TRU Solid Waste: sludge TRU waste from PFP operations. Contains small quantities of plutonium and americium, and traces of strontium and cesium.
- Neutralized Current Acid Waste (NCAW): acid waste from PUREX, neutralized by the addition of sodium hydroxide.

The DST farms are in the 200 East and 200 West Areas. The DST farms became operational in the 1980s.

The 241-AY and 241-AZ Tank Farms are referred to collectively as the Aging-Waste Facilities (AWFs). The 241-SY Tank Farm is the only DST farm in the 200 West Area; the other five are in the 200 East Area. Each DST can hold 3790 to 4390 kL (1,000,000 to 1,160,000 gal) of high-level mixed waste. DSTs have been used to store liquid radioactive waste (TRU, high-level, low-level, and Hanford Site facility waste). DSTs have been used exclusively for receiving liquid waste since 1980, when SSTs were retired from waste-receiving service. Several plants in the 200 East and 200 West Areas of the Hanford Site transfer mixed wastes from the facility through buried transfer lines to the DSTs. The liquid waste is accumulating in the DSTs until it can be treated and disposed. There are 28 tanks in the system.

In addition to the tanks and tank farms, the DST system includes the following ancillary equipment: transfer lines, double-contained receiver tanks, diversion boxes and valve pits, diverter stations, and catch tanks.

The DSTs are fabricated as two concentric tanks. The freestanding primary tank contains the waste material. The primary tank is 22.9 m (75 ft) in diameter and 14.2 m (46 ft) high at the crown, and sits on a concrete insulating pad. The secondary tank, 1.5 m (5 ft) larger in diameter than the primary tank,

creates a 0.78 m wide (2.5 ft wide) surrounding space called the annulus, and sits on a concrete structural pad. The secondary tank wall joins the primary tank dome at the upper haunch area. These two tanks are enclosed in a reinforced concrete shell 14.6 m (48 ft) high at the crown. The secondary liner also is constructed of carbon steel 1 to 1.3 cm (0.4 to 0.5 in.) thick. The bottom of the secondary tank is fabricated from 1 cm (0.4 in.) steel plate. The secondary tank lower knuckle is made of a 1.3 cm (0.5 in.) steel plate that extends about 0.6 m (2 ft) from the floor and is welded to a wall plate. The resulting annulus is designed to contain primary tank leaks and protect surrounding ground from contamination. The completely enclosed annulus serves as a containment barrier if the primary tank should leak. The annulus is ventilated and continually monitored for evidence of primary tank leakage. The concrete shell encloses both primary and secondary tanks for additional containment, radiation shielding, and structural support. Figure 3-13 illustrates a typical DST. Figure 3-14 summarizes tank dimensions and capacity and Figure 3-15 shows the actual construction of DSTs (particular tanks pictured are not known).

241-AN Tank Farm Facilities (200 East Area)

The 241-AN Tank Farm has seven DSTs, each with a capacity of 4390 kL (1,160,000 gal). The tanks essentially are identical except for tank 241-AN-101, which has two additional concrete process pits, and tank 241-AN-107, which has 80 risers because of the 21 airlift circulator assemblies installed in the tank. The 241-AN Tank Farm is an integrated facility with dedicated service and ventilation equipment. The tanks are specifically designed for storage of double-shell slurry produced at the 242-A Evaporator.

241-AW Tank Farm Facilities (200 East Area)

The 241-AW Tank Farm has six DSTs, each capable of holding 4390 kL (1,160,000 gal). The farm is an integrated facility with dedicated ventilation and service equipment. The 241-AW Tank Farm stores low-heat radioactive liquid waste generated by the PUREX Plant. The tanks are specifically designed for storage of 242-A Evaporator feed. Tank 241-AW-102 is the feed tank for the 242-A Evaporator and is used for all waste concentration operations. Tank 241-AW-101 was designed to be used as an alternate feed tank. Waste designated for concentration is pumped to feed tank 241-AW-102 for transfer to the 242-A Evaporator.

241-AP Tank Farm Facilities (200 East Area)

The 241-AP Tank Farm is the most recently constructed (1983 to 1986) and has eight 4390 kL (1,160,000 gal) DSTs and associated facilities. The 241-AP Tank Farm is designed to operate in a manner similar to the 241-AW Tank Farm. Liquid wastes are transferred to or from the 241-AP Tank Farm via 241-AW Tank Farm facilities. The 241-AP facilities also include the 241-AP-271 Instrument Control Building, the 241-AP-801 Water Service Building, and the 241-AP-273 Compressor Building.

241-AY and 241-AZ Tank Farm Facilities (200 East Area)

The 241-AY and 241-AZ Tank Farms are part of Hanford's AWFs and are in the 200 East Area. Each tank farm has two 3790 kL (1,000,000 gal) DSTs. Aging waste was transferred from the PUREX Plant to the 241-AY and 241-AZ Tank Farms through either a primary line or a backup line. The primary line was routed through the 241-AX-155 diversion box to one of the two AWFs. The tank design used in the 241-AY and 241-AZ Tank Farms differs from the basic design used in all previous tanks. This design features a heat-treated, stress-relieved primary steel liner and a nonstress-relieved outer steel liner, both inside a reinforced concrete shell. These tanks also differ from other DSTs by containing two major support systems and a subsystem. These additional systems, along with airlift circulators, steam coils,

and exhaust condensers, allow the tanks to receive and store high-heat-generating wastes with minimum probability of loss of integrity.

241-SY Tank Farm Facilities (200 West Area)

The 241-SY Tank Farm consists of three tanks (3790 kL [1,160,000 gal] each) and is the only DST farm in the 200 West Area. Tank 241-SY-102 had airlift circulators identical to those in the 241-AW Tank Farm. The airlift circulators are out of service and the risers have been blanked off.

3.2.3.2.3 Waste Transfer Systems

As part of the ongoing SST closure project, waste is being transferred from the SST system to the DST system, through a system of underground pipelines. Cross-site waste transfer systems exist to transfer waste between the 200 East and 200 West Areas. Pipelines transporting waste normally are either buried at least 0.9 m (3 ft) below grade to provide shielding from radiation emitted by the waste, or have concrete shielding. These transfer lines are interconnected by a series of diversion boxes (belowgrade concrete routing structures with nozzles for jumper connections to permit routing liquid waste from one buried line to another). Jumpers are rigid pipe structures with fittings that can be connected to wall nozzles routing from tank farm to tank farm or processing facility to processing facility.

3.2.3.2.4 Current Operations of Tank Farm Systems

The tanks are currently used to safely store the tank waste until remediation measures are implemented. Liquid waste continues to be received into the DST tank farms (primarily from the SST system, 242-A Evaporator, and 222-S Laboratory).

Routine operations include management oversight, regulatory compliance, and reporting activities, and operations and maintenance of facilities and equipment. Tank monitoring activities support waste management by gathering information on waste temperature, liquid levels, and solid levels as required to safely manage and operate the tank farms. Leak detection activities involve in-tank liquid level monitoring, leak detection monitoring of the annulus for the DSTs, drywell monitoring around tanks for increases in radioactivity levels, and groundwater monitoring. Other routine operations include updating waste volume projections, tank waste transfers, tank waste sampling and characterization, and evaporation (242-A Evaporator operation). The 242-A Evaporator is used to manage waste volume by evaporating the water from the tank waste. Condensate water from the evaporator is transferred to the Effluent Treatment Facility (ETF) for treatment and release to the state-approved land disposal site. Concentrated waste from the evaporator is returned to the DSTs.

3.2.3.2.5 Summary of Tank Waste Characterization Data

Substantial historical information is available for the Hanford DST and SST systems, along with the associated production operations, which generated the original waste streams stored in the DSTs and SSTs (TFCOUP, Kirkbride et al. 2003; and *A History of the 200 Area Tank Farms*, Anderson and Mudd 1990). Table 3-5, Table 3-6, Table 3-7, and Table 3-8 are from TFCOUP Appendices C and D, and summarize the chemical and radionuclide inventory for the first four HLW and eleven LAW waste tanks currently scheduled[2] for processing by WTP. Step 1 implementation of the *Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project* (RDQO) (Wiemers

[2] Tank sequence is potentially subject to change to improve tank inventory management (refer to Section 3.2.3.2.4).

et al. 1998) has been completed. The results of this work provide new tank characterization data for tanks 241-AY-101 and 241-AN-107 that conform to the data requirements in the RDQO (i.e., data was derived according to SW-846 analytical requirements, with approved minor method modifications). Archived tank material was analyzed by BWX Technology Services (BWXS) and Battelle Pacific Northwest Division (PNWD); results are summarized in Table 3-9, Table 3-10, Table 3-11, and Table 3-12. For details on RDQO implementation and the data summarized by the tables, see the *Regulatory Data Quality Objectives Optimization Report* (24590-WTP-RPT-MGT-04-001).

The operational history of each tank is in *Hanford Tank Chemical and Radionuclide Inventories: Hanford Defined Waste Model* (Agnew 1997). The document presents a computer database and model used to capture individual tank fill histories and transfers. Additional operations contributing to waste composition and variability among tanks are included, such as the addition of chemicals (e.g., addition of nickel ferrocyanide to some tanks to precipitate and recover uranium). Agnew's computer model is used to predict concentrations of various chemicals and radionuclides in individual tanks.

3.2.4 Process Equipment and Operating Cycle Information [Part 3: 9–10]

Historical information for the Hanford DST and SST systems includes the associated production operations that generated the original waste streams stored in the DSTs and SSTs, as well as past and current waste management practices that have changed tank wastes over time (TFCOUP; Anderson and Mudd 1990). The TFCOUP is the best comprehensive source of data on waste feed composition currently available. For brevity, this information is not included here, but is available upon request.

3.2.5 Waste Variability and Contributing Factors [Part 3: 11]

Because the tanks hold waste from a variety of operations, tank contents have changed over time. Records were kept as transfers were made, but the inter-tank piping allowed the contents to cascade from one tank to another. Consequently, the tanks now contain a variable mixture of sludge, saltcake, and liquid. Tank-by-tank characterization would be required to determine the actual contents of any given tank.

Because of severe limitations in tank space, some wastes were concentrated by in-tank or external evaporation (242-A, 242-B, 242-S, and 242-T Evaporators, and ITS) with condensates routed to land disposal facilities, recycled to other tanks, or treated for disposal. Such processes gradually converted SST waste into mixed sludges and saltcake; most of the recent wastes from PUREX and supernates from older wastes have been consolidated into the DSTs. In-tank precipitation and mineralization have also changed the properties of some components in the waste, such as sodium, aluminum, and NO_3 in cancrinite ($2NaAlSiO_4 \cdot 0.52NaNO_3 \cdot 0.68H_2O$); aluminosilicate; and iron bismuth silicate hydroxide. Such wastes are often highly stratified with lateral and vertical inhomogeneities caused by the mixing and settling characteristics of the sludge (Lambert et al. 1996).

3.2.6 Periodic Variation of Waste Composition and Generation Rates [Part 3: 12]

The variability of waste feed from a regulatory standpoint is discussed in the RDQO (Wiemers et al. 1998). The RDQO considered possible means of variability unrelated to tank fill history (e.g., possible spontaneous manufacture of compounds in the tank environment). The RDQO defines the initial COCs in the waste feed, how they were derived, and which COCs may plausibly be in the tanks. This list was subsequently modified by *Data Quality Objectives Process in Support of LDR/Delisting at the WTP* (24590-WTP-RPT-ENV-01-012), also referred to as the Land Disposal Restrictions (LDR)/Delisting

DQO (inlcuded as Supplement 2 of this petition). Part 4 of this petition describes these DQO processes and their contribution to the COC list in more detail.

The composition of the petitioned waste may periodically vary due to variability in the waste feed streams; however, the resultant glass will be formulated to remain within acceptable glass compositions (Section 3.6.1.3). Variations in feed composition will be accommodated by formulating the glass so that its predicted properties meet applicable criteria. The vitrified waste product is extensively modeled using characterization information, target glass composition, and the TCLP response-glass composition model to project IHLW durability on a batch- or waste-type basis. Each melter feed batch (contents of melter feed vessel [MFV]) is a subset of HLW feed and is not expected to vary substantially while it is being vitrified. The process control strategy is designed to accommodate unforeseen changes in feed content, and GFC additions are adjusted to compensate for feed variations. The melter feed preparation vessel (MFPV) content will be monitored. The MFPV initial sample results (collected before GFC addition) will be used in conjunction with glass formulation algorithms to determine the GFC additions, and MFPV final sample results (after GFC addition) will be used to verify and report the projected IHLW composition (Section 3.6.1.3). Since no other additions/treatment occur between the MFPV and the melter, the MFPV is the ideal control point. Monitoring its content through periodic sampling will facilitate the detection of variation in feed, and GFCs will be adjusted accordingly.

Pretreatment process variations and the addition of LAW pretreatment recycle streams and GFCs will contribute to melter feed variability. The degree of variability in waste feed from the Hanford waste tanks has not been determined, and is to be investigated as part of the RDQO implementation. The variations in tank waste feed will not degrade glass durability, since the WTP process control strategy allows adjusting GFCs to control IHLW composition (Section 3.6.1.3).

3.3 Contributing Waste Treatment Processes [Part 3]

3.3.1 Contribution of Waste Treatment Processes to Petitioned Waste [Part 3: 13]

This section discusses the waste treatment processes that produce the final waste form, primarily waste feed delivery, pretreatment, and HLW vitrification.

3.3.2 Waste Treatment Process Descriptions [Part 3: 14]

The WTP feed treatment processes are summarized below. Details on waste stream pretreatment and vitrification and information specific to offgas collection and treatment systems are in Supplement 1 (excerpt from 24590-WTP-RPT-ENV-03-001, *Modification to the Dangerous Waste Permit*, specifically, Sections 4.1.2 through 4.1.4, and Figures 4A-1 through 4A-4). Additional schematics and drawings are available in Appendices 8 through 10 of Attachment 51 of Chapter 10 of the *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967).

3.3.2.1 Waste Feed Delivery

Waste feeds will be received at the WTP PT facility by pipeline transfers from staging tanks in the DST farms. The feed will be a slurry of liquid waste (supernatant and dissolved saltcake, LAW feed) and entrained solids (HLW feed). Feed from the Hanford waste tanks is expected to be of four major types, or waste feed envelopes:

- Envelope A. This waste feed envelope will contain cesium at concentrations high enough to warrant removal of these radionuclides during pretreatment, to ensure that the ILAW glass will meet applicable requirements. The removed material will be incorporated into Envelope D.
- Envelope B. This waste feed envelope will contain higher concentrations of cesium than Envelope A. Cesium must be removed to comply with the ILAW specifications. This envelope may also contain concentrations of chlorine, chromium, fluorine, phosphates, and sulfates that are higher than those in Envelope A, which may limit the waste incorporation rate into the glass. The removed material will be incorporated into Envelope D.
- Envelope C. This waste feed envelope will contain organic compounds containing complexed strontium and TRU (Sr/TRU) that will require removal in a processing step unique to this waste envelope. As with Envelopes A and B, cesium will also require removal in pretreatment to ensure that ILAW glass meets applicable requirements. The removed material will be incorporated into Envelope D.
- Envelope D. HLW feed will be in the form of a slurry containing approximately 10 to 200 grams of unwashed solids per liter. Envelope D will incorporate the materials removed from Envelope A, B, and C waste. The majority of the liquid fraction of the slurry will be separated from the solids and classified as Envelope A, B, or C waste. The remaining high-solids fraction will be Envelope D waste.

The envelopes are not intended to define variability in concentration of the COCs, although some of them are coincidentally included in the envelope specifications. Envelope D is the HLW fraction of the as-received tank waste; the LAW supernatant is Envelopes A, B, and C, depending on its composition. Although LAW envelopes can be pumped from the DST separately from the HLW, the HLW must be transferred from the DST as a slurry, and will be received initially as a combination of Envelopes A/D, B/D, or C/D. Envelope D is primarily insoluble metal oxides (e.g., iron, aluminum, and zirconium) and contains most of the long-lived radionuclides (e.g., americium, curium, uranium, and plutonium). Specifications for the HLW feed maximum concentrations of selected chemicals and radionuclides of importance to processing are in Table 3-13, Table 3-14, Table 3-15, and Table 3-16 (DOE 1997).

3.3.2.2 Waste Feed Receipt and Pretreatment

The waste feed receipt process system receives waste from the DST system, facilitates waste sampling, provides lag storage, and transfers the waste feed for treatment in the PT facility as described below.

Figure 3-16 diagrams the WTP processes. The Envelope D solids will be received at the PT facility combined with LAW supernates (tank liquids) (Section 3.3.2.1). Wastes staged in the DST system (lower left corner of Figure 3-16) will be received and processed through the WTP's PT operations (including feed evaporation, ultrafiltration, and ion exchange). The HLW and LAW feeds are separated upon receipt at the PT facility. The LAW feeds undergo pretreatment to remove entrained solids, precipitate excess Sr/TRU, and remove soluble ^{137}Cs before vitrification. The Sr/TRU and ^{137}Cs removal byproducts are combined with the HLW feed during later points of pretreatment. HLW pretreatment is limited mainly to solids concentration and addition of LAW pretreatment byproducts. These pretreated wastes will be fed to the LAW or HLW vitrification systems for production of ILAW and IHLW, respectively.

Both LAW and HLW feed streams will be concentrated if necessary to bring their sodium molarity within processing specifications. Subsequently, Sr/TRU-rich LAW (e.g., Envelope C) will undergo precipitation to facilitate Sr/TRU removal during filtration. Sr/TRU precipitation products are mostly strontium (Sr or SrO) and manganese (Mn or MnO_2). In some waste, radioactive TRU and strontium have been

complexed with organics and remain in the aqueous phase, and would remain in the LAW feed if not precipitated. The Sr/TRU process adds nonradioactive strontium to feed to dilute the radioactive strontium. Permanganate is used as a strong oxidizer that reacts with the organic complexes and causes TRU to precipitate (manganese oxide solids). The filtration step will separate the Sr/TRU solids, adding strontium and manganese oxide solids (to facilitate precipitation) to the solid (HLW) fraction. The Sr/TRU precipitate will be washed to remove residual LAW supernate. Caustic and/or oxidative leaching (if necessary) will be performed to remove chemical constituents (e.g., aluminum) that contribute to excess IHLW product volume. After washing and/or leaching, the solids will again be ultrafiltered to remove liquid and concentrate the solids. Washed solids removed from the LAW feed stream are then stored and eventually blended with HLW feed before HLW vitrification. HLW feed does not require Sr/TRU precipitation, but is filtered to further increase the solid content of the HLW slurry (liquid permeate of Envelope D feeds is processed with LAW liquids).

After filtration, the LAW permeate will undergo ion exchange to remove ^{137}Cs. The fully loaded ion exchange resin will be eluted to remove ^{137}Cs, and reconditioned for reuse or disposed. The ^{137}Cs eluate will be concentrated by evaporation; the concentrated eluate will be blended with pretreated HLW feed before transfer to the HLW vitrification facility. Blended HLW feed is staged in one or more large HLW blend vessels before transfer to HLW vitrification.

LAW pretreatment byproducts (mainly solids and precipitated radionuclides) are blended with the pretreated HLW feed in predetermined ratios. The ratios are controlled to enable HLW vitrification to consistently produce IHLW within a glass composition region for each batch of waste that will satisfy product quality requirements with high confidence after accounting for variations and uncertainties (Section 3.6.1.3).

The pretreated HLW feed will include solids from the HLW vitrification offgas treatment system and canister decontamination solutions recycled to HLW pretreatment. Figure 3-16 uses shading to distinguish offgas treatment steps from other process operations, since these processes contribute to IHLW production through minor offgas treatment equipment recycle streams. LAW pretreatment products, offgas treatment system recycle streams, and spent IHLW canister decontamination fluids will be accumulated in the PT facility, until they are blended with the HLW feed stream.

3.3.2.3 Vitrification

The HLW feed concentrate is blended with the LAW intermediate waste products (separated Sr/TRU and ^{137}Cs) to create blended waste feed, and transferred from the PT facility to two HLW MFPVs in a wet process cell of the HLW facility. Process control samples are collected from these vessels and analyzed to determine the GFC formulation (CCN 079274) and to provide information needed for reporting in accordance with the National Geologic Repository. Typically, the MFPVs will operate in opposite cycles (one vessel is filled and sampled while the other is being emptied). After initial sample analysis (e.g., prior to GFC addition), appropriate GFCs will be added to the MFPV. The glass former feed hopper will receive blended glass formers and reductant (e.g., silica, boric acid, calcium silicate, ferric oxide, lithium carbonate, and sucrose) from the BOF glass former system. After blending, the glass formers will be gravity-fed into the MFPV, where they will be mixed with the HLW concentrate to form a uniform slurry that is the melter feed. The slurry will then be fed to a HLW MFV and then to the HLW melter. This is discussed in more detail below.

Blended waste feed from HLW blending vessel in PT will be transferred to the MFPV in the HLW vitrification facility in a batch-wise fashion. The quantity transferred will be confirmed by level detection

measurements taken in the HLW blending vessel and MFPV vessel. A batch of GFCs will be prepared by transferring individual GFCs from storage silos to feed hoppers. Transfer of the GFCs will be terminated when the calculated weight of each GFC is received in the appropriate hopper. GFCs from each hopper will then be transferred to a blending hopper also equipped with load cells to confirm that the correct mass of GFCs was delivered to the MFPV. The weight of the combined GFCs will be confirmed to match the sum of weights prescribed for the individual GFCs, and the batch will then be blended and transferred to a glass former feed hopper in the HLW facility.

The blended waste feed in the MFPV will be mixed with the GFCs as they are added from the feed hopper. The resultant melter feed slurry will be transferred to the MFV, from which it is fed continuously into the HLW melter. The volume of slurry transferred will be confirmed by level measurements taken in the sending and receiving vessels.

The HLW facility includes two melter systems to convert blended slurries of liquid HLW feed and GFCs into molten glass. The molten glass will be discharged from the melter into metal canisters, where it will cool to form IHLW. Figure 3-17 is a schematic of the WTP melter design. An isometric view of an HLW melter is in Figure 3-18.

During melter operation, a slurry of GFCs and waste (melter feed) will be delivered from the MFV through a low-volume pump and added to the melter through the feed inlets. As the slurry is fed, molten glass will accumulate in the melter. Air bubblers may be used to mix and agitate the molten glass. At the surface of the melt (the interface between the melt pool and plenum air), a cold cap will form as lower temperature feed is introduced onto the melt pool. The cold cap aids melter operation by trapping heat in the melt pool. Typically, as the material in the cold cap heats and melts into the molten glass pool, more feed will be added to maintain cold cap balance.

Water and volatiles will evaporate or decompose and be drawn away through the offgas system. Nonvolatiles will react to form oxides and become part of the molten glass. Waste feed will be continuously fed to the melter from the MFV through an air displacement slurry pump at a rate that sustains the target production rate (typically 260 to 420 L/h). The melter will contain 4.10 m^3 (9 metric tons) of molten glass. Glass will typically be discharged from the melter at nominal rate of 500 kg/h, approximately 4 times the average glass production rate, in a batch-wise fashion. The timing and volume of each pour event (batch discharge) will be such that glass levels within the melters remain relatively constant. It is anticipated that each glass discharge event will last 30 minutes, with 90 minutes between each cycle. At a nominal production rate of 3 MTG per day[3], the average residence time in each HLW melter is about 3 days. The hazardous and dangerous waste constituents in the melter feed will be destroyed, removed, or immobilized through vitrification.

The process holdup in the melter will fill about three canisters with IHLW product. To transfer the molten glass from the melter to the canisters, the silicate melt must be of pourable viscosity. Viscosity is primarily a function of the temperature of the glass. The nominal glass melt pool temperature is 950 °C to 1250 °C; this temperature will be measured with thermocouples in thermowells, submerged into the melt pool at various locations. The power to the melter electrodes will be regulated to maintain the temperature within the nominal range.

[3] This value is twice the production rate previously documented in Appendix H of Supplement 2. The production rate shown has been updated based on research conducted since the publication of Appendix H of Supplement 2 and represents the forecasted production rate with melter enhancements such as providing agitation with bubblers. See 24590-WTP-DB-ENG-01-001.

Instrumentation, alarms, controls, and interlocks are provided to indicate or prevent the following conditions:

- Decrease or loss of melter plenum vacuum
- Loss of agitation (mixing) in the feed tank
- Melt temperature becoming too high or too low
- Electrode extension temperature becoming too high
- Plugged feed nozzle
- Overfilling of a glass container

The glass discharge system includes the melter glass level detectors, canister glass level detection equipment, riser, airlift lance, trough, and a heated discharge chamber. Glass discharge from the melter will be initiated by injecting air or an inert gas at the bottom of the airlift riser. As the gas bubbles rise in the glass, they will entrain molten glass in the riser to the inlet of the glass pour trough, where the gas bubbles burst. The entrained glass then flows into the trough. The glass then gravity-flows down the trough to the pour tip and into the canister. The rate of glass discharge will be controlled by adjusting the rate at which gas is injected into the bottom of the riser. Glass discharge will be started and stopped based on the level of glass in the melter, and monitored to prevent overfilling. Additional information is provided in Section 3.3.6.1.

3.3.2.4 Canister Handling

Glass will be poured into austenitic (304L) stainless steel canisters 0.61 m (24 in.) outside diameter (DOE 2002b) by 4.5 m (15 ft) tall. The IHLW canisters have walls approximately 3.42 mm (0.135 in.) thick[4] and a nominal capacity of 1.22 m^3 (1.6 yd^3). The glass will be poured in a series of lifts until the canister is filled. After filling, the canister will remain in place for initial cooling, then be removed to the canister-handling cave to cool sufficiently to permit canister handling and closure activities.

Each canister will be fabricated to comply with a stringent specification that ensures the canister will maintain structural integrity during filling and handling. Each canister will be inspected before acceptance by the WTP (24590-WTP-PL-RT-03-002, specifically, Section[s] 3.3 and 4.3). Canisters that meet the specifications will be accepted at the HLW facility and filled with molten glass/waste product that cools to form IHLW glass.

Each canister will have a unique alphanumeric identifier welded to the outside, to which all the documentation associated with the canister is referred. In the HLW facility, unfilled canisters will be moved to racks inside the canister-handling cave and stored until ready for filling. Before filling, each canister is removed from the storage racks and into the vitrification cave. The canister lid will be removed just before placing the canister under one of two pour stations. After filling and initial cooling, the canister will be moved from the melter pour station back to the canister-handling cave, where it will be placed on a cooling rack.

After cool down, the filled canister will be transferred to a station in the canister-handling cave where the contents are inspected and prepared for sealing. A lid will be welded over the canister opening by

[4] Pending drop test results, canister design is subject to change.

automated welding operated remotely from the process-operating corridor. The canister will be transferred to another cave for decontamination.

If required, the canister will be decontaminated by nitric acid and cerium (Ce^{+4}) chemical milling. This process uses a redox mechanism to dissolve a thin layer of the canister's outer wall material. The process is self-limiting because the dissolution rate drops off as the Ce^{+4} is converted to Ce^{+3}. The chemical milling will remove the heat scale formed on the outer surface of the canister during filling, leaving a silvery matte finish characteristic of freshly etched stainless steel. Development of this process for the West Valley Demonstration Project (WVDP), near West Valley, New York, showed that adequate decontamination could be achieved by removing a 5 μm layer from the surface of the canister.

The decontaminated canister will be then swabbed remotely for removable contamination. If surface contamination is within specification limits (DOE 2000), the canister will be transferred to the canister storage cave. If the canister exceeds contamination limits, it will be returned to the chemical milling process for further decontamination. Eventually, IHLW canisters meeting specifications will be loaded into a shipping cask for transfer to interim storage in the canister storage building (CSB). Details of the IHLW canister management and tracking system are in Supplement 1.

3.3.3 Waste Treatment Process Schematic [Part 3: 15]

A simplified WTP flow diagram is in Figure 3-16. The petitioned waste form is shown as the glass product output from the HLW facility. (LAW facility output is not part of this petition; ILAW is planned for disposal on the Hanford Site at a permitted disposal facility.)

3.3.4 Nonprocess Secondary Wastes [Part 3: 16]

Secondary waste products are produced in solid, liquid, and gaseous forms. Secondary waste types are any non-glass waste streams, including nonhazardous/nonradioactive, mixed waste, and nonradioactive hazardous and dangerous secondary waste. Management of secondary wastes is summarized below and described in detail in *Secondary Wastes Compliance Plan* (24590-WTP-PL-RT-03-003). The primary secondary waste from the HLW vitrification facility is offgas. Waste streams associated with offgas treatment and canister decontamination are recycled through the PT facility. The paragraphs below summarize secondary waste streams of the WTP.

Secondary waste is generated during waste handling and processing and can be categorized as solid waste, liquid waste, and air emissions, and either radioactive or nonradioactive. Radioactive solid waste can be composed of the following:

- Organic solids such as spent cesium ion-exchange resin
- Organic sludges such as lubricating greases
- Metal debris such as discarded process equipment, including valves and pumps
- Inorganic or organic nonmetal debris such as glass fiber or paper HEPA filters
- Organic debris such as plastic, rubber, wood, paper, cloth, and biological materials
- Heterogeneous debris such as paper filters in a metal frame
- Specific waste forms such as spent laboratory analysis chemicals, organic analytical wastes that cannot be reprocessed through the PT facility, spent catalyst modules, spent silver mordenite and activated carbon, spent bubblers, thermowells, pipe jumpers, and spent melters

Nonradioactive solid wastes can consist of the following:

- Spilled or unusable laboratory or water treatment chemicals
- Spilled or unusable paints, solvents, and paint-related materials
- Spent or spilled petroleum, oils, and lubricants from mechanical systems
- Degreasing solvents, decontamination chemicals (especially chelating agents), paints, and other characteristic or listed hazardous waste
- Contaminated absorbents or cleanup debris
- Failed equipment containing a dangerous waste or component thereof

Solid wastes can also be low-level (debris generated during maintenance and operations) and TRU (HEPA filters, spent ultrafilter modules, and HLW melter consumables exceeding 100 nCi/g).

Secondary solid wastes will be packaged in containers for transportation offsite or disposal at the appropriate Hanford disposal facility.

Secondary liquid wastes fall into three categories: nonradioactive, nondangerous liquid effluents; radioactive, dangerous liquid effluents; and liquid sanitary waste.

Nonradioactive secondary liquid effluents will consist of wastewater that meets acceptance criteria for discharge directly to the Hanford 200 Area Treated Effluent Disposal Facility (TEDF). Its chemical composition will depend on the actual composition of the raw water supplied to the facility, the number of concentration cycles used for the cooling tower, and the associated blowdown rate. The water is predominantly filtered Columbia River water. Most plant systems that flow to the BOF nonradioactive liquid waste disposal system merely concentrate the constituents in the raw water system. The largest sources of nonradioactive liquid waste disposal system flows are cooling tower blowdown, steam boiler blowdown, and reverse osmosis unit process effluent. Effluent also includes floor drains and sumps, which will have regular steam pop-off valve discharges.

Radioactive secondary liquid effluents will consist of dilute process waste liquid effluents containing both radioactive and dangerous waste components. The effluent will meet acceptance criteria for discharge to Hanford's Liquid Effluent Storage Facility (LERF) and the ETF for subsequent treatment. Radioactive, dangerous liquid effluent is derived from evaporation, treatment of melter offgas streams, and equipment decontamination. The major sources of liquid waste are the waste feed evaporator, the LAW caustic scrubber, and treated LAW evaporation process system (refer to Figure 3-16). The waste feed evaporator, used in PT for the initial concentration of waste feed (if required), will generate condensate that may contain low levels of radioactive and hazardous components. The LAW evaporation process system, which is used to concentrate the LAW before transfer and blending with glass formers, will generate a similar secondary waste stream. Both systems have inline radiation monitoring of the process condensate so that condensate may be recycled back through the evaporator if contaminated above acceptable levels.

Liquid sanitary waste consists of sanitary sewer discharges in accordance with appropriate permits (refer to **Table 3-2**). Sanitary waste will be generated from sanitary facilities without showers, such as office and construction craft support buildings. The onsite sanitary sewage system is designed as a conventional gravity collection system that treats and disposes of effluent through a septic tank and pressurized drainfield system.

Secondary air emissions will consist of treated gaseous effluents from the WTP discharged to the atmosphere in accordance with appropriate permits (refer to **Table 3-2**). The principal contributors to the PT offgas stream are vessel vents, fluidic device exhaust (e.g., reverse-flow diverters and PJMs), and evaporator exhaust. Vessel vent and evaporator exhaust are expected to contain higher concentrations of organic constituents.

The principal components of the melter offgas streams are air and water vapor; secondary components are acid gases, aerosols, particulates, and volatile organic compounds. Water in the melter feed is vaporized to steam. Acid gases are generated from the decomposition of salts and organic compounds in the feed. Aerosols are present due to cold-cap solids being entrained in the offgas stream.

Offgas from the treatment process is treated to a level protective of human health and the environment. Each HLW melter will have a dedicated primary system where the offgas from the melter will pass through a film cooler, submerged bed scrubber (SBS), wet electrostatic precipitator (WESP), high-efficiency mist eliminators (HEMEs), and HEPA filters to remove particulates, aerosols, and radionuclides. The offgas will then pass through a secondary offgas system consisting of treated activated carbon, silver mordenite, thermal catalytic oxidation, and selective catalytic reduction, to remove mercury and halides, destroy organics, and reduce NO_x. The scrubber solution is recharged periodically and the spent scrubber solution is recycled to the evaporator feed vessels in the PT facility. Spent Ce^{+4} canister decontamination solution is also recycled to the PT facility, along with the spent scrubber solution (Section 3.3.5). Offgas equipment is shown schematically in Figure 3-16.

3.3.5 Nonprocess Wastes Entering Waste Treatment Processes [Part 3: 17]

Process wastes (e.g., waste tank feed) entering the treatment process are discussed in Section 3.3.2.2. This section summarizes the nonprocess waste contribution to HLW treatment. Figure 3-16 identifies these as recycle streams.

The waste feed evaporation process system (FEP) receives recycles from the PT and HLW facilities (Figure 3-16). Streams recycled to the FEP system are collected before being received into the FEP feed receipt vessels:

- Effluents consisting primarily of ultrafiltration wash solution, leach solution, acid and caustic filter cleaning effluent, cesium/nitric acid recovery evaporator condensate, and dilute effluents from cesium ion exchange
- HLW acidic and pretreatment waste consisting primarily of neutralized purge solution from the HLW SBS, WESP, and HEME condensate; neutralized canister decontamination waste solution from HLW vitrification; PT facility caustic scrubber condensate and purge solution; PT facility vessel ventilation HEME condensate collection; and PT facility PJM and reverse flow diverter ventilation demister condensate collection
- The spent resin liquor stream recycle

The FEP system can concentrate dilute LAW or HLW feed if necessary. Five-molar sodium is regarded as the optimum feed condition for unit operations downstream of the FEP evaporation process. The contribution of the recycle streams to feed evaporation is controlled to dilute the feed as needed. The insoluble solids from these recycle streams are anticipated to come mainly from the HLW offgas system condensate. During routine operations, a very small amount of solids will be present in the HLW

scrubber condensate, and is expected to contribute less than 0.1 % (oxide basis) to the HLW feed. Dissolved solids from canister decontamination will precipitate during neutralization but are expected to contribute less than 0.2 % (oxide basis) to the HLW feed.

Concentrate from the FEP is processed through the PT facility to create LAW and HLW melter feed (liquid and solids fractions, respectively; Section 3.3.2.2). Condensate from the FEP is stored in the process condensate collection tanks, and either recycled back to the PT facility or discharged to LERF or ETF. The process condensate recycled through the PT facility is used for wash water for the solids washing in ultrafiltration and as dilution water for various WTP systems.

The HLW feed also receives Sr/TRU precipitates as a byproduct of LAW feed pretreatment (e.g., process waste) rather than a recycle stream (e.g., nonprocess waste) (Section 3.3.2.2).

3.3.6 Process Equipment [Part 3:18]

The following subsections describe the WTP process equipment used to produce the petitioned waste form, and the HLW melter. More detailed information on waste pretreatment processes, ancillary equipment, and related systems is in Supplement 1.

3.3.6.1 HLW Melter

The HLW melter system consists of two melters, designed based on commercial glass industry technology developed over the past 70 years and adapted for radioactive vitrification plants. The WTP melter design includes bubbler technology to enhance production rates, first demonstrated at Savannah River in 1995 at Duratek's M Area melter. The WTP HLW melters are used to convert slurried radioactive wastes to chemically durable borosilicate glass. Figure 3-17 is a section view through the glass discharge parallel to the immersed electrodes.

The WTP HLW melters are designed to produce up to 3 MTG/day (3.3 tons/day) per melter, for a combined production rate of 6 MTG/day (6.6 tons/day). The HLW melters nominally operate between 950 °C and 1250 °C (1750 °F and 2300 °F). The HLW melters have a molten glass surface area of approximately 3.72 m^2 (40 ft^2). The melters are approximately 3.3 m high by 4.3 m deep by 4.3 m wide (11 ft × 14 ft × 14 ft).

The glass in a full HLW melter has a volume of approximately 4.1 m^3 (145 ft^3) and weighs approximately 9 metric tons (9.9 tons). An entire melter, including the supporting structure and transport mechanism, weighs approximately 90 metric tons (99 tons) empty, or 99 metric tons (109 tons) filled with glass. The melters have a single, internal glass chamber with a nearly rectangular hexahedron shape. Electrodes mounted on opposite ends of the glass pool power the melters. After the melter is started, the glass pool is maintained at the desired temperature by putting alternating current through the molten glass that dissipates heat (joule heating).

Each HLW melter has four volumetric regions: the glass pool, the plenum, and two discharge chambers. The glass pool is lined with refractory designed to withstand molten glass temperatures and corrosion. The top of the glass pool is contiguous with the bottom of the plenum (gas space above the glass pool). The plenum is lined with refractory to withstand hot corrosive gases, thermal shock, and glass/feed splatter. All glass pool components (e.g., level detector, thermowells, bubblers) are installed through the plenum via penetrations in the melter lid. Several other melter services, including feed nozzles, startup heaters, bubblers, thermowells, glass level monitor, and discharge riser air lances, enter the melter

through ports in the lid. The discharge chambers are insulated, heated chambers attached to the side of the melter. A metal plate (dam) in the refractory wall between the glass pool and discharge chambers prevents glass from leaking through high-temperature refractory. The discharge chambers contain troughs to direct molten glass from the glass pool into the glass disposal canisters.

Production rate is enhanced using bubblers, which enhance heat transfer between the molten glass pool and the cold cap (unmelted melter feed).

Surrounding these internal regions are the cooling, support, and containment structures. Water-cooled panels surround the glass pool refractory to remove heat that would otherwise place a thermal load on the building's ventilation system. This cooling also halts the migration of glass and extends the refractory operating life. Conventional glass melters rely on natural cooling to contain the molten glass. Figure 3-19 illustrates the principles of this containment.

Figure 3-19 shows a general section from the molten glass pool, the glass contact refractory, and the water-cooling panel that surrounds the glass pool. The temperature profile in the refractory is the descending solid line, with an interface temperature (temperature where the glass touches the refractory) of 1114 °C (2037 °F) (temperatures along the line are read from the left ordinate). Along the temperature profile, the typical viscosity of a glass, if it were at that location, follows the dashed line, with values read off the right ordinate. Below the glass transition temperature, typically between 430 °C and 500 °C (800 °F and 930 °F), glass becomes a solid; viscosity is so high and flow is so slow that it behaves like a solid for the duration of the melter's operating life. Thus, the refractory cooling ensures that glass does not seep through the refractory, the glass that does penetrate a modest depth becomes its own seal.

The melter is supported by a base structure with transport wheels mounted along the sides of the base assembly. This system allows the HLW melter to move into or out of the melter cave along rails on which it is set. The base provides the attachment points for the melter seismic restraints, the melter transport connections, and the cooling for the bottom refractory.

3.3.6.1.1 Melter Feed System

The feed system includes the air displacement slurry pumps, feed lines, feed nozzles, plenum thermocouples, and controls. The feed system supplies melter feed to the melting chamber. A demineralized water flush system for the feed lines and nozzles is also included in the design to prevent dried feed residuals or deposits from plugging the lines and nozzles when melter feeding is stopped.

3.3.6.1.2 Confinement System

The confinement system consists of the melter refractory, cooling panels (walls and base), dam, lid, shell (wall modules), base with integral transportation and seismic restraint, and ventilation subsystems. The first barrier against glass migration is the refractory system, in conjunction with the cooling system. The second layer is the melter shell, which works in conjunction with the melter ventilation system to contain volatile materials and particulate. Active cooling outside the refractory is provided by a water-cooled jacket, which transfers heat from the HLW melter through heat exchangers to the facility cooling towers. The water jacket cooling loop is a closed system that isolates the water circulating through the water jacket from the water in the cooling water loop circulating to the cooling tower. The refractory package provides an adequate barrier should there be a loss of cooling. The HLW melter lid is constructed of a steel outer shell and is insulated from the melter plenum by refractory material.

3.3.6.1.3 Joule Heating System

The HLW melter joule heating system that sustains the melting process includes the electrodes, electrode extensions, electrode buses, power supplies, glass pool thermocouples, and control system. The joule heating system will provide the heat required to overcome thermal losses, evaporate water, and melt feed materials by passing alternating electrical current through the molten waste glass via electrodes. The electrode extensions will be cooled to halt glass migration along the thermally conductive electrodes as they pass through refractory and the melter shell. Two thermowells mounted from the melter lid with multiple element thermocouples will be used to provide glass temperature feedback control.

3.3.6.1.4 Glass Discharge System

The glass discharge system consists of the glass level detector, riser, dam, trough, discharge chamber (including discharge heaters, discharge thermocouples, discharge ventilation), discharge viewing, canister level monitor, and controls. The discharge system will have a glass flow path routed through a hole in the refractory block at the bottom of the melt pool to a hole in a refractory block at the rear of the discharge trough (Figure 3-17, airlift riser). A gas supply tube inserted vertically into the refractory riser will bubble gas into the riser column to create a buoyant lift to effect glass discharge. At the top of the refractory riser, the trough will route the discharged glass to a connected HLW canister by gravity. The temperature in the discharge chamber will be monitored and controlled with thermocouple(s). Resistance heaters will be powered to maintain chamber temperature.

Melter feed rate, bubbling rate (agitation), and power consumption are balanced to achieve the desired throughput. The melter plenum will be maintained at a nearly constant vacuum to contain the gases released from reacting melter feed. The glass temperature will be maintained between 950 °C and 1250 °C (1740 °F and 2280 °F). The temperature will be measured using thermocouples placed in thermowells submerged in the pool at two locations. From these individual temperatures, an average glass pool temperature will be determined and used to control electrode power. Temperature, melt pool level, and plenum pressure is monitored continuously. The melter is typically fed and operated continuously. Glass is poured into HLW canisters in batches, approximately 230 kg (500 lb) per batch or lift. Each lift lasts about 30 minutes and is repeated every 2 to 4 hours. Production operations are suspended at the conclusion of waste processing, before major plant maintenance, or when the melter needs to be replaced.

3.3.7 Operating Cycles [Part 3: 19]

The WTP is expected to operate continuously once hot commissioning is completed. Activities such as maintenance, cleaning, safety shutdown, and melter replacement, etc. will not affect glass quality.

3.3.7.1 Melter Start Up

The melter will be started up with pre-made glass (frit). Temporary radiant heaters mounted inside the plenum through nozzles in the melter lid will provide the heat for startup. When the melter reaches its operating temperature, frit will be added to begin establishing a molten glass path between the joule heating electrodes. Once the glass is deep enough to form a conducting path between the electrodes, joule heating is initiated. Frit will continue to be fed until the melting cavity is full enough to sustain operation. At this time the start-up heaters will be removed.

Additional frit will then be added to raise the molten glass pool to its normal operating level, and the remaining normal melter operating lid components will be installed. At the conclusion and acceptance of all relevant startup procedures and acceptance checks, waste feed will commence. Figure 3-20 shows the interior of a pilot-scale melter used for research melter, and shows a melt pool without a cold cap, but with agitation by air injection through bubblers. Figure 3-21 shows the same melter with a partial cold cap, and Figure 3-22 shows a close-up of the cold cap with a breach in the cold cap through which bubbled air escapes the melt below.

The HLW melters are designed to be remotely operated and maintained. Remote maintenance will be performed by a power manipulator, overhead crane, and auxiliary hoist, or by through-wall master-slave manipulators. The melter will be positioned in the HLW melter cave for ease of access and viewing of both discharge chambers during operations, and for viewing access to the melter lid to facilitate removal and replacement of subcomponents, if needed. A rail and transport system will be used to place and remove the entire melter structure within the processing cell.

The HLW melter systems that include the feed system have the ability to stop waste feed. Automatic systems terminate feed to the melter if a specified operating condition is exceeded. The following melter components and conditions are monitored and have high/low warning and trip points to ensure safe melter operation; melter level, temperature (melt pool, plenum, and refractory), plenum pressure, cooling water jacket pressure, temperature, and water flow, and electrode temperature, voltage, amperage, resistance, and wattage. Other systems are monitored for long-term performance such as the airlift discharge pressure, heater power consumption, and bubbler pressure. This design approach is consistent with WAC 173-303-680 requirements to protect human health and the environment.

The melters are fed via two air displacement slurry pumps (per melter) that use pressurized air as the motive force. Each pump supplies feed at 50 to 300 L/hr to a feed nozzle installed on each melter (two nozzles per melter). After each feed cycle, the pump and feed line are completely scavenged by airflow, which keeps lines from plugging. The feed is injected into the melters through the feed nozzles on top of the melter, creating a cold cap (Figure 3-21), where waste feed undergoes physical and chemical changes (Figure 3-22). The glass product in the melter is then air lifted through the discharge chamber and into the glass container. Melter offgas is generated, steadily with modest fluctuations, from HLW vitrification, and directed to a dedicated offgas system.

The melter systems are designed to minimize the need for waste feed interruption. Melter level, plenum pressure, process alarming, and optimized operating procedures will be in place to minimize the occurrences of feed disruption. Because of the high thermal inertia and the relatively slow rates of change in the operating states of the melter, operators have adequate time to react to potential upset conditions. For instance, each 1-minute feed cycle of the slurry pump adds approximately 3.2 L (0.85 gal) per feed nozzle of melter feed to the melter, raising the liquid level in the melter cold cap no more than 0.22 mm (0.01 in.) per feed cycle. This provides ample time for operator response. System interlocks allow continued melter operations without inadvertent feed interruption and provide a sufficient safety margin.

3.3.7.2 Melter Shutdown

The spent melter will be disconnected and prepared for transport out of the HLW melter cave. A consumable bucket with interchangeable lid cutouts ("templates") will be used to import and export any melter consumables.

The melter cave support handling system will provide a decontamination tank in the equipment decontamination area to allow decontamination of consumables and equipment before hands-on maintenance in the crane maintenance area. In the decontamination tank, the equipment will be soaked in demineralized water and/or nitric acid. The equipment decontamination area will also be used to decontaminate equipment with manipulators before items can be removed for hands-on maintenance.

Regulated HLW facility tank system process and leak detection system instruments and parameters are described in Supplement 1, along with details of other melter management and maintenance activities.

Spent melters will be placed in an overpack before they are removed from the HLW facility. The overpack will be moved to the HLW failed melter storage area before land disposal, and then disposed at the Hanford Site if it meets the low-level waste definition and the land disposal facility waste acceptance criteria.

Spent and failed melters will be replaced with new melters, rather than being dismantled, repaired, and reused. A transporter will be used to move a new HLW melter to the HLW facility loading dock. The melter will be offloaded, transferred through the rollup doors to the melter cave airlock, transferred through the airlock, and docked to the melter cave shield door. After opening the shield doors, the melter will be installed in the melter cave.

The process of removing a spent HLW melter from a cave is the reverse of the installation. The spent melter will be moved through the melter airlock through the rollup doors and placed on the transporter, to be moved out of the HLW vitrification plant.

Before disposal, the spent melter will be stored in the failed melter storage area. If a melter fails to meet the waste acceptance criteria of the receiving treatment, storage, or disposal facility, it will be further decontaminated, treated, repackaged, and/or otherwise processed to enable the spent melter to meet the receiving facility's waste acceptance criteria.

3.3.8 Composition Control and Variability [Part 3: 20 – 21]

Variations in IHLW compositions produced from a given waste type[5] will depend on:

- Variations in waste feed compositions within and between waste types
- Variations in MFPV[6] and GFC compositions/masses

Variability of the IHLW is expected to be due mainly to variation in the feed, leading to variation in the glass formulation required to produce a conforming glass. The WTP project strategy for managing such variability and controlling IHLW is discussed in Section 3.6.1.3.

[5] A waste type is the HLW material contained in a feed staging tank plus estimated additions of pretreatment products and process recycle streams (24590-WTP-PL-RT-03-002). A waste type is assumed to be the waste that is derived from an individual DST, as stored immediately before transfer to the staging tank for delivery to the WTP.

[6] Refer to Section 3.2.6.

3.4 Waste Management Operations [Part 3]

3.4.1 Land-Based Units [Part 3: 22]

The petitioned waste has not been generated. The untreated waste feed has not been managed in land-based units; therefore, information required for those units is not applicable.

3.4.2 Interim Storage of Petitioned Waste

Immediately after production, the petitioned waste will be stored in interim in the WTP HLW canister storage cave. From the WTP, it will be transferred, within the Hanford Site on nonpublic roads, to the CSB in the 200 East Area. The IHLW will remain in the CSB until the National Geologic Repository is licensed and shipping procedures are in place to transfer it there. Once the IHLW is transferred to the National Geologic Repository, it will remain there permanently.

3.4.3 WTP Interim Storage Location

Following are details of the WTP interim storage unit.

WTP Interim Storage Location (to be built):

Hanford Tank Waste Treatment and Immobilization Plant (on site)
Hanford Facility, 200 East Area
Washington 99354
RCRA ID number: WA7890008967 (EPA and State Identification number for Hanford Facility)

Storage area identification number and name:

H-0132, IHLW Canister Storage Cave

Approximate dimensions:

19 m long × 7 m wide × 4.6 m high (63 × 23 × 15 ft)

The canister storage cave will be a vault-type, natural convection-cooled, dry storage area in the HLW facility with storage capacity for 45 IHLW canisters. It is designed to manage canisters that have been welded closed and decontaminated, that require temporary storage before transfer to an interim storage facility at the Hanford Site. The systems associated with the canister storage cave include overhead crane, grapples, and power manipulator.

The canister storage cave is designed to prevent the release of dangerous constituents and their exposure to the outside environment. It will be a steel-reinforced concrete-walled structure fully enclosed in the HLW facility. The interior floor and a portion of the walls will have a protective coating. The roof of the HLW facility will consist of metal roofing, roof insulation, and a vapor barrier. Runoff will be collected by roof drains.

3.4.4 Canister Storage Building

The second interim storage unit is in the 200 East Area of the Hanford Site.

Canister Storage Building:

US Department of Energy
Office of River Protection
P.O. Box 450
Richland, Washington 99352
RCRA ID number: WA7890008967 (EPA and State Identification number for Hanford Facility)

Approximate dimensions (for each of three storage vaults):

39 m long × 15 m wide × 11.3 m high (128.5 × 50.25 × 37.1 ft)

The CSB is a vault-type, natural convection-cooled, dry storage structure initially designed to store IHLW, but modified to also store spent nuclear fuel in multicanister overpacks (MCOs). It is designed to manage IHLW canisters that have been welded closed and decontaminated, that require temporary storage before transfer to an alternate storage facility or disposal unit. The systems associated with the CSB include overhead crane, shielded turret, grapples, and power manipulator. The CSB also has a sample and weld station (gas tungsten arc welding) to support management of MCOs. The CSB is designed to prevent the release of dangerous constituents and their exposure to the outside environment. The CSB is a reinforced concrete-walled structure consisting of three separate vaults. Waste containers are stored vertically through perforations in the operating deck (top of the vaults) over the subgrade vaults. The operating deck is 1.52 m (5 ft) thick, reinforced, and has 226 penetrations for vertical storage of MCOs or IHLW canisters. Compression tubes are used to secure MCOs and IHLW canisters in the operating deck, and allow for thermal expansion/contraction of waste containers while maintaining a seal of the lower plenum below the operating deck.

3.5 Process Materials [Part 3]

3.5.1 List of Materials [Part 3: 25]

The IHLW consists mainly of waste feed from the Hanford waste tanks and GFCs. Categories of GFCs are glass network formers (such as SiO_2 and B_2O_3) that form a continuous three-dimensional network, and glass network modifiers (such as Li_2O and Na_2O) that act as fluxes to lower melt viscosity or melting temperature.

A control system will be used to calculate the amounts of pretreated feed, GFCs, and additives required to make up a batch of melter feed in the MFPV. The initial calculations will account for the heel of the residual blended feed from the preceding MFPV batch. The GFCs expected to be used include the compounds in Table 3-17 and possibly sucrose (a reductant) as needed to balance redox reactions and manage foaming in the melter[7]. The GFCs and reductants will be nonhazardous. Annual quantities have not yet been determined.

[7] The addition of reductants to high nitrate feeds is necessary to control melt foaming. The amount of sugar required increases with the amount of nitrates in the feed, and decreases with the amount of waste organics in the feed, which themselves act as reductants. Consequently, the oxidants and reductants in the feed must be balanced. It is anticipated that most HLW feeds can be processed without added reductants.

3.5.2 Material Safety Data Sheets [Part 3: 26]

Material safety data sheets for all GFCs are in Appendix B.

3.5.3 Oils, Greases, or Hydraulic Fluids [Part 3: 27]

No oils, greases, or hydraulic fluids are expected to enter the process and will not affect the petitioned waste form.

3.6 Special Information [Part 3]

The premise for exclusion of the petitioned waste (IHLW) is that:

- IHLW glass properties are exclusively a function of glass composition.
- By controlling the IHLW composition, the WTP will produce only compliant IHLW.

This section and the following subsections provide the special information requested by the delisting framework to support this premise.

3.6.1 Upfront Exclusion [Part 3: 28]

This petition requests an upfront conditional exclusion for a waste that is not currently generated but will be generated in the future. The following subsections provide the following information:

- A request for upfront conditional exclusion with a description of the model that provides the supporting basis
- A description of the approach that will be used to control the process and ensure the treated IHLW will meet the conditions for exclusion

3.6.1.1 IHLW Glass Durability Model

The WTP undertook extensive research to produce information demonstrating that the Hanford tank waste could be successfully processed to produce IHLW compliant with applicable proposed delisting levels (refer to Section 4.0, Table 4-2). This petition presents the results of research to substantiate how vitrification effectively treats HLW.

The research program designed to support this petition used a graded approach to data collection and is discussed in the LDR/Delisting DQO (Supplement 2). The LDR/Delisting DQO established the criteria for developing adequate test data with acceptable data quality to support a successful, technology-based, upfront petition for delisting IHLW product; it also identified the test data required to demonstrate compliance with the proposed delisting levels. The WTP performed the testing to support this delisting petition. The research program used nonradioactive simulants of HLW representing a "bounding" glass[8], a nominal glass, and a range of glasses representing both nominal and variant glass compositions. The research testing involved:

[8] The "bounding" glass is bounding in terms of its TCLP response, such that the WTP is not expected to produce glasses with a TCLP response any worse than that of this glass. It is not bounding in terms of any single constituent concentration.

1. Development and testing of bounding glass compositions
2. Development and testing of a nominal glass composition
3. Development of constraints for the design of glass formulation test matrices (primarily to support the development of glass durability models)
4. Statistical design of the test matrices
5. Fabrication of the test glasses in the matrices
6. TCLP testing of the fabricated glasses according to SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA 1999) at an independent laboratory
7. Independent data validation
8. Development and recommendation of initial TCLP model forms
9. Detailed statistical analyses of the TCLP data to develop the final TCLP models and uncertainty statements

The bounding glass is a conservative representation of a highly leachable (i.e., least durable) glass and is designed primarily to confirm, through limited testing, that certain low-release COCs[9] do not leach from the glass at or above their respective proposed delisting levels, even when added to glass ("spiked") at levels well above anticipated melter feed concentrations. The bounding glass is not an appropriate representation of IHLW production glasses, as it is not likely to pass other relevant criteria (WASRD [DOE 2002a] and processability) even if it meets the criteria for delisting.

The nominal glass tested was designed as a potential target formulation for processing HLW during early research studies. The glass was developed for treatment of WTP flowsheet-based feeds from tank 241-AZ-101 and has been extensively tested on pilot-scale (one-third of full-scale) melter systems. Although this composition does not necessarily reflect a target composition to be used during WTP production, it does represent typical WTP glass in that its TCLP response is similar to glasses that will be produced by the WTP.

The compositional range of statistically designed glasses ("matrix" glasses) was designed to encompass the WTP projected IHLW compositions under development, within the waste loading constraints for glass production (Gan et al. 2002). Figure 3-23 shows the range for major components in the matrix glasses relative to the current projected range of HLW melter feeds for the first four HLW waste tanks. The figure is based on projected MFPV content (24590-WTP-MRQ-PO-03-090), matched with GFCs at an assumed waste loading of 28 wt% to create a range of the projected melter feed concentrations for several major glass components. The figure shows normalized ratios of model components (Section 3.6.1.2) for projected compositions for direct comparison to the range represented by matrix test glasses. The figure is an example, and data used to create the figure are subject to revision as more accurate forecasts of feed composition and waste loading are developed.

Under conditions developed to mimic what will occur in the WTP melters, the Vitreous State Laboratory (VSL) spiked and vitrified the simulants at a crucible scale. A commercial environmental laboratory, Severn Trent Laboratories (STL), performed the TCLP analysis on the glasses; the results for IHLW nominal glass were below the toxicity characteristic and proposed health-based delisting levels for

[9] Low-release COCs (arsenic, barium, beryllium, chromium, copper, nickel, lead, selenium, silver, vanadium, and zinc) are those expected to release far below their limit even when loaded at concentrations exceeding those expected to be in the waste.

all COCs except cadmium. Glasses that exceeded criteria for cadmium were matrix glasses specifically designed to exceed the proposed delisting levels in order to provide data regarding the compositions and conditions under which a glass might not meet proposed delisting levels. These glasses are essential to modeling TCLP response as a function of glass composition (Section 3.6.1.2), but do not represent glasses that WTP would produce since they obviously exceed proposed delisting levels.

The results of the research program to support this petition are in *Regulatory Testing of RPP-WTP HLW Glasses to Support Delisting Compliance, Final Report* (Kot et al. 2004) (Supplement 4). VSL prepared and tested a nominal IHLW glass simulant spiked with excess COCs, a bounding IHLW glass spiked with excess COCs, and 102 statistically designed matrix glasses. Glasses were subjected to TCLP (SW-846 Method 1311) (all samples), acid digestion (Method 3010A), and inductively coupled plasma atomic emission spectrometry (Method 6010A) analysis (selected samples). All of the glasses were spiked with COCs relevant to WTP delisting TCLP compliance. Cyanide and mercury were also spiked into both the nominal and bounding glass and tested (SW-846 Methods 9012A, 7470A, and 7471A). The principal conclusions from this work are:

- The TCLP results for arsenic, barium, beryllium, chromium, copper, nickel, lead, selenium, silver, vanadium, and zinc for all glasses were well below their respective proposed delisting levels.
- The results for antimony and thallium in IHLW glasses (spikes of the bounding and typical glasses) indicate that these constituents can leach from inappropriately designed glasses.
  - For the bounding glass, equating the 90 % upper confidence interval[10] (UCI) for antimony to its proposed delisting level yielded a maximum allowable Sb_2O_3 concentration of about 1.2 wt%, which is over four times the maximum expected concentration in WTP IHLW glasses. Similarly, equating the 90 % UCI for thallium to its proposed delisting level yielded a maximum allowable Tl_2O_3 concentration of 0.205 wt%, which is about 1.1 times the maximum concentration of Tl_2O_3 in IHLW expected by the WTP. The average TCLP release of the bounding IHLW glass was approximately 0.15 % and 0.34 % of the total glass antimony and thallium content, respectively.
  - Antimony did not leach from the nominal glass at levels approaching proposed delisting levels (maximum antimony result was 0.103 mg/L). For the nominal glass, equating the 90 % UCI for thallium to its limit yielded a maximum allowable Tl_2O_3 concentration of 0.517 wt%, approximately 2.9 times the expected maximum concentration in WTP IHLW glasses. Performance for the nominal glass composition was exceptional, with an average TCLP release (excluding nondetect results) of 0.037 % and 0.11 % of the total glass antimony and thallium content, respectively.
  - The matrix glasses had a maximum Sb_2O_3 concentration of 0.30 wt% and exhibited a maximum TCLP antimony release of 0.0829 mg/L, well below the proposed delisting level. The matrix glasses had a maximum Tl_2O_3 concentration of 0.33 wt% and exhibited a maximum TCLP thallium release of 0.0832 mg/L, well below the proposed delisting level.
- Mercury and cyanide were not detected in the glass at levels above their applicable proposed delisting levels. Data confirmed the volatility of these compounds under vitrification conditions.
- Cadmium was the only COC found to leach from some of the tested IHLW compositions at levels that could approach or exceed proposed health-based delisting levels.
  - For the bounding glass, the TCLP results varied from 0.427 mg/L to 0.824 mg/L, with a corresponding UCI of 0.727 mg/L.

[10] The UCI is the appropriate statistic for comparison to delisting criteria (LDR/Delisting DQO, Supplement 2).

- For the nominal glass, the TCLP results varied from 0.0240 mg/L to 0.0306 mg/L, less than one-tenth the results of the bounding glass, and well below the proposed delisting level.
- For the matrix glasses, the TCLP results varied from 0.0078 mg/L to 2.24 mg/L. Evaluation of the TCLP data for 100 matrix glasses (two outlier glasses were not considered, see Section 5.8.5.7) led to the development of a model for relating cadmium TCLP release to the glass composition.
- A cadmium oxide loading less than 0.10 wt% is predicted to not result in cadmium leachates in excess of proposed delisting levels regardless of the overall glass composition (Section 3.6.1.2).

3.6.1.2 TCLP Response - Glass Composition Model

Special information in this section of the petition includes the TCLP model. The model will be refined as future data from the WTP research program (24590-WTP-PL-RT-01-002) become available. Future data may provide additional information that could cause components appearing in a future TCLP cadmium release model to change, or necessitate expansion of the compositional range encompassed by the model. It is not likely the future data would warrant changes to the general model form and approach. The model presented here is an example of how the TCLP response modeling will be used to project the cadmium release of selected glass compositions before actual production.

Many aspects of the TCLP release mechanism are known, but for complex multicomponent waste glasses, empirical model forms provide the most practical starting point for the development of quantitative models. There have been different approaches to modeling the TCLP releases of elements from simulated waste glasses (Vienna et al. 1998, Pickett and Jantzen 2002). PNWD selected the TCLP normalized boron release as representative or conservative[11] of normalized releases of toxic or restricted elements and successfully used it to model the TCLP releases for these elements (Vienna 1998, Kim and Vienna 2002). Pickett and Jantzen (2002) also used normalized boron release as a representative of glass dissolution under TCLP conditions and developed the models for normalized releases of Ni and U.

Seventeen empirical mixture experiment model forms were evaluated by predicted versus measured (PvM) property plots, standardized residual plots, outlier diagnostics, three R^2 statistics, root mean squared error (RMSE), and statistical lack-of-fit (LOF) tests. A linear mixture model with generalized normalization was chosen. The original model form included the 20 components used in development of the matrix glasses. Unnecessary model terms were dropped from the original model using the statistical process of backward elimination. The process of model development and evaluation is complex; consult Section 6 of *Regulatory Testing of RPP-WTP HLW Glasses to Support Delisting Compliance, Final Report* (Kot et al. 2004, Supplement 4) for additional details. The model chosen for predicting the cadmium TCLP release is a 10-component linear mixture model of the form:

$$\ln(c_{Cd}) = \sum_{i=1}^{9} b_i x_i + d \ln(m_{CdO}) \tag{3.1}$$

where:

c_{Cd} = unnormalized estimated cadmium leachate concentration

x_i = normalized mass fraction of component i (Al_2O_3, B_2O_3, Fe_2O_3, Li_2O, MnO, Na_2O,

[11] Boron is representative or conservative of normalized releases of other glass components, meaning it leaches at normalized rates equal to or greater than other glass components.

SiO_2, ZnO, and ZrO_2), such that the sum of their mass fractions equals 1

b_i, d = empirically determined coefficients

m_{CdO} = unnormalized mass fraction (actual mass fraction) of CdO in the glass

The coefficients, three R^2 statistics, and RMSE are in Table 3-18.

The long form of the TCLP response-glass composition model[12] is:

$$\begin{aligned}\ln(c_{CdO}) = {} & 0.3257\,x_{Al_2O_3} + 8.0665\,x_{B_2O_3} + 1.5677\,x_{Fe_2O_3} + 11.3541\,x_{Li_2O} + 10.7633\,x_{MnO} \\ & +9.3328\,x_{Na_2O} + 0.1617\,x_{SiO_2} + 15.4324\,x_{ZnO} + 2.0438\,x_{ZrO_2} + 0.9859\ln(m_{CdO})\end{aligned} \tag{3.2}$$

The modeled TCLP release concentrations in the leachate are transformed to the natural logarithm of the concentrations. Log transformations have the advantage of equalizing variance of response values (as required for unweighted least squares regression techniques), and compositional dependence of leach test data is linearized (the need for nonlinear terms is reduced).

The model was validated using a combination of data sets. Model validation methods assess how well a fitted model predicts property values for glasses not used in fitting the model. Validation generally consists of using a fitted model to predict property values for a set of validation data, and then comparing the predicted property values to the measured values from the validation database. Data sets developed from the test matrix glasses and from historical research were used to validate the model by means of the validation R^2 statistic and PvM plots.

Figure 3-24 provides the PvM plot for the TCLP response-glass composition model. Supplement 4 provides additional information on the model derivation and validation.

As detailed in the LDR/Delisting DQO (Supplement 2), the model results are used to construct 90 % UCIs per SW-846 Chapter 9 (EPA 1999). These 90 % UCIs are then used to decide if the average c_{Cd} released from the glass could be expected to exceed the corresponding limits. The UCI is used to describe the uncertainty associated with model predictions at a single specific composition.

A 100(1–α)% UCI for the true <u>mean</u> response value for a given glass of composition $\boldsymbol{a}$ is

$$\underbrace{\hat{y}(\boldsymbol{a})}_{\substack{\text{predicted Cd release in} \\ \ln(\text{mg/L})}} + \underbrace{t_{1-\alpha,n-p}\,RMSE\sqrt{\boldsymbol{a}^T(A^T\mathrm{W}A)^{-1}A}}_{\substack{\text{confidence interval contribution} \\ \text{(model uncertainty)}}} \tag{3.3}$$

where:

[12] This form of the model is for the release predictions based on oxide valence states that were the basis for model development (Cooley et al., 2003), after backward elimination of unnecessary model terms. Alternate forms of the model for are presented in Section 5.8.5.7.

a = composition vector;
$\boldsymbol{a} = \left(x_{Al_2O_3} \quad x_{B_2O_3} \quad x_{Fe_2O_3} \quad x_{Li_2O} \quad x_{MnO} \quad x_{Na_2O} \quad x_{SiO_2} \quad x_{ZnO} \quad x_{ZrO_2} \quad m_{Cd}\right)$

$\hat{y}(\boldsymbol{a})$ = model predicted value (e.g., $\ln(c_{Cd}) = \sum_{i=1}^{9} b_i x_i + d\ln(w_{CdO})$)

α = type I error, 10 %, such that $100(1-\alpha)$ is the desired confidence (e.g., 90 %)

$t_{1-\alpha,n-p}$ = $100(1-\alpha)$-percentile of the Student's t-distribution with n-p degrees of freedom (e.g., $t_{0.9,90} = 1.291029$)

n = number of data points used to fit the model (e.g., 100)

p = number of parameters estimated in the model (e.g., 10)

$RMSE$ = root mean squared error (e.g., $RMSE = \sqrt{\frac{\sum_{i=1}^{n}(\hat{y}_i - y_i)^2}{n-p}}$)

- $\hat{y}_i$ = predicted property value (mathematically transformed, if appropriate for model form used) for i^{th} data point made using the model fitted to all n data points
- y_i = predicted property value (mathematically transformed, if appropriate for model form used) for i^{th} data point made using a model fitted to all n data points except the ith

$\boldsymbol{a}^T$ = vector transpose of the glass composition vector $\boldsymbol{a}$

A^T = matrix transpose of the glass matrix A

A = glass matrix A (used to estimate model coefficients via regression) expanded in the form of the model

$\boldsymbol{a}$ = vector A expanded in the form of the model (vector form of normalized composition of glass being modeled)

W = an $n \times n$ diagonal weight matrix with entries w_i, $i = 1, 2, \ldots, n$ (i.e., the weights associated with the model development set of n data points).

Note that the covariance matrix, $\boldsymbol{C}$, for the model data is a constant, and is described by equation 3.4, below. Table 3-19 provides the model covariance vector, $\boldsymbol{C}$, for the 10-term model for original oxides, as described in equation 3.4:

$$\boldsymbol{C} = RSME^2 \times (A^T W A)^{-1} \tag{3.4}$$

Substituting for $RSME^2 \times (A^T W A)^{-1} = \boldsymbol{C}$ in equation 3.3 yields $\hat{y}(\boldsymbol{a}) + t_{1-\alpha,n-p}\sqrt{\boldsymbol{a}^T \boldsymbol{C} \boldsymbol{a}}$.

A UCI is appropriate when an uncertainty statement is desired about the true mean response for a given glass composition. The UCI is in transformed units since the model relates the natural logarithm of TCLP cadmium release in ln(mg/L) units to glass composition. When the equation is applied using the TCLP cadmium release model, the resulting $100(1-\alpha)$% UCI for the true mean response value for a given glass

composition $\boldsymbol{a}$ is in units of ln(mg/L). Statistical intervals in units of ln(mg/L) can be back-transformed to the original units of mg/L by exponentiating. The resulting back-transformed interval is a 90 % UCI on the true median response value (e.g., c_{Cd}) for the given glass composition $\boldsymbol{a}$, assuming that experimental errors in the data used to develop the model are lognormally distributed. Supplement 4 contains an example of use of the TCLP response-glass composition model to obtain predicted TCLP cadmium release (c_{Cd}) and a corresponding 90 % UCI for two of the matrix glasses.

The TCLP-response composition model and corresponding requirement for a 90 % UCI can be used to calculate a theoretical cadmium oxide loading for variant glass composition corresponding to the worst theoretical glass composition as determined from the boundaries of the matrix glass used to build the model. Supplement 4 reports the constituent-specific cadmium release coefficients and the variance-covariance matrix associated with the model coefficients that were used for such a determination. Within the composition region represented by the matrix glasses, this variant glass represents an extreme glass composition whose corresponding modeled cadmium release is at the limit. This composition has been determined through an iterative process by which multiple theoretical compositions are developed and modeled until the minimum Cd concentration corresponding to a Cd release at the limit is determined. In theory, with the cadmium oxide loading held at 0.13 wt%, adjustments to other glass components (within the range of matrix glass compositions) will reduce cadmium leachate concentrations. Within the composition region represented by the TCLP-response model, a cadmium oxide loading less than 0.13 wt% is predicted to not result in cadmium leachates above proposed delisting levels, regardless of the overall glass composition. Table 3-20 summarizes this theoretical variant glass composition and corresponding model results.

The processes of glass fabrication between crucible scale and melter scale are largely equivalent. WTP pilot melter test data clearly show that controlling the melter feed composition adequately controls the glass composition produced. It follows that the use of crucible melts fabricated and tested over a relatively broad composition region can be used to predict the TCLP responses of melter-produced glasses within the same region (Supplement 6).

3.6.1.3 Process Control Strategy

A unique aspect of the WTP process is that it must produce a waste form that adheres to very strict performance standards as defined in the WASRD (DOE 2002a) and meet the delisting criteria. This means that variability in the waste stream is controlled by sophisticated modeling strategies that formulate conforming glass product by adding the correct GFCs to the concentrated HLW stream. In other words, variability in the composition of the waste product is not an accident, but is carefully controlled in order to always produce IHLW that conforms to strict product standards.

A process control strategy will be implemented to ensure that WTP will produce only glass that meets the delisting criteria. This control strategy includes the use of the TCLP response-glass composition model (Section 3.6.1.2), process sampling/analyses, and strict composition control. Blended waste feed will be transferred from the HLW blend vessel in the PT facility to the MFPV in the HLW facility. The chemical composition of the MFPV contents will be measured analytically, before GFC addition. The MFPV contents will be sampled (in replicate - two or more duplicate samples) to determine proper GFCs and melter control conditions (e.g., redox) (termed "MFPV initial"). Sufficient sample numbers will be taken and analyzed from each MFPV batch to directly measure waste composition variation. The analytes measured will include the key COCs for delisting (i.e., cadmium and thallium) and the major chemical components that have the potential to influence TCLP response (Section 3.6.1.2). GFCs and required control additives (e.g., sucrose) will then be added to the MFPV based on the analytical results returned

from initial MFPV sample(s). The MFPV contents will be resampled (in replicate) to confirm proper GFC addition and report product chemical and radionuclide composition ("MFPV final") (CCN 079274). Samples will be prepared by methods such as fusion or digestion, or in the case of MFPV final samples, could include laser ablation of actual crucible-scale active glass made from the MFPV final samples. Analysis will be by inductively coupled plasma atomic emissions spectroscopy and/or mass spectroscopy.

The WTP will produce only glass that meets applicable criteria. To manage production, a range of acceptable glass compositions is developed to describe possible glass formulations that correspond with compliant glass forms. These glass compositions (as determined by the composition of the pretreated feed mixed with GFCs) will satisfy product quality requirements with high confidence after accounting for applicable variations and uncertainties. The specific region of glass compositions covered depends on the chemical composition of the waste type. Concentrations of major constituents (e.g., aluminum, sodium, iron, and zirconium) and minor constituents (e.g., noble metals, RCRA metals, phosphate, and sulfate) are all considered. Possible variations and uncertainties are accounted for to provide high confidence that glass produced meets all applicable requirements. Variation in the waste type is accommodated during production operations by adjusting the mass and composition of GFCs added.

The range of acceptable glass compositions is initially derived through research (fabrication and testing of glass compositions, refer to Supplement 4 and Section 5). Glass formulation is an iterative process in which glass property-composition models, knowledge, and experience are used to select glass compositions covering the range of glass components and waste constituent concentrations of interest. Data from testing programs specific to WTP, as well as test and production data from other vitrification plants, are used to refine the property-composition models and define a range of acceptable glass compositions for each waste type. Multiple glass formulations are tested according to the applicable criteria (delisting, land disposal, waste processing, and the National Geologic Repository waste acceptance criteria) to determine a range of conforming glass compositions. Most of the testing is done at crucible scale, with nonradioactive material containing radionuclide surrogates. The results of such research are subject to verification with actual bench-scale radioactive IHLW and pilot-scale melter-produced simulated IHLW (Section 3.6.2).

Within the range of acceptable glass compositions, target glass compositions are identified based on expected compositions of the projected IHLW feed, including tank waste and pretreatment recycle stream contributions. The target glass composition is achieved by balancing the appropriate waste loading and GFC mixture with blended (concentrated and pretreated) HLW feed. Pre-existing glass durability models are used to predict glass properties (e.g., leach resistance) for glasses within the compositional region used in developing the model. Such models are used to relate the waste composition and glass properties, and aid in formulating additional glasses for testing. These, in turn, generate data to validate and refine the model.

The IHLW compliance strategy will account for variations and uncertainties in the data used for process control during operation of the HLW facility. To this end, statistical methods will be applied to quantify uncertainties, compensate for feed variability, and provide a safety margin to ensure the projected glass composition is sufficiently close to the target composition to meet processability and glass durability requirements. Such statistical analysis will ensure that the IHLW will meet the requirements with high confidence after accounting for variations and uncertainties. Process control is generally concerned with batch-wise (e.g., MFPV volumetric basis) control of the vitrification process. Statistical confidence intervals are used to demonstrate compliance with proposed delisting levels for each IHLW waste type.

Pretreatment products and concentrated HLW feed from the PT facility are blended with GFCs in the MFPV to ensure that glass composition will fall within the range of possible glass formulations that correspond with glass forms complying with applicable requirements. The WTP control systems are designed to consistently achieve an IHLW composition within the range of acceptable glass compositions. Proof of formulation and control of the proper target composition for each batch is critical to ensure that, among other things, the waste is suitable for delisting.

The ultrafiltration and ion-exchange pretreatment products (Sr/TRU precipitate and cesium concentrate) are stored in the PT facility as they are generated. These products and process recycle streams will be blended with each batch of pretreated HLW feed in the HLW blend vessel in the PT facility. The blend ratios will be controlled within acceptable ranges to meet a process feed specification for the HLW facility. The process feed specification will establish operating and concentration limits that enable HLW vitrification to consistently produce acceptable IHLW, and other processing requirements that must be met before feeding the melter.

Composition control during production relies on analysis of process samples from the MFPV. Analysis of the MFPV contents will consist of sampling after each batch transfer of waste from the pretreatment blend vessel to confirm that the blended HLW feed can be vitrified to meet processing and product requirements (MFPV initial sample). The results of this sampling will also be used to define (or confirm) a formulation of GFC additions for vitrification. The amounts of each GFC will be determined using a process control algorithm to obtain a glass that meets proposed delisting levels, requirements for disposal of IHLW in the National Geologic Repository, and processing-related requirements inherent in the HLW facility design. The resultant IHLW must meet the glass qualification criteria in Table 3-21, and minimum waste loading criteria in Table 3-22. Specifically, glass composition-property response models for each applicable glass composition constraint will be used to determine the appropriate GFC masses to be added to each HLW batch transferred to the MFPV. After GFC addition, a second MFPV sample(s) will be used to determine the IHLW product composition before production (MFPV final sample). The control system will be designed to prevent errors in combining the feed and GFCs. If an error in melter feed composition occurs, composition adjustments will be made. Feed batches will not be transferred to the MFV until it is determined that vitrification will produce an acceptable glass product. The MFPV final process samples (after GFC additions) are a compliance hold point. The waste will not move forward until analytical results of the MFPV final sample(s) confirm that a compliant glass product will be produced.

The process monitoring samples are based on demonstrating compliance with National Geologic Repository disposal specifications, rather than environmental compliance issues. The sampling strategies are evolving as the WTP qualification[13] program progresses and are subject to revision in accordance with the *IHLW Product Compliance Plan* (24590-WTP-PL-RT-03-002). The sampling data will be acquired under the WTP *Quality Assurance Manual* (24590-WTP-QAM-QA-01-001), which complies with *Quality Assurance Requirements and Description* (DOE 2003) for the National Geologic Repository project. Process sampling data will not be subject to all EPA analytical protocols, and due to the radioactivity of the samples, detection limits and QC samples accompanying such process monitoring samples will not meet all QA/QC criteria specified by SW-846 (EPA 1999). SW-846 requirements for split and duplicate analyses will not be performed, and smaller samples shall be used in accordance with EPA/NRC guidelines for testing mixed waste (62 FR 62079). Such QC analyses and the large sample

[13] Qualification activities are performed before production operations to generate the data necessary to demonstrate compliance with the product specifications. Analyses, demonstrations, tests, and inspections are being conducted to prequalify IHLW for disposal in the National Geologic Repository.

size prescribed by SW-846 methods are counter to the intent of the "as low as reasonably achievable" (ALARA) program, and to principles in joint EPA/NRC guidance that formalize the need to minimize exposure to radiation (EPA 1997). Target analytes and applicable detection limits[14] will be established based on relevant data needs such as projecting cadmium leachability using the TCLP response-glass composition model.

3.6.2 Glass Formulation Development Process

Glass formulation development addresses issues of processability, waste loading, and durability (e.g., resistance to degradation under disposal conditions). The goal is to develop glass formulations that will meet durability, processing, and minimum waste loading requirements (e.g., maximize waste loading to minimize volume of glass). The WTP glass formulation development program uses simulants and develops glass property-composition relationships (or models) for Hanford tank waste. Glass formulation requires testing simulated waste glass composed of simulants (simulated waste feed plus applicable recycle streams) and GFCs. Also, as appropriate, batched oxides representing the chemical makeup of a target glass composition are validated using actual Hanford tank waste samples.

Development of glass formulations is an iterative process: prospective glasses are formulated, melted in small crucible melts, and characterized to obtain the required property-composition information. The results are then analyzed, and revised compositions are generated in order to optimize the glass properties with respect to the constraints. In parallel, statistically designed matrices of glasses are also generated and characterized. As tank waste characterization data becomes available, an appropriate glass formulation can be selected (and modified if necessary) from the known and proven glass compositions. The composition is then fabricated from the simulated waste feed and appropriate GFC additions. Simulated glass is fabricated to represent an actual radioactive waste glass and is compositionally similar to radioactive glass, except the simulated glass does not contain radionuclides. Glass composition, excluding loss of volatile constituents, is essentially the sum of the simulant components and the components of the GFCs. These components are generally expressed as percent weight oxide since they are converted to their oxide form in the glass melt. Experimentation with simulated glass permits formulation development and testing without exposing analytical personnel to radiation. An evaluation of preliminary radioactive crucible melt data shows that the actual waste glass is at least as durable as the simulated glasses with similar composition. The difference in durability can be attributed primarily to radiolysis of water and air in the radioactive glass test (Wronkiewicz 1993). Preliminary glass property models have been developed that can predict the impact of composition differences on chemical durability of glass. These models suggest that differences in component concentrations of several percent for most components and 0.5 % for the most influential components are required to impact the chemical durability of glass by an amount greater than the measurement uncertainty (*Preliminary Validation of HLW Glass Simulant and Scale,* 24590-HLW-RPT-RT-03-01).

Statistical and experimental design methods are applied to develop and test nonradioactive glass formulations that adequately cover the glass composition region of interest for a given waste feed. Statistical methods are used to develop and validate property-composition models to define a range of glass compositions that will yield a compliant waste form for each potential melter feed. Melter feed formulations are based on the WTP flowsheet models, assessment of annual TFCOUP publications (Kirkbride et al. 2003, PNWD 1999), and recent WTP waste characterization work.

[14] Model sensitivity does not warrant detection limits in the low part-per-million range, as is typical for SW-846 methods. Likewise, inputs to the model do not include all the toxicity characteristic metals, and do include some nonhazardous metals such as aluminum, sodium, and iron.

Composition variation studies are performed in which melter feed compositions are varied to determine specific component effects on melter process rates and characteristics, and the resulting glass composition and durability. The contribution of WTP recycle streams from sludge washing and leaching is also accounted for. These studies provide a knowledge base of potentially suitable glass formulations for WTP processing. If waste characterization information (not previously available) indicates the potential need for a glass composition outside the range of prequalified compositions (i.e., compositions and variations known to comply with relevant criteria) in advance of production, experiments are performed to acquire the data necessary to expand the region of qualified glass compositions.

Simulants are materials designed to emulate specific types of chemical or physical behavior of actual mixed Hanford tank wastes. Simulants are compared to actual wastes or glasses with respect to key chemical species and physical characteristics to ensure representativeness. Simulant glasses can be made directly from reagent chemicals as well, without producing a liquid waste simulant, depending on the process or property to be simulated.

Experienced suppliers developed waste simulants for melter testing. LAW simulants are supplied as liquids. HLW simulants are made up as melter feeds (waste with GFCs already added). For glass chemical durability (leach resistance), it has been repeatedly shown that only the chemical composition of the final product is important. The relationship of chemical composition to glass properties such as melt viscosity and leach resistance is the basis for developing ILAW and IHLW models.

GFCs are assigned to a feed based on knowledge of glass chemistry (data from implementation of successive glass testing programs), model results, and waste loading requirements. Key parameters such as sodium and sulfate content and the potential redox state of the melt (Fe^{2+}:Fe^{3+} and total organic carbon content) are considered during selection of a target formulation. Since simulant composition is essentially limited to the range of waste feed compositions, GFC content is adjusted so the corresponding glass formulation meets waste form qualifications (e.g., waste loading restrictions and durability requirements).

Multiple formulations are usually tested at crucible scale to determine the optimal formulation for use with actual waste. Crucible melt tests provide a means to determine basic kinetic and thermodynamic parameters and quickly screen the effects of the variables of interest, including glass composition, temperature, redox, and GFCs. Iterative testing is usually implemented to determine the optimum waste loading and ensure minor variations in glass composition do not have an unacceptable impact on glass properties. The results are recorded and become part of the overall knowledge base of potentially suitable glass formulations.

Selection of representative glass formulations based on the simulant work is in turn used to prepare glasses from actual Hanford tank waste. Actual waste samples are characterized before and after pretreatment and any expected waste stream blending to provide composition data essential for the selection of the optimal GFC mix for the prescribed glass formulation.

Due to the minor differences between the waste characterization information used for initial formulation (Best Basis Inventory, TFCOUP, Dynamic G-2 model results, historical sample data), and characterization of the actual Hanford tank waste sample to be vitrified, minor adjustments to the target composition are often required. Most notably, minor constituents and trace alkali metals not incorporated into simulant-based formulations (due to lack of complete historical waste characterization information) must be accounted for in development of the corresponding active glass formulation. Impurities in the GFCs must also be accounted for, and may vary from batch to batch. As a result, the target composition

may deviate from the formulation originally specified for a number of trace level constituents; however, the overall composition remains essentially unchanged. Once a glass formulation has been selected, the active waste is vitrified in crucible form for subsequent analysis (Figure 3-25).

3.6.3 Bench-Scale Process Compared to Full-Scale Process [Part 3: 29]

The basis for requesting upfront exclusion is the bench-scale research done specifically for this petition. Information substantiating the representativeness of bench-scale and simulant work is provided below.

Preliminary Validation of HLW Glass Simulant and Scale (24590-HLW-RPT-RT-03-001) (Supplement 6) summarizes the justification for using simulant to develop the TCLP response-glass composition model. Simulants are used because of the high cost of testing high-level radioactive waste and because of the risk that radioactive testing poses to human health. The testing involves two types of leaching: the product consistency test (PCT), a measure of waste form durability not directly related to RCRA; and the TCLP, a key test for delisting compliance.

In the melter, the melter feed is continuously fed onto the glass melt surface, where it quickly dries and forms a solid crust, the cold cap. The cold cap covers most of the melt surface, forming a layer that reduces volatility or evaporation of components from the glass melt. The feed material gradually converts to glass melt under the cold cap at the cold cap–glass melt interface. In the cooler regions, near the top of the cold cap, most of the water is evaporated. As the temperature increases, the salt components (e.g., alkali nitrates, nitrites, hydroxides, carbonates) melt and begin to dissolve the solid materials. At higher temperatures, these salts decompose, releasing gases (e.g., NO_x, CO_x) to the melter offgas treatment system. Finally, at the cold cap–glass melt interface, the solid materials are dissolved into the glass melt. The melt is mixed by a combination of natural convection and bubbling. Melt material remains in the melter for approximately 85 hours before it is air lifted from the bottom of the melter into the pour channel and the glass canister. In each canister, a portion of the melt cools rapidly as it contacts the canister walls, while a portion of the melt near the canister center cools more slowly. When the melt cools to the glass transition temperature, typically between 400 and 500 °C, it becomes a solid glass.

Crucible-scale melts are designed to mimic processes that would occur at full-scale. The crucible feed material is loaded into a covered crucible (typically fabricated from platinum alloys) and the crucible is placed in a resistance-heated furnace, heated to approximately 1150 °C, and held for between 1 and 4 hours. As the dried material is heated in the furnace, it undergoes reactions similar to those that occur in the melter cold cap. The molten salt forms at temperatures of roughly 300 °C and begins to dissolve solid particles of the feed, creating an alkali-rich glass melt. At higher temperatures, the salts decompose, generating gases that exit the crucible leaving the high-alkali glass melt. As the temperature continues to increase, the remaining solid particles dissolve into the glass melt. The glass melt is mixed by surface tension-driven convection in the crucible and may be further mixed by mechanical stirring or bubbling during the melting stage, or by quenching, grinding, and remelting. The melt is rapidly cooled by pouring onto a plate or mold, or allowing the crucible to cool in air or water. Typically, samples of crucible glass are cooled according to temperature histories that bound those expected during canister cooling (e.g., samples are rapidly quenched and heat treated according to a canister centerline cooling schedule). By this method, glasses can be fabricated for testing. The compositions and temperature histories of the glasses are easily controlled and varied to simulate those of melter-produced glass.

The melt time in crucible studies is short relative to melter glass production (1 to 4 hours versus 85 hours). This time is sufficient to fabricate a well-mixed, homogeneous melt while minimizing the impact of volatility on composition. In a glass melter, the melt surface area-to-volume ratio is smaller than in a

crucible and the melt is covered with a cold cap; therefore, the volatility rates are generally lower than in crucible melts.

HLW glasses (either crucible or melter scale) are not typically single-phased materials. Noble metals (palladium, rhodium, ruthenium, etc.) and their oxides will exist as separate phases in the glass. Some crystalline phases such as spinels may form in small quantities (<5.0 %) depending on the glass composition and the cooling times. These crystalline phases do not adversely affect glass durability (Kim et al. 1995; Cicero et al. 1993; Riley et al. 2001) but can be a concern with respect to settling in the melter, thereby shortening its life.

Preliminary Validation of HLW Glass Simulant and Scale (Supplement 6) compares simulant and active waste results to both the TCLP and the PCT, and describes the impacts observed with reproducing glass at both the crucible scale and pilot scale.

3.6.4 Differences Between Bench-Scale and Full-Scale Processes [Part 3: 30]

Preliminary Validation of HLW Glass Simulant and Scale (Supplement 6) explains the factors that affect glass durability, such as the following:

- The effect of adding a small fraction of a COC or an oxide becomes exceedingly small as the concentration falls below 0.01 wt%.
- In general, radiolysis decreases the TCLP leaching rate, if all other test conditions remain equal. This means that the actual TCLP concentration levels in the leachate (based on an 18-hour test) will be less under the influence of a radiation field than they will be in the absence of such a field.

Glass properties are determined primarily by the glass composition. The temperature history of the melt may also influence glass properties, but its influence on the chemical durability of glass is significant only if phase changes occur in the melt. Glass response to well-defined physical and chemical conditions (e.g., TCLP) is primarily determined by the thermodynamic state functions: temperature, composition, pressure, etc. For TCLP, temperature and pressure are controlled, so response is a function only of composition. The simulant and actual tank AZ-102, C-104, and C-106 glass compositions for COCs and TCLP response model terms are in Table 3-23. Generally, the compositions of the simulant and actual HLW glass are similar, and fall within the range covered by the IHLW test matrix. There are compositional relative differences above 50 %, but none of these components are above 0.5 wt %. Differences in component concentrations of several percent for most components and up to 0.5 % for the most influential components are required in order to impact the chemical durability of glass by an amount greater than the measurement uncertainty (Supplement 6). There is some uncertainty in both target composition (due primarily to mass measurement, chemical impurities, and volatility) and analyzed compositions (due primarily to analytical imprecision).

3.6.5 Impact of Differences [Part 3: 31]

In summary, the parameter that most strongly influences the properties of HLW glass is composition. The testing performed in support of the glass durability model development and validation activities includes multiple simulated HLW crucible melts, some radioactive crucible melts, and some simulated HLW melter tests. Because of the strong effect of composition on the leach resistance of glass, there is no need for direct one-to-one comparison correspondence of test glass compositions. Rather, the simulant

crucible melts are made over a region of compositions, and the responses can be interpolated within that region to the glasses produced with actual HLW, regardless of scale.

3.6.6 Multiple Waste Treatment Facility [Part 3: 32]

The WTP is not a multiple waste treatment facility; the only wastes to be treated have been generated at the Hanford Site, stored in SSTs and DSTs, and transferred to the DST system for staging and delivery to the WTP.

Table 3-1 WTP Standard Industrial Classification Codes

Priority	Code	Description
1	9999	Nonclassifiable
2	4953	Refuse Systems
3	9511	Air and Water Resource and Solid Waste Management
4	8733	Research Noncommercial

Table 3-2 WTP Permits

Permit Type	Permit Title	Permit Number
RCRA	Hanford Facility RCRA Permit	WA7890008967
RCRA	WTP Dangerous Waste Permit, Attachment 51	WA7890008967
RCRA	WTP Dangerous Waste Permit (Class III Mod to HSWP)	WA7890008967
AIR	Radioactive Air Emissions License - HLW Vitrification Facility Conditions	AIR-03-1012
AIR	Radioactive Air Emissions License - Analytical Laboratory Facility Conditions	AIR-03-1013
AIR	Radioactive Air Emissions License - LAW Vitrification Facility Conditions	AIR-03-1014
AIR	Radioactive Air Emissions License - PT facility Conditions	AIR-03-1015
AIR	Radioactive Air Emissions Excavation Permit	AIR-02-1014
AIR	Prevention of Significant Deterioration Permit	PSD-02-01
AIR	Nonradioactive Air Permit, Amendment 1	DE02NWP-002
AIR	Nonradioactive Air Permit, Structural Steel Fire Proofing Coating System	DE05NWP-003
AIR	Hanford Site Title V Air Operating Permit	00-05-006
WATER	State Waste Discharge Permit 9240	ST 9240
WATER	State Waste Discharge Permit 4511	ST 4511
WATER	Sand & Gravel - Concrete Batch Plant Permit	WAG-50-5180
WATER	Sand & Gravel - Pit 30 Permit	WAG-50-5181

Table 3-3 Waste Generating Facilities

Facility	Function	Operations Period
T Plant	Plutonium recovery, decontamination facility	1944 to 1956, plutonium recovery. 1957 to present, decontamination and repair facility
B Plant	Plutonium recovery and separation of cesium and strontium from other waste	1945 to 1952, 1968 to 1985
REDOX (S Plant)	Plutonium and uranium recovery	1952 to 1966
PUREX Plant	Plutonium and uranium recovery	1956 to 1972, 1983 to 1990
PFP (Z Plant)	Refine plutonium from PUREX Plant	1949 to 1989
U Plant	Uranium recovery from reclaimed tank waste	1952 to 1958

PFP = Plutonium Finishing Plant

PUREX = Plutonium/Uranium Extraction

REDOX = Reduction-Oxidation

Table 3-4 Approximate Liquid/Solid Content Hanford Tank Waste

Tank Type	Liquid	Sludge	Saltcake	Double-Shell Slurry (Considered Solid)	Total
SST	2 %	33 %	65 %	N/A	100 %
DST	77 %	9 %	4 %	10 %	100 %

DST = Double-shell tank

N/A = Not applicable

SST = Single-shell tank

Table 3-5 Chemical and Radionuclide Analyte Composition of the Liquid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Liquid (kL)		2.81E+03	4.57E+03	4.57E+03	4.57E+03	2.63E+03	2.96E+03	2.86E+03	2.86E+03	2.83E+03	2.86E+03	3.40E+03	4.57E+03	4.55E+03	3.24E+03	3.25E+03	2.59E+03	3.60E+03
Mass of Liquid (kg)		3.91E+06	6.72E+06	6.29E+06	6.79E+06	3.71E+06	4.12E+06	3.76E+06	3.76E+06	3.73E+06	4.11E+06	4.70E+06	6.69E+06	6.43E+06	4.37E+06	4.92E+06	3.61E+06	5.05E+06
Avg. liquid density (g/cc)		1.394	1.470	1.376	1.485	1.408	1.394	1.314	1.314	1.316	1.437	1.382	1.464	1.414	1.352	1.516	1.394	1.402
Liquid Component	**Units**	**Concentration**																
Ag	mg/L	8.07E-01	1.86E+00	6.35E+00	3.45E+00	6.59E+00	7.26E+00	1.66E+00	1.66E+00	1.08E+01	2.57E+00	1.49E+00	3.78E+00	8.30E-01	8.77E+00	2.69E+00	1.21E+00	7.49E-01
$Al(OH)_4^-$	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Al	mg/L	8.14E+03	1.46E+04	2.11E+04	2.33E+04	2.10E+04	2.14E+04	8.64E+03	8.64E+03	2.56E+04	1.37E+04	9.24E+02	2.65E+04	3.06E+04	2.34E+04	3.43E+04	1.78E+04	1.65E+04
As	mg/L	2.22E+00	9.12E+00	3.35E+01	1.84E+01	2.90E+00	3.22E+00	1.54E+01	1.54E+01	2.98E+01	7.03E+00	2.35E+01	1.65E+01	6.95E+00	4.45E+00	1.13E+00	2.63E+01	2.07E+01
B	mg/L	1.89E+01	1.90E+01	3.80E+01	3.70E+01	2.41E+01	2.65E+01	2.22E+01	2.22E+01	4.52E+01	1.07E+01	1.81E+01	4.89E+01	6.16E+00	3.55E+01	1.09E+01	2.23E+01	1.71E+01
Ba [a]	mg/L	4.89E-01	3.91E+00	1.99E+01	9.29E+00	1.46E+00	1.62E+00	6.34E+00	6.33E+00	1.50E+01	3.56E+00	4.69E+00	7.57E+00	3.50E+00	2.21E+00	5.50E-01	8.47E-01	3.81E-01
Be	mg/L	1.48E+00	6.17E-01	2.05E+00	9.98E-01	2.12E-01	2.35E-01	4.00E-01	4.00E-01	1.49E+00	3.50E-01	7.42E-01	8.62E-01	3.51E-01	5.40E-01	1.58E-01	1.29E+00	1.02E+00
Bi	mg/L	3.05E+00	1.88E+01	3.28E+01	2.38E+01	7.93E+00	7.49E+00	1.72E+01	1.72E+01	3.02E+01	1.66E+01	7.62E+00	2.85E+01	2.06E+01	5.88E+00	5.60E+00	5.80E+00	3.71E+00
Ca	mg/L	9.54E+00	3.87E+01	6.82E+01	4.73E+01	3.90E+00	4.31E+00	2.47E+02	2.47E+02	3.00E+01	7.03E+00	4.48E+02	7.84E+01	3.02E+01	4.45E+00	1.14E+00	1.03E+01	7.72E+00
Cd [a]	mg/L	2.28E+00	2.83E+00	7.50E+00	1.48E+00	4.27E-01	4.56E-01	3.46E+01	3.46E+01	1.51E+00	3.54E-01	5.07E+01	2.07E+00	4.20E-01	2.29E+00	7.27E-01	9.97E-01	7.80E-01
Ce	mg/L	2.50E-01	7.85E+00	3.98E+01	1.87E+01	2.93E+00	3.22E+00	6.32E+00	6.31E+00	2.98E+01	7.01E+00	3.90E+01	1.51E+01	6.96E+00	4.42E+00	1.12E+00	2.59E+00	1.52E+00
Cl	mg/L	2.27E+03	3.81E+03	4.39E+03	5.91E+03	4.94E+03	4.92E+03	2.42E+03	2.42E+03	6.08E+03	6.14E+03	1.75E+03	7.41E+03	5.62E+03	5.03E+03	3.64E+03	4.26E+03	3.85E+03
CN	mg/L	8.91E+00	6.47E+00	5.69E-02	8.14E-01	6.88E-04	7.68E-04	0.00E+00	0.00E+00	3.23E-04	0.00E+00	0.00E+00	2.28E+01	5.15E-02	9.68E-06	0.00E+00	0.00E+00	0.00E+00
Co [a]	mg/L	5.88E-01	2.06E+00	7.97E+00	3.77E+00	6.94E-01	7.77E-01	1.52E+00	1.52E+00	5.95E+00	1.40E+00	3.33E+00	3.68E+00	1.41E+00	9.47E-01	2.54E-01	2.02E+00	1.51E+00
CO_3^{-2} [a]	mg/L	4.49E+04	5.97E+04	3.49E+04	4.72E+04	3.30E+04	2.89E+04	4.67E+04	4.67E+04	1.36E+04	6.03E+04	5.95E+04	3.25E+04	1.93E+04	8.01E+03	1.67E+04	1.86E+04	2.09E+04
$Cr(OH)_4^-$	mg/L	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cr	mg/L	1.86E+02	1.32E+03	6.91E+02	1.33E+03	1.90E+02	1.95E+02	1.63E+02	1.63E+02	1.50E+02	2.60E+02	1.37E+02	7.65E+02	6.66E+02	2.92E+02	2.22E+02	1.12E+02	1.14E+02
Cs [a]	mg/L	7.53E+00	6.98E+00	1.13E+01	1.00E+01	9.64E+00	1.05E+01	1.15E+01	1.15E+01	8.77E+00	3.68E+00	1.22E+01	1.40E+01	1.12E+01	1.38E+01	5.20E+00	9.94E+00	8.23E+00
Cu	mg/L	1.92E+00	1.90E+00	4.44E+00	3.20E+00	1.79E+00	1.98E+00	1.50E+01	1.50E+01	3.21E+00	7.56E-01	2.32E+01	3.85E+00	7.68E-01	1.89E+00	5.68E-01	1.35E+00	1.02E+00
F	mg/L	3.20E+03	2.81E+03	9.01E+02	2.60E+03	4.31E+02	3.82E+02	1.09E+02	1.09E+02	2.67E+02	1.66E+03	1.41E+02	6.87E+02	3.42E+02	4.46E+02	5.67E+02	1.15E+03	1.61E+03
Fe	mg/L	3.14E+00	1.17E+01	2.14E+01	1.64E+01	6.68E+00	7.12E+00	2.48E+01	2.48E+01	1.50E+01	4.65E+00	1.42E+03	2.17E+01	8.92E+00	2.68E+00	7.40E-01	4.05E+00	2.96E+00
H^+	mg/L	0.00E+00	7.16E+01	0.00E+00	8.82E-04	3.35E-04	3.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H_2O	mg/L	8.78E+05	8.00E+05	7.73E+05	7.65E+05	8.86E+05	8.77E+05	8.22E+05	8.22E+05	8.28E+05	9.14E+05	8.04E+05	7.60E+05	7.68E+05	8.64E+05	9.84E+05	8.78E+05	8.85E+05
Hg	mg/L	4.91E-02	1.31E+01	1.23E-02	4.39E-02	2.70E-02	3.01E-02	0.00E+00	0.00E+00	7.12E-05	0.00E+00	0.00E+00	3.10E-02	1.17E-02	1.24E-01	3.09E-01	0.00E+00	0.00E+00
K	mg/L	3.45E+04	5.63E+03	7.67E+03	6.02E+03	3.27E+03	3.40E+03	1.29E+03	1.29E+03	4.10E+03	3.01E+03	1.57E+03	7.02E+03	5.40E+03	8.38E+03	5.69E+03	2.26E+04	2.54E+04
La	mg/L	1.48E+00	2.16E+00	4.80E+00	4.26E+00	1.12E+01	1.24E+01	7.82E+00	7.81E+00	8.34E-01	1.94E-01	2.57E+01	1.52E+00	2.59E+00	6.44E-01	2.14E-01	7.50E-01	5.79E-01
Li	mg/L	4.13E-01	1.48E+00	4.29E+00	3.14E+00	4.40E+00	4.85E+00	5.34E-01	5.33E-01	3.63E+00	8.58E-01	2.35E+00	3.18E+00	1.46E+00	1.08E+01	3.42E+00	3.05E+00	2.39E+00
Mg	mg/L	3.71E+00	1.08E+01	3.99E+01	2.16E+01	2.25E+01	2.48E+01	1.57E+01	1.57E+01	2.98E+01	7.04E+00	6.69E+00	3.71E+01	7.11E+00	3.45E+01	1.08E+01	4.47E+00	3.02E+00
Mn	mg/L	1.51E+00	4.46E+00	4.30E+00	3.41E+00	2.61E+00	2.79E+00	1.22E+01	1.21E+01	3.03E+00	1.52E+00	4.37E+02	4.17E+00	2.73E+00	3.46E+00	1.08E+00	2.22E+00	1.94E+00
Mo	mg/L	1.72E+01	4.54E+01	5.56E+01	2.53E+01	3.00E+01	3.31E+01	2.84E+01	2.84E+01	5.86E+01	1.39E+01	2.70E+01	7.00E+01	1.05E+01	5.20E+01	1.61E+01	3.07E+01	2.37E+01
Na	mg/L	1.57E+05	2.11E+05	1.93E+05	2.27E+05	1.59E+05	1.59E+05	1.61E+05	1.61E+05	1.56E+05	1.61E+05	1.88E+05	2.23E+05	1.99E+05	1.61E+05	1.61E+05	1.61E+05	1.61E+05

Table 3-5 Chemical and Radionuclide Analyte Composition of the Liquid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Liquid (kL)		2.81E+03	4.57E+03	4.57E+03	4.57E+03	2.63E+03	2.96E+03	2.86E+03	2.86E+03	2.83E+03	2.86E+03	3.40E+03	4.57E+03	4.55E+03	3.24E+03	3.25E+03	2.59E+03	3.60E+03
Mass of Liquid (kg)		3.91E+06	6.72E+06	6.29E+06	6.79E+06	3.71E+06	4.12E+06	3.76E+06	3.76E+06	3.73E+06	4.11E+06	4.70E+06	6.69E+06	6.43E+06	4.37E+06	4.92E+06	3.61E+06	5.05E+06
Avg. liquid density (g/cc)		1.394	1.470	1.376	1.485	1.408	1.394	1.314	1.314	1.316	1.437	1.382	1.464	1.414	1.352	1.516	1.394	1.402
Liquid Component	**Units**	**Concentration**																
Nd	mg/L	3.24E+00	8.87E+00	3.33E+01	1.87E+01	2.25E+01	2.48E+01	1.19E+01	1.19E+01	2.97E+01	7.02E+00	7.42E+01	3.70E+01	6.94E+00	3.46E+01	1.08E+01	4.45E+00	3.00E+00
NH3	mg/L	2.52E+00	3.82E+01	1.08E+01	1.64E+02	8.41E-02	9.79E-02	7.85E+01	7.84E+01	2.24E+03	5.34E+02	3.77E+01	2.80E+01	1.04E+01	6.50E+03	2.06E+03	6.10E+01	3.77E+00
Ni [a]	mg/L	9.08E+00	2.19E+01	6.03E+01	2.66E+01	5.86E+00	6.35E+00	2.35E+02	2.34E+02	6.55E+00	6.45E+00	4.83E+02	4.26E+01	9.67E+00	6.93E+00	2.21E+00	3.60E+00	2.46E+00
NO_2	mg/L	5.31E+04	6.56E+04	7.87E+04	7.98E+04	7.32E+04	7.31E+04	6.22E+04	6.22E+04	7.49E+04	7.55E+04	6.64E+04	1.00E+05	9.10E+04	7.16E+04	5.95E+04	6.93E+04	6.50E+04
NO_3	mg/L	1.49E+05	2.12E+05	1.63E+05	2.18E+05	1.26E+05	1.24E+05	1.49E+05	1.49E+05	1.00E+05	1.26E+05	2.04E+05	1.89E+05	1.72E+05	8.79E+04	1.10E+05	1.26E+05	1.32E+05
OH(BOUND)	mg/L	6.58E+03	3.78E+04	6.02E+04	5.77E+04	3.45E+04	3.80E+04	2.27E+04	2.27E+04	6.08E+04	1.44E+04	0.00E+00	6.11E+04	7.35E+04	4.62E+04	1.42E+04	2.37E+04	1.80E+04
OH^-	mg/L	4.72E+04	2.42E+04	2.25E+04	2.93E+04	5.41E+04	5.18E+04	5.28E+03	5.28E+03	3.80E+04	4.63E+04	1.13E+04	3.60E+04	3.26E+04	6.57E+04	1.20E+05	6.59E+04	6.78E+04
Pb	mg/L	1.69E+01	3.53E+01	4.42E+01	3.66E+01	2.75E+01	2.93E+01	9.93E+01	9.92E+01	3.32E+01	1.71E+01	3.39E+02	4.23E+01	4.84E+01	6.74E+01	2.13E+01	2.88E+01	2.21E+01
Pd	mg/L	1.14E-01	2.79E-01	0.00E+00	7.38E-04	2.71E-04	3.03E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PO_4	mg/L	1.72E+03	1.00E+04	2.86E+03	5.02E+03	2.98E+03	2.84E+03	3.92E+03	3.92E+03	1.02E+03	5.94E+03	2.19E+03	6.93E+03	8.48E+03	1.14E+03	1.41E+03	1.31E+03	1.11E+03
Pr	mg/L	2.98E-02	2.45E-02	4.87E-05	3.00E-03	2.06E-06	2.30E-06	0.00E+00	0.00E+00	2.82E-07	0.00E+00	0.00E+00	1.54E-01	4.65E-05	8.45E-09	0.00E+00	0.00E+00	0.00E+00
Pu [a]	mg/L	7.64E-03	5.63E-02	1.53E-02	9.05E-03	2.51E-03	2.52E-03	5.54E-02	5.54E-02	4.60E-04	1.29E-03	8.29E-01	9.63E-03	8.27E-03	4.73E-03	1.71E-03	5.98E-03	7.89E-03
Rb	mg/L	4.35E+00	5.80E-01	8.05E-04	5.61E-02	3.47E-04	3.88E-04	0.00E+00	0.00E+00	4.67E-06	0.00E+00	0.00E+00	2.47E+00	7.70E-04	1.40E-07	0.00E+00	0.00E+00	0.00E+00
Rh	mg/L	4.77E-01	1.06E+00	1.56E-03	9.01E-02	5.51E-04	6.16E-04	0.00E+00	0.00E+00	9.03E-06	0.00E+00	2.01E+01	4.77E+00	1.49E-03	2.70E-07	0.00E+00	0.00E+00	0.00E+00
Ru [a]	mg/L	6.41E+00	1.29E+01	5.86E-03	3.54E-01	6.33E-04	7.07E-04	1.98E-15	1.98E-15	3.40E-05	4.60E-16	1.75E-15	1.80E+01	5.60E-03	1.02E-06	1.26E-16	4.58E-16	3.60E-16
Sb [a]	mg/L	1.30E-01	3.92E+00	2.43E+01	6.26E+00	1.35E+01	1.48E+01	1.28E-01	1.28E-01	1.79E+01	4.22E+00	2.51E-01	8.95E+00	3.96E+00	2.07E+01	6.45E+00	1.58E+01	1.24E+01
Se [a]	mg/L	3.78E+00	2.62E+01	6.07E+01	4.11E+01	2.26E+01	2.50E+01	1.55E+01	1.55E+01	2.99E+01	7.07E+00	1.67E+01	6.90E+01	2.73E+01	3.48E+01	1.09E+01	1.03E+01	7.72E+00
Si	mg/L	1.72E+02	3.61E+02	1.26E+02	2.01E+02	1.62E+02	1.61E+02	3.05E+01	3.05E+01	1.34E+02	6.11E+01	2.07E+01	1.21E+02	7.86E+01	2.32E+02	1.87E+02	1.16E+02	1.39E+02
SO_4	mg/L	5.06E+03	1.29E+04	5.74E+03	1.34E+04	6.57E+03	5.89E+03	1.07E+04	1.07E+04	1.98E+03	5.81E+03	8.10E+03	5.76E+03	3.92E+03	1.15E+03	1.85E+03	1.91E+03	2.01E+03
Sr [a]	mg/L	4.71E-01	4.14E+00	2.57E+00	3.20E+00	2.30E+00	2.55E+00	1.44E+00	1.44E+00	6.26E-02	8.40E-01	7.22E-01	3.24E+00	1.47E+00	3.60E+00	1.84E+00	2.49E-01	3.62E-01
Ta	mg/L	1.29E-01	3.96E-02	9.83E-06	6.11E-04	2.10E-06	2.35E-06	0.00E+00	0.00E+00	5.70E-08	0.00E+00	1.88E+01	3.01E-02	9.40E-06	1.71E-09	0.00E+00	0.00E+00	0.00E+00
Tc [a]	mg/L	3.25E+00	7.30E+00	1.24E+01	1.18E+01	6.70E+00	6.79E+00	5.70E+00	5.69E+00	9.66E+00	1.04E+01	5.28E+00	1.29E+01	9.19E+00	5.70E+00	5.77E+00	7.59E+00	7.49E+00
Te	mg/L	1.82E-01	3.63E-01	4.87E-05	3.00E-03	2.94E-06	3.28E-06	0.00E+00	0.00E+00	2.82E-07	0.00E+00	0.00E+00	1.40E-01	4.66E-05	8.45E-09	0.00E+00	0.00E+00	0.00E+00
Th [a]	mg/L	1.38E+02	4.00E+01	9.78E+01	4.53E+01	1.17E+01	1.05E+01	1.30E+00	1.30E+00	1.07E+02	2.62E+01	9.22E+01	3.98E+01	1.00E+02	1.50E+01	2.99E+01	1.21E+01	1.87E+01
Ti	mg/L	7.33E-01	1.01E+00	4.10E+00	2.13E+00	2.25E+00	2.48E+00	3.85E-01	3.85E-01	2.97E+00	7.04E-01	2.35E+00	3.71E+00	7.05E-01	3.45E+00	1.08E+00	2.62E+00	2.06E+00
Tl	mg/L	2.18E-01	9.35E+00	1.30E+00	2.20E+01	4.48E+01	4.93E+01	1.14E+00	1.14E+00	5.92E+01	1.41E+01	1.20E-01	2.55E+00	1.21E+00	6.89E+01	2.14E+01	2.08E+01	1.57E+01
TOC	mg/L	2.38E+03	3.26E+03	6.24E+03	3.57E+03	2.02E+03	2.00E+03	1.74E+04	1.74E+04	1.79E+03	2.28E+03	3.06E+04	5.78E+03	3.05E+03	1.50E+03	8.34E+02	2.59E+03	2.50E+03
U [a]	mg/L	7.83E+01	4.66E+02	2.03E+01	2.01E+01	1.46E+01	1.39E+01	1.35E+01	1.35E+01	2.29E+00	1.18E+00	8.44E+01	2.76E+01	1.96E+01	1.41E+00	2.00E+00	1.84E+01	3.55E+01
V	mg/L	9.98E-01	4.17E+00	1.67E+01	9.69E+00	1.12E+01	1.24E+01	1.55E+00	1.55E+00	1.49E+01	3.53E+00	3.33E+00	1.85E+01	3.49E+00	1.73E+01	5.37E+00	2.24E+00	1.51E+00
W	mg/L	3.16E+01	3.90E+00	2.56E-02	1.57E+00	5.08E-04	5.67E-04	0.00E+00	0.00E+00	1.49E-04	0.00E+00	0.00E+00	7.84E+01	2.45E-02	4.44E-06	0.00E+00	0.00E+00	0.00E+00
Y [a]	mg/L	2.64E-02	2.72E-01	7.20E+00	3.50E-01	3.33E-04	3.72E-04	1.21E+00	1.21E+00	3.14E-02	2.98E-06	6.88E+00	3.46E+00	5.67E-01	1.25E-03	4.33E-07	3.05E-06	5.38E-06

Table 3-5 Chemical and Radionuclide Analyte Composition of the Liquid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Liquid (kL)		2.81E+03	4.57E+03	4.57E+03	4.57E+03	2.63E+03	2.96E+03	2.86E+03	2.86E+03	2.83E+03	2.86E+03	3.40E+03	4.57E+03	4.55E+03	3.24E+03	3.25E+03	2.59E+03	3.60E+03
Mass of Liquid (kg)		3.91E+06	6.72E+06	6.29E+06	6.79E+06	3.71E+06	4.12E+06	3.76E+06	3.76E+06	3.73E+06	4.11E+06	4.70E+06	6.69E+06	6.43E+06	4.37E+06	4.92E+06	3.61E+06	5.05E+06
Avg. liquid density (g/cc)		1.394	1.470	1.376	1.485	1.408	1.394	1.314	1.314	1.316	1.437	1.382	1.464	1.414	1.352	1.516	1.394	1.402
Liquid Component	**Units**	**Concentration**																
Zn	mg/L	6.24E+00	2.43E+00	4.21E+00	4.28E+00	5.41E+00	5.97E+00	1.58E+00	1.58E+00	1.88E+01	4.46E+00	1.52E+01	3.88E+00	8.19E-01	5.84E+00	1.69E+00	3.25E+00	2.25E+00
Zr [a]	mg/L	3.06E+00	2.82E+01	4.89E+00	3.75E+00	3.71E+00	3.89E+00	8.77E+00	8.76E+00	3.12E+00	1.69E+00	5.00E+01	5.27E+00	4.19E+00	4.37E+00	1.88E+00	8.23E+00	9.85E+00
106-Ru	Bq/L	6.80E-03	1.87E-02	4.20E-03	1.86E-03	3.59E-04	3.95E-04	2.55E-04	2.55E-04	2.54E-04	5.90E-05	2.25E-04	6.31E-04	4.54E-04	5.24E-05	1.61E-05	5.87E-05	4.63E-05
113m-Cd	Bq/L	7.36E+05	4.25E+05	8.87E+05	6.37E+05	2.72E+05	3.00E+05	4.63E+05	4.64E+05	4.46E+05	2.16E+05	5.49E+05	9.13E+05	6.21E+05	3.23E+05	9.94E+04	3.74E+05	2.86E+05
125-Sb	Bq/L	2.79E+05	9.96E+04	7.15E+04	4.49E+04	2.08E+04	2.18E+04	2.28E+04	2.28E+04	2.17E+04	1.20E+04	2.10E+04	3.84E+04	2.70E+04	1.15E+04	6.45E+03	1.32E+04	1.13E+04
126-Sn	Bq/L	3.77E+04	2.32E+04	4.63E+04	3.47E+04	6.03E+04	7.16E+04	1.85E+04	1.85E+04	1.87E+04	1.05E+04	2.80E+05	5.79E+04	3.49E+04	1.47E+05	4.89E+04	2.04E+04	1.47E+04
129-I	Bq/L	3.60E+03	9.95E+03	1.44E+04	1.47E+04	4.16E+03	4.27E+03	3.24E+03	3.24E+03	6.24E+03	3.83E+03	4.21E+03	1.22E+04	1.22E+04	7.55E+03	6.23E+03	6.82E+03	6.32E+03
134-Cs	Bq/L	1.08E+05	2.73E+04	6.66E+03	2.25E+03	2.43E+02	2.63E+02	2.05E+02	2.05E+02	2.15E+02	9.26E+01	1.79E+02	2.65E+03	1.29E+03	8.84E+01	4.72E+01	7.69E+03	6.23E+03
137-Cs	Bq/L	5.01E+09	4.72E+09	7.22E+09	6.64E+09	7.85E+09	8.18E+09	7.69E+09	7.68E+09	5.59E+09	6.62E+09	8.41E+09	8.47E+09	6.77E+09	8.97E+09	5.83E+09	7.30E+09	6.96E+09
137m-Ba	Bq/L	4.72E+09	4.42E+09	6.87E+09	6.28E+09	7.50E+09	7.68E+09	7.27E+09	7.27E+09	5.30E+09	6.30E+09	8.00E+09	8.03E+09	6.44E+09	8.54E+09	5.55E+09	6.98E+09	6.60E+09
14-C	Bq/L	1.94E+04	4.34E+05	3.72E+05	4.34E+05	2.90E+05	2.46E+05	2.17E+04	2.17E+04	3.63E+04	5.80E+05	2.33E+05	9.53E+04	1.34E+05	1.49E+05	4.43E+05	2.01E+05	2.82E+05
151-Sm	Bq/L	2.09E+08	1.28E+08	2.24E+08	1.60E+08	5.56E+07	9.90E+07	1.02E+08	1.02E+08	1.03E+08	2.90E+07	8.62E+07	2.88E+08	1.93E+08	9.05E+07	3.03E+07	1.13E+08	8.13E+07
152-Eu	Bq/L	5.58E+04	3.06E+04	4.23E+04	2.59E+04	1.66E+04	1.84E+04	2.24E+04	2.24E+04	2.21E+04	5.21E+03	1.89E+04	4.12E+04	2.89E+04	1.62E+04	4.97E+03	1.82E+04	1.43E+04
154-Eu	Bq/L	1.03E+05	5.30E+05	3.93E+05	7.38E+05	3.57E+05	3.94E+05	1.88E+06	1.88E+06	2.24E+05	5.29E+04	8.39E+06	7.15E+05	5.02E+05	2.06E+05	6.41E+04	1.72E+05	1.35E+05
155-Eu	Bq/L	2.86E+04	1.56E+05	1.95E+05	3.31E+05	1.60E+05	1.77E+05	4.40E+05	4.40E+05	6.33E+04	1.49E+04	2.33E+06	1.26E+05	1.33E+05	4.99E+04	1.55E+04	1.48E+05	1.19E+05
226-Ra	Bq/L	3.63E+03	7.24E+03	3.32E+00	2.45E+00	1.02E+00	1.11E+00	1.72E+00	1.72E+00	1.65E+00	8.53E-01	1.78E+00	4.18E+00	2.59E+00	1.35E+00	5.10E-01	1.56E+00	1.23E+00
227-Ac	Bq/L	2.61E+01	4.03E+01	4.96E+01	3.63E+01	1.81E+01	1.91E+01	2.70E+01	2.70E+01	2.60E+01	1.29E+01	2.24E+01	5.90E+01	4.65E+01	2.34E+01	1.17E+01	2.67E+01	2.23E+01
228-Ra	Bq/L	2.10E+03	4.34E+02	1.11E+03	6.58E+02	3.25E+02	3.46E+02	4.39E+02	4.39E+02	7.98E+02	3.24E+02	7.94E+02	7.69E+02	1.13E+03	3.21E+02	2.03E+02	3.53E+02	3.08E+02
229-Th	Bq/L	1.07E+02	3.57E+01	1.19E+02	5.96E+01	5.62E+01	6.00E+01	8.44E+01	8.44E+01	8.31E+01	2.03E+01	7.15E+01	1.31E+02	1.14E+02	7.46E+01	4.33E+01	8.26E+01	7.38E+01
231-Pa	Bq/L	6.37E+01	1.21E+02	9.07E+01	7.19E+01	3.79E+01	3.90E+01	4.88E+01	4.88E+01	4.59E+01	3.23E+01	3.99E+01	1.10E+02	7.18E+01	4.09E+01	2.51E+01	4.72E+01	4.08E+01
232-Th	Bq/L	5.61E+02	1.63E+02	3.99E+02	1.84E+02	4.77E+01	4.28E+01	5.28E+00	5.28E+00	4.34E+02	1.07E+02	3.76E+02	1.62E+02	4.08E+02	6.11E+01	1.22E+02	4.92E+01	7.61E+01
232-U	Bq/L	5.60E+02	3.93E+02	1.19E+02	1.13E+02	1.14E+02	1.00E+02	1.98E+02	1.98E+02	3.14E+01	1.68E+01	2.04E+03	1.64E+02	2.18E+02	1.36E+01	1.86E+01	1.12E+02	2.14E+02
233-U	Bq/L	2.49E+03	2.49E+03	5.37E+02	5.22E+02	5.27E+02	4.68E+02	9.14E+02	9.14E+02	1.45E+02	7.75E+01	9.43E+03	7.62E+02	1.02E+03	6.42E+01	8.80E+01	5.26E+02	1.01E+03
234-U	Bq/L	1.10E+03	5.79E+03	2.96E+02	2.77E+02	1.83E+02	1.68E+02	1.89E+02	1.89E+02	3.39E+01	1.76E+01	1.21E+03	4.10E+02	2.85E+02	2.22E+01	3.10E+01	3.04E+02	5.90E+02
235-U	Bq/L	4.75E+01	2.46E+02	1.25E+01	1.25E+01	7.22E+00	6.43E+00	6.65E+00	6.65E+00	1.33E+00	6.91E-01	4.48E+01	1.67E+01	1.25E+01	8.61E-01	1.20E+00	1.47E+01	2.11E+01
236-U	Bq/L	4.65E+01	1.25E+02	1.41E+01	9.97E+00	9.41E+00	8.59E+00	6.71E+00	6.71E+00	1.54E+00	7.98E-01	4.27E+01	2.04E+01	1.24E+01	1.28E+00	1.81E+00	3.38E+01	6.74E+01
237-Np	Bq/L	4.40E+03	1.49E+04	1.52E+05	2.03E+04	7.48E+02	7.43E+02	2.81E+04	2.81E+04	1.36E+03	1.63E+02	1.66E+03	2.16E+04	2.04E+04	6.62E+02	9.57E+02	9.11E+02	1.05E+03
238-Pu	Bq/L	2.36E+03	7.02E+03	1.73E+03	7.70E+02	2.09E+02	2.09E+02	3.31E+03	3.30E+03	3.68E+01	9.29E+01	4.99E+04	1.88E+03	1.05E+03	4.57E+02	1.66E+02	1.46E+03	2.06E+03
238-U	Bq/L	9.66E+02	5.75E+03	2.51E+02	2.48E+02	1.80E+02	1.72E+02	1.66E+02	1.66E+02	2.82E+01	1.45E+01	1.04E+03	3.40E+02	2.42E+02	1.74E+01	2.46E+01	2.26E+02	4.37E+02
239-Pu	Bq/L	1.62E+04	1.20E+05	3.29E+04	1.95E+04	5.35E+03	5.37E+03	1.19E+05	1.19E+05	9.84E+02	2.76E+03	1.78E+06	2.06E+04	1.77E+04	1.01E+04	3.64E+03	1.25E+04	1.65E+04
240-Pu	Bq/L	3.29E+03	2.33E+04	5.70E+03	3.21E+03	1.02E+03	1.02E+03	2.10E+04	2.09E+04	1.83E+02	5.19E+02	3.19E+05	3.78E+03	3.13E+03	2.10E+03	7.59E+02	3.40E+03	4.53E+03

Table 3-5 Chemical and Radionuclide Analyte Composition of the Liquid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Liquid (kL)		2.81E+03	4.57E+03	4.57E+03	4.57E+03	2.63E+03	2.96E+03	2.86E+03	2.86E+03	2.83E+03	2.86E+03	3.40E+03	4.57E+03	4.55E+03	3.24E+03	3.25E+03	2.59E+03	3.60E+03
Mass of Liquid (kg)		3.91E+06	6.72E+06	6.29E+06	6.79E+06	3.71E+06	4.12E+06	3.76E+06	3.76E+06	3.73E+06	4.11E+06	4.70E+06	6.69E+06	6.43E+06	4.37E+06	4.92E+06	3.61E+06	5.05E+06
Avg. liquid density (g/cc)		1.394	1.470	1.376	1.485	1.408	1.394	1.314	1.314	1.316	1.437	1.382	1.464	1.414	1.352	1.516	1.394	1.402
Liquid Component	**Units**	**Concentration**																
241-Am	Bq/L	9.16E+03	3.51E+06	3.12E+05	4.71E+04	1.06E+05	1.10E+05	3.53E+06	3.53E+06	2.93E+03	6.42E+03	1.80E+07	1.19E+05	6.21E+04	8.94E+04	2.94E+04	1.77E+04	1.99E+04
241-Pu	Bq/L	2.90E+04	2.36E+05	4.18E+04	1.81E+04	8.42E+03	8.43E+03	1.10E+05	1.10E+05	1.19E+03	3.36E+03	1.66E+06	2.59E+04	2.12E+04	1.65E+04	5.99E+03	4.56E+04	6.12E+04
242-Cm	Bq/L	4.45E+00	3.14E+02	9.47E+02	1.21E+02	4.96E+02	4.22E+02	1.01E+04	1.01E+04	1.07E+01	7.57E+01	5.28E+04	3.25E+02	1.74E+02	1.87E+02	1.22E+02	2.77E+02	5.36E+02
242-Pu	Bq/L	4.20E-01	5.70E+00	6.53E-01	2.35E-01	1.14E-01	1.16E-01	1.47E+00	1.47E+00	1.58E-02	4.17E-02	2.22E+01	3.21E-01	4.11E-01	2.13E-01	7.72E-02	4.81E-01	6.44E-01
243-Am	Bq/L	4.64E-01	4.49E+00	1.23E+01	1.92E+00	5.66E+00	5.82E+00	1.42E+02	1.42E+02	1.20E-01	2.82E-01	9.16E+02	5.49E+00	2.78E+00	6.10E+00	2.00E+00	1.13E+00	1.27E+00
243-Cm	Bq/L	1.65E+00	1.07E+02	1.86E+02	5.45E+01	3.43E+01	2.91E+01	6.67E+02	6.67E+02	1.39E+00	5.21E+00	3.48E+03	2.14E+02	7.26E+01	1.27E+01	8.30E+00	1.01E+02	2.02E+02
244-Cm	Bq/L	3.00E+01	2.17E+03	2.83E+03	9.79E+02	2.73E+02	2.33E+02	4.42E+03	4.41E+03	1.78E+01	3.73E+01	2.05E+04	3.86E+03	1.22E+03	1.28E+02	8.38E+01	1.93E+03	3.86E+03
3-H	Bq/L	1.88E+05	1.69E+06	1.30E+06	2.10E+06	8.84E+04	7.84E+04	1.03E+04	1.03E+04	8.39E+03	2.81E+04	5.27E+04	2.56E+05	3.71E+05	1.67E+04	2.56E+04	5.88E+04	8.02E+04
59-Ni	Bq/L	1.32E+04	1.25E+04	2.29E+04	1.37E+04	5.59E+03	6.06E+03	9.91E+03	9.91E+03	9.15E+03	8.52E+03	1.80E+04	3.79E+04	1.89E+04	7.22E+03	2.52E+03	8.78E+03	6.51E+03
60-Co	Bq/L	5.41E+04	7.94E+04	1.46E+05	8.38E+04	3.29E+04	3.60E+04	3.59E+05	3.58E+05	2.12E+04	1.61E+04	8.53E+05	7.82E+04	4.57E+04	2.90E+04	9.13E+03	2.27E+04	1.74E+04
63-Ni	Bq/L	1.18E+06	1.09E+06	1.90E+06	1.15E+06	4.91E+05	5.32E+05	8.60E+05	8.59E+05	7.92E+05	7.43E+05	1.57E+06	3.08E+06	1.53E+06	6.22E+05	2.17E+05	7.52E+05	5.57E+05
79-Se	Bq/L	2.90E+03	2.67E+04	2.23E+04	1.78E+04	1.54E+04	2.06E+04	1.42E+04	1.42E+04	4.42E+03	6.69E+03	2.39E+04	3.56E+04	2.68E+04	1.26E+04	6.27E+03	1.57E+04	1.13E+04
90-Sr	Bq/L	1.21E+07	3.91E+08	8.69E+07	9.79E+07	8.64E+06	9.18E+06	1.56E+09	1.56E+09	3.90E+06	6.06E+07	2.24E+09	9.79E+07	3.49E+07	3.15E+06	8.82E+06	6.21E+07	1.10E+08
90-Y	Bq/L	1.21E+07	3.71E+08	8.70E+07	1.29E+08	8.64E+06	9.18E+06	1.51E+09	1.51E+09	3.90E+06	6.07E+07	2.30E+09	1.09E+08	3.49E+07	3.15E+06	8.82E+06	6.21E+07	1.10E+08
93-Zr	Bq/L	2.90E+05	2.23E+05	3.71E+05	2.50E+05	1.35E+05	1.43E+05	2.09E+05	2.08E+05	2.02E+05	8.18E+04	1.78E+05	4.09E+05	3.52E+05	1.76E+05	9.60E+04	2.00E+05	1.71E+05
93m-Nb	Bq/L	2.39E+05	2.02E+05	3.24E+05	2.30E+05	1.25E+05	1.33E+05	1.88E+05	1.88E+05	1.81E+05	8.38E+04	1.66E+05	3.68E+05	3.21E+05	1.60E+05	8.58E+04	1.81E+05	1.55E+05
99-Tc	Bq/L	2.08E+06	4.67E+06	7.91E+06	7.58E+06	4.29E+06	4.35E+06	3.65E+06	3.64E+06	6.18E+06	6.65E+06	3.38E+06	8.26E+06	5.88E+06	3.65E+06	3.69E+06	4.86E+06	4.79E+06

a Includes contribution of isotopes.

Source: TFCOUP, Rev. 5, Appendix D, Tables D-1 and D-2 (Kirkbride, et al. 2003). Chemical concentrations converted from mol/L to mg/L equivalents.

Table 3-6 Chemical and Radionuclide Analyte Composition of the Solid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Solid (kL)		2.58E+01	0.00E+00	0.00E+00	0.00E+00	2.45E+01	0.00E+00	4.73E+00	4.73E+00	0.00E+00	0.00E+00	7.81E+00	0.00E+00	2.00E+01	0.00E+00	0.00E+00	2.38E+01	0.00E+00
Mass of Solid (kg)		7.75E+04	0.00E+00	0.00E+00	0.00E+00	7.34E+04	0.00E+00	1.42E+04	1.42E+04	0.00E+00	0.00E+00	2.34E+04	0.00E+00	6.00E+04	0.00E+00	0.00E+00	7.15E+04	0.00E+00
Wt% solids in feed		1.941 %	0.000 %	0.000 %	0.000 %	1.942 %	0.000 %	0.376 %	0.376 %	0.000 %	0.000 %	0.496 %	0.000 %	0.924 %	0.000 %	0.000 %	1.941 %	0.000 %
Solid Component	**Units**	**Concentration**																
Ag	mg/kg	8.50E+02	No solids	No solids	No solids	1.69E+02	No solids	1.52E+01	1.52E+01	No solids	No solids	4.14E+01	No solids	7.73E-04	No solids	No solids	2.23E+02	No solids
$Al(OH)_4^-$	mg/kg	--	No solids	No solids	No solids	--	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Al	mg/kg	9.39E+04	No solids	No solids	No solids	7.07E+04	No solids	7.31E+04	7.31E+04	No solids	No solids	6.20E+04	No solids	1.61E+05	No solids	No solids	1.31E+05	No solids
As	mg/kg	3.68E+01	No solids	No solids	No solids	4.42E+02	No solids	4.91E+02	4.91E+02	No solids	No solids	1.66E+02	No solids	4.27E-03	No solids	No solids	4.25E+02	No solids
B	mg/kg	6.96E+01	No solids	No solids	No solids	1.55E+03	No solids	3.77E+02	3.76E+02	No solids	No solids	1.32E+02	No solids	3.88E-03	No solids	No solids	1.03E+03	No solids
Ba [a]	mg/kg	9.11E+02	No solids	No solids	No solids	2.20E+02	No solids	2.51E+02	2.51E+02	No solids	No solids	8.19E+01	No solids	2.13E-03	No solids	No solids	1.86E+02	No solids
Be	mg/kg	4.19E+00	No solids	No solids	No solids	2.21E+01	No solids	6.99E+00	6.99E+00	No solids	No solids	3.85E+00	No solids	2.13E-04	No solids	No solids	1.98E+01	No solids
Bi	mg/kg	1.59E+02	No solids	No solids	No solids	3.30E+02	No solids	3.54E+02	3.54E+02	No solids	No solids	3.57E+01	No solids	9.06E+01	No solids	No solids	2.78E+02	No solids
Ca	mg/kg	6.32E+03	No solids	No solids	No solids	2.41E+03	No solids	3.94E+03	3.94E+03	No solids	No solids	1.66E+03	No solids	2.69E+05	No solids	No solids	6.17E+03	No solids
Cd [a]	mg/kg	1.64E+02	No solids	No solids	No solids	1.10E+02	No solids	3.49E+02	3.49E+02	No solids	No solids	1.44E+02	No solids	6.75E-04	No solids	No solids	1.16E+02	No solids
Ce	mg/kg	1.38E+03	No solids	No solids	No solids	4.41E+02	No solids	3.66E+02	3.75E+02	No solids	No solids	2.33E+02	No solids	4.27E-03	No solids	No solids	3.98E+02	No solids
Cl	mg/kg	6.96E+01	No solids	No solids	No solids	1.93E+01	No solids	5.00E+00	5.00E+00	No solids	No solids	1.51E+00	No solids	1.77E+00	No solids	No solids	1.78E+01	No solids
CN	mg/kg	2.32E+01	No solids	No solids	No solids	1.42E+00	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Co [a]	mg/kg	4.95E+01	No solids	No solids	No solids	8.83E+01	No solids	7.90E+01	7.89E+01	No solids	No solids	2.26E+01	No solids	1.57E-03	No solids	No solids	8.16E+01	No solids
CO_3^{-2} [a]	mg/kg	1.02E+05	No solids	No solids	No solids	1.56E+02	No solids	5.61E+05	5.61E+05	No solids	No solids	3.41E+05	No solids	3.90E+01	No solids	No solids	1.83E+02	No solids
$Cr(OH)_4^-$	mg/kg	--	No solids	No solids	No solids	--	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Cr	mg/kg	2.80E+03	No solids	No solids	No solids	1.60E+04	No solids	1.25E+04	1.25E+04	No solids	No solids	2.16E+03	No solids	1.63E+03	No solids	No solids	1.86E+04	No solids
Cs [a]	mg/kg	2.30E+01	No solids	No solids	No solids	1.38E+02	No solids	1.06E+02	1.06E+02	No solids	No solids	4.09E+01	No solids	1.14E+01	No solids	No solids	1.09E+02	No solids
Cu	mg/kg	4.01E+02	No solids	No solids	No solids	8.57E+01	No solids	1.84E+02	1.84E+02	No solids	No solids	1.79E+02	No solids	5.81E-04	No solids	No solids	8.35E+01	No solids
F	mg/kg	7.28E+01	No solids	No solids	No solids	1.80E+02	No solids	1.07E+02	1.07E+02	No solids	No solids	1.70E+01	No solids	2.82E+01	No solids	No solids	8.05E+02	No solids
Fe	mg/kg	1.63E+05	No solids	No solids	No solids	1.30E+03	No solids	1.69E+04	1.69E+04	No solids	No solids	1.88E+04	No solids	1.74E+02	No solids	No solids	1.73E+03	No solids
H^+	mg/kg	--	No solids	No solids	No solids	--	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
H_2O	mg/kg	--	No solids	No solids	No solids	--	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Hg	mg/kg	2.85E+02	No solids	No solids	No solids	3.20E-02	No solids	--	--	No solids	No solids	--	No solids	8.26E-05	No solids	No solids	--	No solids
K	mg/kg	8.78E+02	No solids	No solids	No solids	2.12E+04	No solids	4.23E+03	4.23E+03	No solids	No solids	2.05E+03	No solids	1.25E+03	No solids	No solids	1.78E+04	No solids
La	mg/kg	1.12E+03	No solids	No solids	No solids	2.21E+02	No solids	3.62E+02	3.62E+02	No solids	No solids	1.30E+02	No solids	3.94E+01	No solids	No solids	1.88E+02	No solids

Table 3-6 Chemical and Radionuclide Analyte Composition of the Solid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Solid (kL)		2.58E+01	0.00E+00	0.00E+00	0.00E+00	2.45E+01	0.00E+00	4.73E+00	4.73E+00	0.00E+00	0.00E+00	7.81E+00	0.00E+00	2.00E+01	0.00E+00	0.00E+00	2.38E+01	0.00E+00
Mass of Solid (kg)		7.75E+04	0.00E+00	0.00E+00	0.00E+00	7.34E+04	0.00E+00	1.42E+04	1.42E+04	0.00E+00	0.00E+00	2.34E+04	0.00E+00	6.00E+04	0.00E+00	0.00E+00	7.15E+04	0.00E+00
Wt% solids in feed		1.941 %	0.000 %	0.000 %	0.000 %	1.942 %	0.000 %	0.376 %	0.376 %	0.000 %	0.000 %	0.496 %	0.000 %	0.924 %	0.000 %	0.000 %	1.941 %	0.000 %
Solid Component	**Units**	**Concentration**																
Li	mg/kg	6.40E+01	No solids	No solids	No solids	1.82E+02	No solids	1.52E+02	1.52E+02	No solids	No solids	2.03E+02	No solids	1.71E-03	No solids	No solids	1.60E+02	No solids
Mg	mg/kg	1.45E+03	No solids	No solids	No solids	4.42E+02	No solids	4.90E+02	4.90E+02	No solids	No solids	7.16E+01	No solids	4.27E-03	No solids	No solids	4.90E+02	No solids
Mn	mg/kg	2.64E+04	No solids	No solids	No solids	1.85E+02	No solids	3.78E+03	3.78E+03	No solids	No solids	1.59E+03	No solids	4.95E+01	No solids	No solids	7.19E+02	No solids
Mo	mg/kg	1.73E+01	No solids	No solids	No solids	5.59E+02	No solids	3.04E+02	3.04E+02	No solids	No solids	9.01E+01	No solids	2.35E-03	No solids	No solids	5.36E+02	No solids
Na	mg/kg	1.27E+05	No solids	No solids	No solids	6.22E+05	No solids	1.34E+05	1.34E+05	No solids	No solids	3.56E+05	No solids	1.30E+04	No solids	No solids	4.13E+05	No solids
Nd	mg/kg	1.83E+03	No solids	No solids	No solids	4.42E+02	No solids	7.12E+02	7.12E+02	No solids	No solids	4.06E+02	No solids	4.27E-03	No solids	No solids	3.75E+02	No solids
NH3	mg/kg	--	No solids	No solids	No solids	1.39E+00	No solids	4.04E+02	4.03E+02	No solids	No solids	1.41E+02	No solids	6.40E-04	No solids	No solids	--	No solids
Ni [a]	mg/kg	4.42E+03	No solids	No solids	No solids	6.72E+02	No solids	2.07E+03	2.06E+03	No solids	No solids	5.39E+02	No solids	1.44E+02	No solids	No solids	3.88E+02	No solids
NO_2	mg/kg	7.01E+01	No solids	No solids	No solids	2.98E+03	No solids	3.80E+03	3.80E+03	No solids	No solids	6.72E+02	No solids	3.61E+02	No solids	No solids	2.53E+03	No solids
NO_3	mg/kg	4.80E+00	No solids	No solids	No solids	2.09E+03	No solids	3.37E+03	3.37E+03	No solids	No solids	7.07E+02	No solids	3.01E+02	No solids	No solids	2.18E+03	No solids
OH(BOUND)	mg/kg	4.10E+05	No solids	No solids	No solids	1.94E+05	No solids	--	--	No solids	No solids	1.10E+05	No solids	4.87E+05	No solids	No solids	3.25E+05	No solids
OH^-	mg/kg	--	No solids	No solids	No solids	--	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Pb	mg/kg	7.71E+03	No solids	No solids	No solids	3.67E+02	No solids	1.81E+03	1.81E+03	No solids	No solids	9.02E+02	No solids	7.95E+01	No solids	No solids	7.99E+02	No solids
Pd	mg/kg	1.65E+01	No solids	No solids	No solids	--	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
PO_4	mg/kg	1.33E+04	No solids	No solids	No solids	5.11E+03	No solids	1.06E+04	1.06E+04	No solids	No solids	1.92E+03	No solids	5.95E+04	No solids	No solids	1.46E+04	No solids
Pr	mg/kg	5.09E+02	No solids	No solids	No solids	4.76E-02	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Pu [a]	mg/kg	5.23E+01	No solids	No solids	No solids	5.65E-01	No solids	6.84E+00	6.84E+00	No solids	No solids	3.65E+00	No solids	4.21E+00	No solids	No solids	1.74E+00	No solids
Rb	mg/kg	--	No solids	No solids	No solids	1.93E-04	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Rh	mg/kg	3.72E+01	No solids	No solids	No solids	1.32E-02	No solids	--	--	No solids	No solids	1.32E+02	No solids	--	No solids	No solids	--	No solids
Ru [a]	mg/kg	7.61E+02	No solids	No solids	No solids	2.19E-01	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Sb [a]	mg/kg	4.72E+00	No solids	No solids	No solids	2.65E+02	No solids	2.83E+02	2.92E+02	No solids	No solids	9.88E+01	No solids	2.56E-03	No solids	No solids	2.55E+02	No solids
Se [a]	mg/kg	2.58E+00	No solids	No solids	No solids	4.41E+02	No solids	4.90E+02	4.90E+02	No solids	No solids	1.11E+02	No solids	4.33E-03	No solids	No solids	4.08E+02	No solids
Si	mg/kg	1.55E+04	No solids	No solids	No solids	5.53E+03	No solids	1.22E+03	1.22E+03	No solids	No solids	3.74E+02	No solids	1.60E+02	No solids	No solids	1.37E+03	No solids
SO_4	mg/kg	1.67E+03	No solids	No solids	No solids	9.60E+03	No solids	6.06E+03	6.06E+03	No solids	No solids	7.34E+02	No solids	4.12E+02	No solids	No solids	1.38E+04	No solids
Sr [a]	mg/kg	3.09E+02	No solids	No solids	No solids	4.41E+01	No solids	3.07E+01	3.07E+01	No solids	No solids	2.19E+01	No solids	1.18E+01	No solids	No solids	3.25E+01	No solids

Table 3-6 Chemical and Radionuclide Analyte Composition of the Solid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Solid (kL)		2.58E+01	0.00E+00	0.00E+00	0.00E+00	2.45E+01	0.00E+00	4.73E+00	4.73E+00	0.00E+00	0.00E+00	7.81E+00	0.00E+00	2.00E+01	0.00E+00	0.00E+00	2.38E+01	0.00E+00
Mass of Solid (kg)		7.75E+04	0.00E+00	0.00E+00	0.00E+00	7.34E+04	0.00E+00	1.42E+04	1.42E+04	0.00E+00	0.00E+00	2.34E+04	0.00E+00	6.00E+04	0.00E+00	0.00E+00	7.15E+04	0.00E+00
Wt% solids in feed		1.941 %	0.000 %	0.000 %	0.000 %	1.942 %	0.000 %	0.376 %	0.376 %	0.000 %	0.000 %	0.496 %	0.000 %	0.924 %	0.000 %	0.000 %	1.941 %	0.000 %
Solid Component	**Units**	**Concentration**																
Ta	mg/kg	4.67E+00	No solids	No solids	No solids	1.94E-04	No solids	--	--	No solids	No solids	9.14E-01	No solids	--	No solids	No solids	--	No solids
Tc [a]	mg/kg	2.56E+00	No solids	No solids	No solids	--	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Te	mg/kg	1.61E+02	No solids	No solids	No solids	4.71E-02	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Th [a]	mg/kg	1.16E+03	No solids	No solids	No solids	4.10E-02	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Ti	mg/kg	2.41E+02	No solids	No solids	No solids	4.44E+01	No solids	4.73E+01	4.73E+01	No solids	No solids	2.04E+01	No solids	4.27E-04	No solids	No solids	4.29E+01	No solids
Tl	mg/kg	5.28E+00	No solids	No solids	No solids	8.79E+02	No solids	9.66E+02	9.65E+02	No solids	No solids	2.18E+02	No solids	--	No solids	No solids	8.20E+02	No solids
TOC	mg/kg	9.60E+03	No solids	No solids	No solids	3.33E+04	No solids	1.39E+05	1.39E+05	No solids	No solids	9.04E+04	No solids	4.69E+03	No solids	No solids	3.69E+04	No solids
U [a]	mg/kg	2.73E+03	No solids	No solids	No solids	1.82E+03	No solids	9.72E+03	9.72E+03	No solids	No solids	3.34E+03	No solids	4.40E+02	No solids	No solids	2.98E+03	No solids
V	mg/kg	1.58E+01	No solids	No solids	No solids	2.21E+02	No solids	7.90E+01	7.90E+01	No solids	No solids	2.17E+01	No solids	2.13E-03	No solids	No solids	1.88E+02	No solids
W	mg/kg	--	No solids	No solids	No solids	1.54E-01	No solids	--	--	No solids	No solids	--	No solids	--	No solids	No solids	--	No solids
Y [a]	mg/kg	2.09E+02	No solids	No solids	No solids	2.17E-02	No solids	1.02E+02	1.01E+02	No solids	No solids	1.08E+02	No solids	--	No solids	No solids	--	No solids
Zn	mg/kg	2.70E+02	No solids	No solids	No solids	2.34E+02	No solids	1.71E+02	1.71E+02	No solids	No solids	3.07E+02	No solids	1.06E-03	No solids	No solids	4.49E+02	No solids
Zr [a]	mg/kg	3.57E+02	No solids	No solids	No solids	1.32E+02	No solids	3.26E+03	3.26E+03	No solids	No solids	4.13E+02	No solids	4.26E+01	No solids	No solids	1.72E+02	No solids
106-Ru	Bq/g solid	1.28E-03	No solids	No solids	No solids	1.03E-05	No solids	5.08E-06	5.08E-06	No solids	No solids	2.03E-06	No solids	2.88E-07	No solids	No solids	1.37E-06	No solids
113m-Cd	Bq/g solid	1.97E+03	No solids	No solids	No solids	9.73E+03	No solids	7.60E+03	7.60E+03	No solids	No solids	1.61E+03	No solids	9.29E+02	No solids	No solids	7.42E+03	No solids
125-Sb	Bq/g solid	2.43E+01	No solids	No solids	No solids	4.71E+02	No solids	3.52E+02	3.52E+02	No solids	No solids	1.50E+02	No solids	4.35E+01	No solids	No solids	2.22E+02	No solids
126-Sn	Bq/g solid	6.83E+02	No solids	No solids	No solids	4.61E+02	No solids	4.42E+02	4.42E+02	No solids	No solids	1.40E+02	No solids	5.63E+01	No solids	No solids	4.71E+02	No solids
129-I	Bq/g solid	2.39E+00	No solids	No solids	No solids	1.15E+01	No solids	1.25E+01	1.25E+01	No solids	No solids	5.31E+00	No solids	3.34E+00	No solids	No solids	1.07E+01	No solids
134-Cs	Bq/g solid	2.17E-01	No solids	No solids	No solids	4.44E-01	No solids	1.48E-01	1.48E-01	No solids	No solids	1.35E-01	No solids	3.32E-02	No solids	No solids	6.73E-02	No solids
137-Cs	Bq/g solid	1.70E+07	No solids	No solids	No solids	4.79E+07	No solids	1.67E+07	1.67E+07	No solids	No solids	1.32E+07	No solids	1.36E+06	No solids	No solids	1.23E+07	No solids
137m-Ba	Bq/g solid	1.38E+07	No solids	No solids	No solids	4.36E+07	No solids	1.58E+07	1.58E+07	No solids	No solids	1.25E+07	No solids	1.29E+06	No solids	No solids	1.37E+07	No solids
14-C	Bq/g solid	8.70E+00	No solids	No solids	No solids	8.53E+00	No solids	5.72E-01	5.73E-01	No solids	No solids	3.48E+00	No solids	7.32E-01	No solids	No solids	7.57E+00	No solids
151-Sm	Bq/g solid	5.67E+06	No solids	No solids	No solids	1.99E+06	No solids	2.50E+06	2.50E+06	No solids	No solids	1.06E+06	No solids	3.01E+05	No solids	No solids	2.05E+06	No solids
152-Eu	Bq/g solid	2.52E+03	No solids	No solids	No solids	4.90E+02	No solids	4.45E+02	4.45E+02	No solids	No solids	1.90E+02	No solids	4.85E+01	No solids	No solids	4.22E+02	No solids
154-Eu	Bq/g solid	2.07E+05	No solids	No solids	No solids	1.17E+04	No solids	6.39E+04	6.39E+04	No solids	No solids	1.07E+05	No solids	3.37E+03	No solids	No solids	8.67E+03	No solids
155-Eu	Bq/g solid	8.46E+04	No solids	No solids	No solids	5.42E+03	No solids	1.56E+04	1.56E+04	No solids	No solids	3.35E+04	No solids	4.03E+02	No solids	No solids	4.25E+03	No solids

Table 3-6 Chemical and Radionuclide Analyte Composition of the Solid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Solid (kL)		2.58E+01	0.00E+00	0.00E+00	0.00E+00	2.45E+01	0.00E+00	4.73E+00	4.73E+00	0.00E+00	0.00E+00	7.81E+00	0.00E+00	2.00E+01	0.00E+00	0.00E+00	2.38E+01	0.00E+00
Mass of Solid (kg)		7.75E+04	0.00E+00	0.00E+00	0.00E+00	7.34E+04	0.00E+00	1.42E+04	1.42E+04	0.00E+00	0.00E+00	2.34E+04	0.00E+00	6.00E+04	0.00E+00	0.00E+00	7.15E+04	0.00E+00
Wt% solids in feed		1.941 %	0.000 %	0.000 %	0.000 %	1.942 %	0.000 %	0.376 %	0.376 %	0.000 %	0.000 %	0.496 %	0.000 %	0.924 %	0.000 %	0.000 %	1.941 %	0.000 %
Solid Component	**Units**	**Concentration**																
226-Ra	Bq/g solid	3.41E-01	No solids	No solids	No solids	3.31E-02	No solids	2.74E-02	2.74E-02	No solids	No solids	8.89E-03	No solids	3.53E-03	No solids	No solids	2.94E-02	No solids
227-Ac	Bq/g solid	1.37E+00	No solids	No solids	No solids	4.50E-01	No solids	4.37E-01	4.38E-01	No solids	No solids	2.14E-01	No solids	5.32E-02	No solids	No solids	4.74E-01	No solids
228-Ra	Bq/g solid	3.03E+00	No solids	No solids	No solids	1.66E+01	No solids	1.32E+01	1.32E+01	No solids	No solids	5.38E+00	No solids	1.81E+00	No solids	No solids	1.37E+01	No solids
229-Th	Bq/g solid	1.09E-02	No solids	No solids	No solids	1.57E+00	No solids	1.67E+00	1.67E+00	No solids	No solids	7.11E-01	No solids	1.69E-01	No solids	No solids	1.68E+00	No solids
231-Pa	Bq/g solid	1.46E+00	No solids	No solids	No solids	6.86E-01	No solids	6.55E-01	6.55E-01	No solids	No solids	3.67E-01	No solids	8.36E-02	No solids	No solids	6.92E-01	No solids
232-Th	Bq/g solid	4.71E+00	No solids	No solids	No solids	8.26E+00	No solids	7.40E+00	7.39E+00	No solids	No solids	3.75E+00	No solids	8.19E-01	No solids	No solids	8.87E+00	No solids
232-U	Bq/g solid	2.94E-01	No solids	No solids	No solids	2.05E+01	No solids	1.43E+02	1.43E+02	No solids	No solids	8.12E+01	No solids	4.39E+00	No solids	No solids	2.40E+01	No solids
233-U	Bq/g solid	1.30E+00	No solids	No solids	No solids	9.36E+01	No solids	6.57E+02	6.57E+02	No solids	No solids	3.75E+02	No solids	2.05E+01	No solids	No solids	1.13E+02	No solids
234-U	Bq/g solid	3.64E+01	No solids	No solids	No solids	2.79E+01	No solids	1.36E+02	1.36E+02	No solids	No solids	4.80E+01	No solids	6.03E+00	No solids	No solids	4.80E+01	No solids
235-U	Bq/g solid	1.47E+00	No solids	No solids	No solids	1.04E+00	No solids	5.37E+00	5.37E+00	No solids	No solids	1.62E+00	No solids	2.47E-01	No solids	No solids	1.86E+00	No solids
236-U	Bq/g solid	1.39E+00	No solids	No solids	No solids	1.49E+00	No solids	4.83E+00	4.83E+00	No solids	No solids	1.70E+00	No solids	2.09E-01	No solids	No solids	4.75E+00	No solids
237-Np	Bq/g solid	2.39E+02	No solids	No solids	No solids	6.82E+01	No solids	7.22E+01	7.22E+01	No solids	No solids	1.69E+01	No solids	2.64E+01	No solids	No solids	7.32E+01	No solids
238-Pu	Bq/g solid	2.53E+04	No solids	No solids	No solids	4.90E+01	No solids	4.18E+02	4.18E+02	No solids	No solids	2.20E+02	No solids	3.34E+02	No solids	No solids	4.36E+02	No solids
238-U	Bq/g solid	3.37E+01	No solids	No solids	No solids	2.24E+01	No solids	1.20E+02	1.20E+02	No solids	No solids	4.13E+01	No solids	5.43E+00	No solids	No solids	3.67E+01	No solids
239-Pu	Bq/g solid	1.13E+05	No solids	No solids	No solids	1.23E+03	No solids	1.50E+04	1.50E+04	No solids	No solids	8.00E+03	No solids	9.15E+03	No solids	No solids	3.72E+03	No solids
240-Pu	Bq/g solid	2.38E+04	No solids	No solids	No solids	2.41E+02	No solids	2.64E+03	2.64E+03	No solids	No solids	1.41E+03	No solids	1.85E+03	No solids	No solids	9.72E+02	No solids
241-Am	Bq/g solid	3.34E+05	No solids	No solids	No solids	7.01E+03	No solids	2.06E+05	2.06E+05	No solids	No solids	1.33E+05	No solids	2.00E+03	No solids	No solids	5.79E+03	No solids
241-Pu	Bq/g solid	2.10E+05	No solids	No solids	No solids	1.98E+03	No solids	1.39E+04	1.39E+04	No solids	No solids	7.32E+03	No solids	1.02E+04	No solids	No solids	1.22E+04	No solids
242-Cm	Bq/g solid	7.65E+02	No solids	No solids	No solids	5.22E+00	No solids	4.71E+02	4.71E+02	No solids	No solids	3.32E+02	No solids	1.46E-01	No solids	No solids	6.30E+00	No solids
242-Pu	Bq/g solid	2.80E+00	No solids	No solids	No solids	2.17E-02	No solids	1.86E-01	1.86E-01	No solids	No solids	9.75E-02	No solids	1.67E-01	No solids	No solids	1.31E-01	No solids
243-Am	Bq/g solid	1.70E+01	No solids	No solids	No solids	3.91E-01	No solids	8.40E+00	8.40E+00	No solids	No solids	5.55E+00	No solids	7.41E-02	No solids	No solids	3.23E-01	No solids
243-Cm	Bq/g solid	3.79E+01	No solids	No solids	No solids	3.61E-01	No solids	3.12E+01	3.12E+01	No solids	No solids	2.20E+01	No solids	9.37E-03	No solids	No solids	1.13E+00	No solids
244-Cm	Bq/g solid	6.38E+02	No solids	No solids	No solids	2.87E+00	No solids	2.07E+02	2.07E+02	No solids	No solids	1.29E+02	No solids	7.25E-02	No solids	No solids	1.83E+01	No solids
3-H	Bq/g solid	7.09E+01	No solids	No solids	No solids	0.00E+00	No solids	0.00E+00	0.00E+00	No solids	No solids	0.00E+00	No solids	2.53E-02	No solids	No solids	0.00E+00	No solids
59-Ni	Bq/g solid	6.71E+03	No solids	No solids	No solids	5.52E+02	No solids	4.63E+02	4.63E+02	No solids	No solids	9.44E+01	No solids	4.74E+01	No solids	No solids	4.96E+02	No solids
60-Co	Bq/g solid	6.22E+01	No solids	No solids	No solids	1.49E+03	No solids	5.73E+03	5.73E+03	No solids	No solids	9.42E+02	No solids	8.58E+01	No solids	No solids	9.46E+02	No solids
63-Ni	Bq/g solid	6.54E+05	No solids	No solids	No solids	4.86E+04	No solids	4.04E+04	4.03E+04	No solids	No solids	8.24E+03	No solids	4.08E+03	No solids	No solids	4.27E+04	No solids

Table 3-6 Chemical and Radionuclide Analyte Composition of the Solid Portion of Delivered LAW Feed

Source Tank		AY-102	AP-101	AP-103	AP-105	AN-104		AN-102	AN-102	AN-105		AN-107	SY-101		AN-103		AW-101	
Batch Name		**LAW-1**	**LAW-2**	**LAW-3**	**LAW-4**	**LAW-5**	**LAW-6**	**LAW-7**	**LAW-8**	**LAW-9**	**LAW-10**	**LAW-11**	**LAW-12**	**LAW-13**	**LAW-14**	**LAW-15**	**LAW-16**	**LAW-17**
Volume of Solid (kL)		2.58E+01	0.00E+00	0.00E+00	0.00E+00	2.45E+01	0.00E+00	4.73E+00	4.73E+00	0.00E+00	0.00E+00	7.81E+00	0.00E+00	2.00E+01	0.00E+00	0.00E+00	2.38E+01	0.00E+00
Mass of Solid (kg)		7.75E+04	0.00E+00	0.00E+00	0.00E+00	7.34E+04	0.00E+00	1.42E+04	1.42E+04	0.00E+00	0.00E+00	2.34E+04	0.00E+00	6.00E+04	0.00E+00	0.00E+00	7.15E+04	0.00E+00
Wt% solids in feed		1.941 %	0.000 %	0.000 %	0.000 %	1.942 %	0.000 %	0.376 %	0.376 %	0.000 %	0.000 %	0.496 %	0.000 %	0.924 %	0.000 %	0.000 %	1.941 %	0.000 %
Solid Component	**Units**	**Concentration**																
79-Se	Bq/g solid	1.40E+02	No solids	No solids	No solids	6.03E+00	No solids	1.09E+01	1.09E+01	No solids	No solids	4.88E+00	No solids	6.00E-01	No solids	No solids	1.54E+01	No solids
90-Sr	Bq/g solid	3.46E+08	No solids	No solids	No solids	1.22E+07	No solids	3.05E+07	3.04E+07	No solids	No solids	1.65E+07	No solids	3.80E+05	No solids	No solids	3.43E+06	No solids
90-Y	Bq/g solid	3.47E+08	No solids	No solids	No solids	9.85E+06	No solids	3.05E+07	3.05E+07	No solids	No solids	1.65E+07	No solids	3.80E+05	No solids	No solids	3.43E+06	No solids
93-Zr	Bq/g solid	6.03E+03	No solids	No solids	No solids	3.77E+03	No solids	3.66E+03	3.66E+03	No solids	No solids	1.48E+03	No solids	4.33E+02	No solids	No solids	3.75E+03	No solids
93m-Nb	Bq/g solid	4.38E+03	No solids	No solids	No solids	3.23E+03	No solids	3.13E+03	3.13E+03	No solids	No solids	1.36E+03	No solids	3.80E+02	No solids	No solids	3.30E+03	No solids
99-Tc	Bq/g solid	1.60E+03	No solids	No solids	No solids	1.78E+04	No solids	4.38E+03	4.38E+03	No solids	No solids	1.87E+03	No solids	8.58E+02	No solids	No solids	7.81E+03	No solids

a Includes contribution of isotopes.

"--" indicates no data.

Source: TFCOUP, Rev. 5, Appendix D, Tables D-3 and D-4 (Kirkbride, et al. 2003). Chemical concentrations converted from g/g solid to mg/kg equivalents.

Table 3-7 Chemical and Radionuclide Composition in HLW Feed Liquids

HLW Batch Group		1	2	3	4
Source tanks		AP-101/AY-102	AZ-101	AZ-102	C Farm Solids
Staging tank		AY-102	AZ-101	AZ-102	AY-101
Analyte	**Units**	**Concentration**			
Ag	mg/L	0.164	0.562	4.209	0.440
$Al(OH)_4^-$	mg/L	3.51	15.32	19.99	15.86
Al	mg/L	1633	5552	10112	5147
As	mg/L	0.444	8.77	7.66	1.25
B	mg/L	3.79	16.6	15.8	3.25
Ba [a]	mg/L	0.0963	0.0695	2.08	0.576
Be	mg/L	0.297	0.261	0.243	0.0649
Bi	mg/L	0.606	0.000	9.59	5.63
Ca	mg/L	1.92	6.50	57.8	10.9
Cd [a]	mg/L	0.458	0.708	1.49	3.16
Ce	mg/L	0.0542	0.0524	4.48	1.47
Cl	mg/L	454	222	2789	1330
CN	mg/L	1.79	1.81	6.89	0.130
Co [a]	mg/L	0.117	0.0524	1.09	0.304
CO_3^{-2} [a]	mg/L	9004	45322	57507	20063
$Cr(OH)_4^-$	mg/L	0.0806	0.0354	0.2385	0.1458
Cr	mg/L	37.4	629	1468	742
Cs [a]	mg/L	1.50	47.7	32.4	2.56
Cu	mg/L	0.386	0.562	1.98	0.600
F	mg/L	641	1844	1696	3477
Fe	mg/L	0.629	1.38	19.0	3.50
H^+	mg/L	0.000	0.000	8.08	0.065
H_2O	mg/L	975494	928527	817169	918285
Hg	mg/L	0.010	0.049	1.75	0.294
K	mg/L	6923	4029	3733	415
La	mg/L	0.293	0.000	0.673	0.319
Li	mg/L	0.0824	0.798	0.663	0.171
Mg	mg/L	0.745	2.31	17.2	1.78
Mn	mg/L	0.301	0.000	3.67	0.820

Table 3-7 Chemical and Radionuclide Composition in HLW Feed Liquids

HLW Batch Group		1	2	3	4
Source tanks		AP-101/AY-102	AZ-101	AZ-102	C Farm Solids
Staging tank		AY-102	AZ-101	AZ-102	AY-101
Analyte	**Units**	**Concentration**			
Mo	mg/L	3.44	78.7	72.1	27.6
Na	mg/L	31510	101979	196689	88291
Nd	mg/L	0.646	2.31	16.7	1.64
NH3	mg/L	0.505	259	139.112	3.51
Ni [a]	mg/L	1.82	0.911	8.10	10.4
NO_2	mg/L	10652	56236	65156	17923
NO_3	mg/L	29940	48438	186566	111581
OH(BOUND)	mg/L	1321	9919	30853	15637
OH^-	mg/L	9468	10453	12135	9029
Pb	mg/L	3.38	2.95	10.3	15.8
Pd	mg/L	0.022	17.7	2.71	0.0523
PO_4	mg/L	345	1419	11458	6205
Pr	mg/L	0.005	0.0524	0.0218	0.000
Pu [a]	mg/L	1.52E-03	2.28E-02	1.39E-01	1.69E-02
Rb	mg/L	0.874	8.17	3.07	0.0739
Rh	mg/L	0.0943	1.86	4.88	0.117
Ru [a]	mg/L	1.28	0.396	3.05	0.052
Sb [a]	mg/L	0.0229	0.0510	2.73	1.73
Se [a]	mg/L	0.757	5.73	29.9	18.9
Si	mg/L	34.6	62.9	357	172
SO_4	mg/L	1015	14873	25327	4934
Sr [a]	mg/L	0.0934	0.0201	3.48	3.51
Ta	mg/L	0.0242	0.0524	0.0221	0.000
Tc [a]	mg/L	0.649	17.2	15.3	2.62
Te	mg/L	0.0366	0.0524	0.039	0.001
Th [a]	mg/L	32.0	0.0497	9.29	10.3
Ti	mg/L	0.147	0.562	1.71	0.177
Tl	mg/L	0.0489	0.052	3.25	1.29
TOC	mg/L	477	467	2337	993

Table 3-7 Chemical and Radionuclide Composition in HLW Feed Liquids

HLW Batch Group		1	2	3	4
Source tanks		AP-101/AY-102	AZ-101	AZ-102	C Farm Solids
Staging tank		AY-102	AZ-101	AZ-102	AY-101
Analyte	**Units**	**Concentration**			
U [a]	mg/L	15.9	2.59	80.8	16.0
V	mg/L	0.199	1.33	3.09	0.607
W	mg/L	6.33	51.4	5.08	0.0974
Y [a]	mg/L	0.00522	1.14	0.160	0.100
Zn	mg/L	1.25	1.15	1.99	0.252
Zr [a]	mg/L	0.611	8.01	7.23	2.27
106-Ru	Ci/L	1.69E-14	7.47E-14	2.16E-13	2.13E-13
113m-Cd	Ci/L	3.76E-06	5.30E-05	1.55E-05	1.59E-06
125-Sb	Ci/L	1.12E-06	8.36E-05	6.62E-05	1.25E-06
126-Sn	Ci/L	2.15E-07	2.15E-06	6.77E-07	8.84E-08
129-I	Ci/L	1.94E-08	8.49E-09	2.04E-07	1.10E-07
134-Cs	Ci/L	3.93E-07	1.23E-04	2.02E-05	3.12E-07
137-Cs	Ci/L	2.63E-02	1.21E+00	8.33E-01	4.80E-02
137m-Ba	Ci/L	2.54E-02	1.15E+00	7.99E-01	4.60E-02
14-C	Ci/L	1.05E-07	1.76E-06	1.15E-05	7.74E-06
151-Sm	Ci/L	9.88E-04	1.26E-02	3.42E-03	3.19E-04
152-Eu	Ci/L	2.85E-07	4.21E-05	8.31E-06	2.19E-07
154-Eu	Ci/L	5.06E-07	2.34E-05	3.09E-05	2.52E-06
155-Eu	Ci/L	1.30E-07	1.54E-05	2.62E-05	9.44E-07
226-Ra	Ci/L	1.94E-08	1.27E-10	8.48E-09	8.06E-11
227-Ac	Ci/L	1.49E-10	1.70E-09	7.22E-10	9.24E-10
228-Ra	Ci/L	1.01E-08	4.83E-14	3.32E-09	1.38E-09
229-Th	Ci/L	5.78E-10	1.07E-12	2.83E-10	2.00E-10
231-Pa	Ci/L	3.45E-10	3.40E-09	1.54E-09	3.60E-09
232-Th	Ci/L	3.52E-09	4.76E-14	1.02E-09	1.13E-09
232-U	Ci/L	3.52E-09	3.96E-11	3.30E-09	3.57E-09
233-U	Ci/L	1.37E-08	1.79E-10	1.18E-08	4.87E-08
234-U	Ci/L	5.29E-09	1.25E-09	2.36E-08	7.27E-09
235-U	Ci/L	2.43E-10	4.74E-11	1.22E-09	2.58E-10

Table 3-7 Chemical and Radionuclide Composition in HLW Feed Liquids

HLW Batch Group		1	2	3	4
Source tanks		AP-101/AY-102	AZ-101	AZ-102	C Farm Solids
Staging tank		AY-102	AZ-101	AZ-102	AY-101
Analyte	**Units**	**Concentration**			
236-U	Ci/L	2.52E-10	1.01E-10	9.76E-10	2.07E-10
237-Np	Ci/L	1.89E-08	3.54E-08	2.45E-07	5.96E-08
238-Pu	Ci/L	1.23E-08	1.36E-07	7.30E-07	7.22E-08
238-U	Ci/L	5.29E-09	8.62E-10	2.69E-08	5.33E-09
239-Pu	Ci/L	8.77E-08	1.27E-06	7.80E-06	9.57E-07
240-Pu	Ci/L	1.76E-08	3.84E-07	2.19E-06	2.34E-07
241-Am	Ci/L	5.02E-08	2.31E-07	1.22E-05	1.45E-06
241-Pu	Ci/L	1.48E-07	6.87E-06	3.60E-05	4.13E-06
242-Cm	Ci/L	2.40E-11	8.62E-11	3.21E-08	8.96E-09
242-Pu	Ci/L	2.28E-12	5.94E-11	3.85E-10	1.21E-10
243-Am	Ci/L	2.51E-12	2.05E-11	8.15E-11	6.60E-11
243-Cm	Ci/L	8.68E-12	1.01E-09	3.33E-09	6.32E-10
244-Cm	Ci/L	1.56E-10	2.09E-08	6.66E-09	1.45E-08
3-H	Ci/L	9.50E-07	9.67E-06	5.40E-05	1.81E-05
59-Ni	Ci/L	7.18E-08	2.01E-12	1.45E-07	5.60E-08
60-Co	Ci/L	2.51E-07	4.27E-06	4.45E-06	4.52E-07
63-Ni	Ci/L	6.33E-06	1.75E-10	1.26E-05	4.83E-06
79-Se	Ci/L	1.59E-08	8.91E-07	6.93E-07	6.63E-07
90-Sr	Ci/L	6.36E-05	6.70E-04	6.73E-03	1.21E-02
90-Y	Ci/L	6.51E-05	6.76E-04	6.84E-03	1.23E-02
93-Zr	Ci/L	1.56E-06	2.05E-05	6.79E-06	1.39E-06
93m-Nb	Ci/L	1.31E-06	1.83E-05	5.99E-06	1.12E-06
99-Tc	Ci/L	1.12E-05	2.98E-04	2.64E-04	4.54E-05

a Includes contribution of isotopes.

Values taken from source document as reported.

Source: TFCOUP, Rev. 5, Appendix C, Tables C-2 and C3 (Kirkbride, et al. 2003). Chemical concentrations converted from mol/L to mg/L equivalents.

Table 3-8 Chemical and Radionuclide Composition in HLW Feed Solids

HLW Batch Group		1	2	3	4
Source tanks		AP-101/AY-102	AZ-101	AZ-102	C Farm Solids
Staging tank		AY-102	AZ-101	AZ-102	AY-101
Analyte	**Units**	**Concentration**			
Ag	mg/kg	850	81	1455	1206
$Al(OH)_4^-$	mg/kg	0.00	0.00	0.00	0.00
Al	mg/kg	93870	192561	121317	119910
As	mg/kg	37	87	53	73
B	mg/kg	70	45	933	1751
Ba [a]	mg/kg	911	706	622	405
Be	mg/kg	4.2	13	12	40
Bi	mg/kg	159	0.27	131	194
Ca	mg/kg	6318	3473	4325	4344
Cd [a]	mg/kg	164	6747	16657	1036
Ce	mg/kg	1382	543	867	388
Cl	mg/kg	69	79	423	56
CN	mg/kg	23	7.3	35	20
Co [a]	mg/kg	49	45	70	27
CO_3^{-2} [a]	mg/kg	101549	36936	48170	95826
$Cr(OH)_4^-$	mg/kg	0.00	0.00	0.00	0.00
Cr	mg/kg	2800	830	2196	6941
Cs [a]	mg/kg	23	34	83	5.5
Cu	mg/kg	402	344	234	253
F	mg/kg	73	4929	784	917
Fe	mg/kg	163370	96512	142764	65076
H^+	mg/kg	0.00	0.00	0.00	0.00
H_2O	mg/kg	0.00	0.00	0.00	0.00
Hg	mg/kg	285	5.0	20	79
K	mg/kg	878	1300	5281	1200
La	mg/kg	1120	2586	4886	1078
Li	mg/kg	64	102	10	11
Mg	mg/kg	1454	637	1095	615
Mn	mg/kg	26418	2177	3133	8618

Table 3-8 Chemical and Radionuclide Composition in HLW Feed Solids

HLW Batch Group		1	2	3	4
Source tanks		AP-101/AY-102	AZ-101	AZ-102	C Farm Solids
Staging tank		AY-102	AZ-101	AZ-102	AY-101
Analyte	**Units**	**Concentration**			
Mo	mg/kg	18	102	124	41
Na	mg/kg	126719	48360	81806	118572
Nd	mg/kg	1828	1824	3014	825
NH3	mg/kg	0.00	0.00	0.00	252
Ni [a]	mg/kg	4418	3997	9014	4064
NO_2	mg/kg	70	13060	33671	6846
NO_3	mg/kg	4.9	8232	6359	2431
OH(BOUND)	mg/kg	410013	494080	428417	367668
OH^-	mg/kg	0.00	1554	0.00	0.00
Pb	mg/kg	7713	717	1679	1676
Pd	mg/kg	16	714	102	0
PO_4	mg/kg	13258	7157	4019	4062
Pr	mg/kg	509	379	570	67
Pu [a]	mg/kg	51	47	166	101
Rb	mg/kg	0.00	20	8.6	257
Rh	mg/kg	38	233	61	148
Ru [a]	mg/kg	761	904	271	0.22
Sb [a]	mg/kg	5.1	11	61	15
Se [a]	mg/kg	2.8	36	17	2.6
Si	mg/kg	15502	5430	15207	11195
SO_4	mg/kg	1663	26646	8837	4899
Sr [a]	mg/kg	307	466	268	130
Ta	mg/kg	3.6	5.3	4.0	1.7
Tc [a]	mg/kg	2.2	6.1	28	1.8
Te	mg/kg	161	117	95	0.06
Th [a]	mg/kg	1171	327	416	49232
Ti	mg/kg	241	93	65	134
Tl	mg/kg	5.2	11	4.0	94
TOC	mg/kg	9593	959	4585	17139

Table 3-8 Chemical and Radionuclide Composition in HLW Feed Solids

HLW Batch Group		1	2	3	4
Source tanks		AP-101/AY-102	AZ-101	AZ-102	C Farm Solids
Staging tank		AY-102	AZ-101	AZ-102	AY-101
Analyte	**Units**	**Concentration**			
U [a]	mg/kg	2731	5314	21596	35604
V	mg/kg	16	27	51	44
W	mg/kg	0.00	18	30	920
Y [a]	mg/kg	209	164	210	110
Zn	mg/kg	271	115	151	637
Zr [a]	mg/kg	357	28093	23538	62759
106-Ru	Ci/g solid	1.59E-14	1.66E-09	2.79E-09	9.11E-13
113m-Cd	Ci/g solid	5.01E-08	7.15E-06	3.00E-06	1.15E-06
125-Sb	Ci/g solid	4.86E-10	7.70E-07	1.96E-06	1.51E-08
126-Sn	Ci/g solid	2.45E-08	1.15E-07	7.72E-08	4.21E-08
129-I	Ci/g solid	6.00E-11	1.78E-09	8.45E-09	5.15E-10
134-Cs	Ci/g solid	3.96E-12	1.55E-08	3.57E-08	1.79E-11
137-Cs	Ci/g solid	3.83E-04	3.06E-04	1.09E-03	8.87E-05
137m-Ba	Ci/g solid	3.70E-04	2.92E-04	1.05E-03	8.50E-05
14-C	Ci/g solid	2.37E-10	8.28E-10	1.18E-09	1.40E-09
151-Sm	Ci/g solid	1.31E-04	9.04E-04	3.82E-04	2.41E-04
152-Eu	Ci/g solid	6.42E-08	4.74E-07	1.82E-07	1.54E-07
154-Eu	Ci/g solid	5.08E-06	1.56E-05	1.90E-05	3.18E-06
155-Eu	Ci/g solid	1.93E-06	1.07E-05	1.69E-05	8.29E-07
226-Ra	Ci/g solid	9.23E-12	1.43E-12	5.30E-13	1.48E-11
227-Ac	Ci/g solid	3.60E-11	2.51E-11	6.61E-12	1.42E-07
228-Ra	Ci/g solid	8.40E-11	3.35E-11	4.52E-11	9.70E-09
229-Th	Ci/g solid	2.96E-13	1.23E-14	5.79E-13	9.03E-10
231-Pa	Ci/g solid	3.60E-11	3.38E-11	1.13E-11	2.30E-07
232-Th	Ci/g solid	1.29E-10	3.38E-11	4.57E-11	5.40E-09
232-U	Ci/g solid	7.87E-12	6.76E-11	8.61E-11	1.68E-08
233-U	Ci/g solid	3.60E-11	3.66E-10	3.91E-10	3.97E-07
234-U	Ci/g solid	9.84E-10	2.55E-09	1.78E-08	2.06E-08
235-U	Ci/g solid	3.60E-11	1.01E-10	4.38E-10	6.02E-10

Table 3-8 Chemical and Radionuclide Composition in HLW Feed Solids

HLW Batch Group		1	2	3	4
Source tanks		AP-101/AY-102	AZ-101	AZ-102	C Farm Solids
Staging tank		AY-102	AZ-101	AZ-102	AY-101
Analyte	**Units**	**Concentration**			
236-U	Ci/g solid	3.60E-11	2.03E-10	8.76E-10	6.75E-10
237-Np	Ci/g solid	6.49E-09	2.77E-08	7.99E-08	5.19E-09
238-Pu	Ci/g solid	6.77E-07	2.85E-07	1.01E-06	4.29E-07
238-U	Ci/g solid	9.12E-10	1.77E-09	7.18E-09	1.19E-08
239-Pu	Ci/g solid	3.00E-06	2.67E-06	9.51E-06	5.94E-06
240-Pu	Ci/g solid	6.43E-07	8.05E-07	2.83E-06	1.23E-06
241-Am	Ci/g solid	9.02E-06	5.35E-05	1.14E-04	1.81E-05
241-Pu	Ci/g solid	5.37E-06	1.44E-05	4.87E-05	1.04E-05
242-Cm	Ci/g solid	2.06E-08	4.62E-08	3.81E-08	2.00E-08
242-Pu	Ci/g solid	7.20E-11	1.35E-10	3.91E-10	1.25E-10
243-Am	Ci/g solid	4.62E-10	1.15E-08	3.44E-08	1.52E-09
243-Cm	Ci/g solid	9.93E-10	4.34E-09	4.01E-09	1.57E-09
244-Cm	Ci/g solid	1.65E-08	9.05E-08	1.67E-07	4.61E-08
3-H	Ci/g solid	1.79E-09	9.74E-10	1.35E-09	7.46E-10
59-Ni	Ci/g solid	2.00E-07	1.64E-07	6.68E-08	1.77E-07
60-Co	Ci/g solid	1.44E-09	8.21E-07	1.19E-06	2.11E-07
63-Ni	Ci/g solid	1.75E-05	1.68E-05	6.84E-06	1.53E-05
79-Se	Ci/g solid	3.78E-09	1.84E-09	1.26E-09	1.43E-08
90-Sr	Ci/g solid	9.12E-03	2.31E-02	1.42E-02	1.75E-03
90-Y	Ci/g solid	9.33E-03	2.33E-02	1.45E-02	1.78E-03
93-Zr	Ci/g solid	1.62E-07	1.44E-06	6.01E-07	2.31E-07
93m-Nb	Ci/g solid	1.21E-07	1.04E-06	4.26E-07	3.80E-07
99-Tc	Ci/g solid	3.67E-08	1.03E-07	4.69E-07	2.99E-08

a Includes contribution of isotopes.

Values taken from source document as reported.

Source: TFCOUP, Rev. 5, Appendix C, Tables C-4 and C-5 (Kirkbride, et al. 2003). Chemical concentrations converted from g/g solid to mg/kg equivalents.

Table 3-9 Results for Detected Organic Analytes in Supernate from the RDQO

CAS Number	Compound	BWXS AN-107 Results (mg/L)	PNWD AN-102 Results (mg/L)
107-87-9	2-Pentanone	0.0018 J	0.10 U
108-88-3	Toluene	0.0014 J^	0.02 U
109-99-9	Tetrahydrofuran	0.0041 J^	0.02 U
110-54-3	n-Hexane	0.0582 F	0.04 U
126-73-8	Tributyl phosphate	2.2953 E [(a)]	0.20 U
62-75-9	N-Nitroso-N,N-dimethylamine	0.5313	0.395 J
64-17-5	Ethyl alcohol	0.01 U	0.404 J
64-18-6	Formic acid	-----	15000
64-19-7	Acetic acid	-----	17000
67-64-1	2-Propanone (Acetone)	0.4225 E F, T	0.10 U
71-36-3	n-Butyl alcohol	0.0651 J	0.0678 J
75-05-8	Acetonitrile	0.0950 J	0.05 U
75-09-2	Dichloromethane (methylene chloride)	0.2475 E F, T	0.02 U
75-65-0	2-Methyl-2-propanol	0.0183 J^	0.04 U
75-69-4	Trichlorofluoromethane	0.0007 U	0.03 U
78-92-2	1-Methylpropyl alcohol (2-butanol)	0.0221 J^	0.02 U
78-93-3	2-Butanone	0.0613	0.06 U
8001-35-2	Toxaphene	0.005 U	0.022 J
96-22-0	3-Pentanone	0.0036 J	0.10 U

----- Indicates data not available.

Values taken from source document as reported (24590-WTP-RPT-MGT-04-001).

^ One or more of the sample aliquot results was a U-flagged non-detect.

F, T Analyte detected above EQL in field F and/or trip T blank.

E The results exceeded the highest calibration standard; it is therefore considered an estimated value.

J Estimated value. The result was less than the EQL and greater than the MDL.

U Non-detect above the MDL. The U-flag is reported with MDL in this table. Please note in the BWXS data packages U-flagged organic analytes are reported with the EQL.

(a) The results for one of the three tributyl phosphate replicates exceeded the highest calibration standard at the instrument.

Table 3-10 Results for Detected Organic Analytes in Sludge from the RDQO

CAS Number	Compound	BWXS AY-102 Results (mg/kg)	PNWD AY-102 Results (mg/kg)
100-41-4	Ethyl benzene	0.0023 J^	0.01 U
106-35-4	3-Heptanone	2.7967 E	0.88 J
106-42-3	p-Xylene & m-Xylene	0.0022 J	0.02 U
106-97-8	Butane	0.1797	0.1 U
106-99-0	1,3-Butadiene	0.0510 ^	0.04 U
107-02-8	Acrolein	0.0406 J	0.03 U
107-12-0	Propionitrile	0.515	0.26 J
107-87-9	2-Pentanone	0.2287 E	0.1 U
108-10-1	4-Methyl-2-pentanone	0.0197 ^	0.03 U
108-38-3	m-Xylene (see 106-42-3)	0.0022 J	0.04 U
108-87-2	Methylcyclohexane	0.0021 J	0.02 U
108-88-3	Toluene	0.0014 J	0.01 U
109-66-0	n-Pentane	0.0589	0.1 U
109-99-9	Tetrahydrofuran	0.0466	0.03 U
110-54-3	n-Hexane	0.0345	0.04 U
11096-82-5	Aroclor-1260	0.06867 U	0.052 J
11097-69-5	Aroclor-1254	0.04167 U	0.051 J
11104-28-2	Aroclor-1221	0.023 U	0.043 J
11141-16-5	Aroclor-1232	0.00753 U	0.042 J
111-65-9	n-Octane	0.0693	0.08 U
111-84-2	n-Nonane	0.0448	0.1 U
123-19-3	4-Heptanone	0.1178	0.03 U
123-38-6	n-Propionaldehyde	0.1553	0.44 J
123-86-4	Acetic acid n-butyl ester	0.0819	0.03 U
12672-29-6	Aroclor-1248	0.04867 U	0.033 J
126-73-8	Tributyl phosphate	8.11	-----
12674-11-2	Aroclor-1016	0.06767 U	0.065 J
142-82-5	n-Heptane	0.1243	0.1 U
144-62-7	Oxalic acid	-----	3600
287-92-3	Cyclopentane	0.0023 J^	0.02 U
4170-30-3	2-Butenaldehyde (2-Butenal)	0.0342 J	0.1 U

Table 3-10 Results for Detected Organic Analytes in Sludge from the RDQO

CAS Number	Compound	BWXS AY-102 Results (mg/kg)	PNWD AY-102 Results (mg/kg)
53469-21-9	Aroclor-1242	0.010 U	0.024 J
58-89-9	Gamma-BHC (Lindane)	0.00433 U	0.0056
591-78-6	2-Hexanone	0.2643 E	0.01 U
64-17-5	Ethyl alcohol	2.70 E	0.418 J
64-19-7	Acetic acid	-----	1300 J
67-63-0	2-Propyl alcohol (Isopropanol)	0.1219 B	0.0834 J
67-64-1	2-Propanone (Acetone)	0.813 E	1.61
71-23-8	n-Propyl alcohol (1-propanol)	0.8103	0.2 U
71-36-3	n-Butyl alcohol	0.931	0.253 J
71-43-2	Benzene	0.0045 J	0.01 U
74-87-3	Chloromethane	0.0053 J	0.01 U
75-05-8	Acetonitrile	1.0437	0.84 J
75-21-8	Oxirane	0.309	-----
78-92-2	1-Methylpropyl alcohol (2-butanol)	0.0637 J	0.09 U
78-93-3	2-Butanone	0.3593 E	0.45 J
8001-35-2	Toxaphene	0.010 U	0.053 J

----- Indicates data not available.

Values taken from source document as reported (24590-WTP-RPT-MGT-04-001).

^ One or more of the sample aliquot results was a U-flagged non-detect.

B Analyte detected above EQL in method blank.

E Results exceeded the highest calibration standard, it is therefore considered an estimated value.

J Estimated value. The result was less than the EQL and greater than the MDL.

U Non-detect above the MDL. The U-flag is reported with MDL in this table. Please note in the BWXS data packages U-flagged organic analytes are reported with the EQL.

Table 3-11 Results for Detected Inorganic Analytes in Supernatant from the RDQO

CAS Number	Compound	BWXS AN-107 Results (mg/L)	PNWD AN-102 Results (mg/L)
7440-22-4	Ag	0.16 J [(a)]	0.20 U
7429-90-5	Al	272	14000
7440-38-2	As	1.35 U	13 J
7440-38-2	As	0.061 J^	-----
7440-39-3	Ba	7.28	0.99
7440-41-7	Be	0.05 J	0.028 J
7440-43-9	Cd	65.3	58
7440-48-4	Co	4.86	3.70
7440-47-3	Cr	179	240
7440-50-8	Cu	32.2	16
7439-89-6	Fe	1743	38
7439-93-2	Li	0.97 U	0.74 J
7439-95-4	Mg	2.94 U	1.10 J
7439-96-5	Mn	589	20
7439-98-7	Mo	43	48
7440-23-5	Na	156000	210000
7440-02-0	Ni	547	390
7723-14-0	P	515	1700
7439-92-1	Pb	392	160
7440-16-6	Rh	60.6 U	8.80 J
7704-34-9	S	3000	-----
7440-36-0	Sb	1.56 U	2.60 J
7782-49-2	Se	0.259 J^	5.10 J
7440-31-5	Sn	9.55 U	16 J
7440-28-0	Tl	5 U	1.60 J
7440-61-1	U	152 J	36 J
7440-62-2	V	0.487 J	0.61 J
7440-33-70	W	29.6 J	120
7440-65-5	Y	12.5 J	2.90
7440-66-6	Zn	22.4	5.00
7440-67-7	Zr	99.6 J	8.3

Table 3-11 Results for Detected Inorganic Analytes in Supernatant from the RDQO

CAS Number	Compound	BWXS AN-107 Results (mg/L)	PNWD AN-102 Results (mg/L)
57-12-5	CN	32.5	R
7664-41-7	NH3	0.97	137
16984-48-8	Fluoride	3893	2370
16887-00-6	Chloride	2270	3550
14797-65-0	Nitrite	78067	78900
14797-55-8	Nitrate	235333	210000
14265-44-2	Phosphate	500 U	4720
14808-79-8	Sulfate	9460	14300

----- Indicates data not available.

Values taken from source document as reported (24590-WTP-RPT-MGT-04-001).

^ One or more of the sample aliquot results was a U-flagged non-detect.

E The results exceeded the highest calibration standard; it is therefore considered an estimated value.

J Estimated value. The result was less than the EQL and greater than the MDL.

R QC failure. A significant quality assurance deficiency was associated with the reported results.

U Non-detect above the MDL. The U-flag is reported with MDL in this table. Please note for the organic analytes in the BWXS data packages U-flagged organic analytes are reported with the EQL.

(a) Results for one of the silver replicates exceeded the highest calibration standard at the instrument. It was also two magnitudes of order higher than the subsequent replicates at 20.1 mg/L; therefore, it was not included in the average for silver.

Note: The supernate results are from two different tanks.

Table 3-12 Results for Detected Inorganic Analytes in Sludge from the RDQO

CAS Number	Compound	BWXS AY-102 Results (mg/kg)	PNWD AY-102 Results (mg/kg)
7440-22-4	Ag	1873	700
7429-90-5	Al	56433	51000
7440-38-2	As	44 J	46 J
7440-38-2	As	2.1 J	-----
7440-39-3	Ba	602	550
7440-41-7	Be	1.1 J	0.9 J
7440-43-9	Cd	95	94
7440-48-4	Co	27 J	29
7440-47-3	Cr	1727	1800
7440-50-8	Cu	250	220
7439-89-6	Fe	78133	81000
7439-93-2	Li	131	140
7439-95-4	Mg	1112	1200
7439-96-5	Mn	17000	18000
7439-98-7	Mo	26 J	19 J
7440-23-5	Na	90233	72000
7440-02-0	Ni	2777	2900
7723-14-0	P	4807	4800
7439-92-1	Pb	3993	4200
7440-16-6	Rh	344 J	34 J^
7440-16-6	Rh	-----	18
7704-34-9	S	10333	-----
7440-36-0	Sb	21 U	20 U
7782-49-2	Se	3.02 J^	25 J
7440-31-5	Sn	283	11 J
7440-25-7	Ta	1810	14
7440-28-0	Tl	83 J^	20 U
7440-61-1	U	1673 J	930 J
7440-62-2	V	19 J	16 J
7440-33-70	W	288 J^	260
7440-65-5	Y	136	110

Table 3-12 Results for Detected Inorganic Analytes in Sludge from the RDQO

CAS Number	Compound	BWXS AY-102 Results (mg/kg)	PNWD AY-102 Results (mg/kg)
7440-66-6	Zn	173	150
7440-67-7	Zr	2090	3000 J
7439-97-6	Hg	7.9	144
57-12-5	CN	13	R
7664-41-7	NH_3	0.21 J^	-----
16984-48-8	Fluoride	63	103 J
16887-00-6	Chloride	252	109
14797-65-0	Nitrite	1793	3590
24959-67-9	Bromide	579	486
14797-55-8	Nitrate	2150	266
14265-44-2	Phosphate	3583	3890
14808-79-8	Sulfate	1670	1220

----- Indicates data not available.

Values taken from source document as reported (24590-WTP-RPT-MGT-04-001).

^ One or more of the sample aliquot results was a U-flagged non-detect.

J Estimated value. The result was less than the EQL and greater than the MDL.

R QC failure. A significant quality assurance deficiency was associated with the reported results.

U Non-detect above the MDL. The U-flag is reported with the MDL.

Table 3-13 HLW Feed Unwashed Solids Maximum Nonvolatile Component Composition Grams per 100 g Nonvolatile Waste Oxides

Nonvolatile Element	Maximum (g per 100 g waste oxides)	Nonvolatile Element	Maximum (g per 100 g waste oxides)
As	0.16	Pu	0.054
B	1.3	Rb	0.19
Be	0.065	Sb	0.84
Ce	0.81	Se	0.52
Co	0.45	Sr	0.52
Cs	0.58	Ta	0.03
Cu	0.48	Tc	0.26
Hg	0.1	Te	0.13
La	2.6	Tl	0.45
Li	0.14	V	0.032
Mn	6.5	W	0.24
Mo	0.65	Y	0.16
Nd	1.7	Zn	0.42
Pr	0.35		

Source: DOE 1997

Table 3-14 HLW Feed Unwashed Solids Volatile Component Composition Grams per 100 g Nonvolatile Waste Oxides

Volatile Components	Maximum (g per 100 g waste oxides)
Cl	0.33
CO_3^{-2}	30
NO_2	36 (total NO_2/NO_3) as NO_3
NO_3	
TOC	11
CN	1.6
NH_3	1.6

Source: DOE 1997

Table 3-15 HLW Feed Unwashed Solids Maximum Radionuclide Composition

Curies per 100 g Nonvolatile Waste Oxides

Isotope	Maximum (Ci per 100 g waste oxides)	Isotope	Maximum (Ci per 100 g waste oxides)	Isotope	Maximum (Ci per 100 g waste oxides)
^{3}H	6.5E-05	^{129}I	2.9E-07	^{237}Np	7.4E-05
^{14}C	6.5E-06	^{137}Cs	1.5E00	^{238}Pu	3.5E-04
^{60}Co	1.0E-02	^{152}Eu	4.8E-04	^{239}Pu	3.1E-03
^{90}Sr	1.0E+01	^{154}Eu	5.2E-02	^{241}Pu	2.2E-02
^{99}Tc	1.5E-02	^{155}Eu	2.9E-02	^{241}Am	9.0E-02
^{125}Sb	3.2E-02	^{233}U	9.0E-07	$^{243+244}Cm$	3.0E-03
^{126}Sn	1.5E-04	^{235}U	2.5E-07		

Source: DOE 1997

Table 3-16 Additional HLW Feed Unwashed Composition for Nonvolatile Components

Grams per 100 g Nonvolatile Waste Oxides

Nonvolatile Element	Maximum (g per 100 g waste oxides)	Nonvolatile Element	Maximum (g per 100 g waste oxides)
Ag	0.55	Ni	2.4
Al	14	P	1.7
Ba	4.5	Pb	1.1
Bi	2.8	Pd	0.13
Ca	7.1	Rh	0.13
Cd	4.5	Ru	0.35
Cr	0.68	S	0.65
F	3.5	Si	19
Fe	29	Ti	1.3
K	1.3	U	14
Mg	2.1	Zr	15
Na	19		
Th	5.0		

Source: DOE 1997

Table 3-17 Nominal Ranges for GFC Mass Fraction Compositions [a]

Oxide or Halide	Kyanite (Al_2SiO_5)	Boric Acid (H_3BO_3)	Wollastonite ($CaSiO_3$)	Iron Oxide (Fe_2O_3)	Olivine (Mg_2SiO_4)	Borax ($Na_2B_4O_7 \cdot 10H_2O$)	Silica (SiO_2)	Rutile (TiO_2)	Zincite (ZnO)	Zircon ($ZrSiO_4$)	Sodium Carbonate (Na_2Co_3)	Lithium Carbonate (Li_2CO_3)
	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range
Al_2O_3	0.54 - 0.60	0 - 0	0.0013 - 0.0027	0.0099 - 0.0201	0.0003 - 0.0078[b]	0 - 0	0.0004 - 0.004	0 - 0.0075	0 - 0	0.001 - 0.004	0 - 0	0 - 0
B_2O_3	0 - 0	0.5625 - 0.5680	0 - 0	0 - 0	0 - 0	0.369 - 0.382	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
CaO	0 - 0.0004	0 - 0	0.4477 - 0.5023	0 - 0.00077[b]	0 - 0.0003[b]	0 - 0	0 - 0.0002	0 - 0	0 - 0	0 - 0	0 - 0.000112	0 - 0.022
CdO	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.0002[b]	0 - 0	0 - 0	0 - 0
Cl	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.0007	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
Cr_2O_3	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.0078[b]	0 - 0	0 - 0	0 - 0.0075	0 - 0	0 - 0	0 - 0.0006	0 - 0.00015
Fe_2O_3	0.0042 - 0.01	0 - 0	0.0029 - 0.0051	0.9615 - 0.9785	0.0468 - 0.1068[b]	0 - 0.000043	0.00003 - 0.000373	0 - 0.025	0 - 0.000043	0.0006 - 0.0009	0 - 0.000011	0 - 0.00003
K_2O	0 - 0.0007	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.0002	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.00001
Li_2O	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.40 - 0.4044
MgO	0 - 0.0004	0 - 0	0 - 0	0.00008 - 0.00365[b]	0.4634 - 0.4934[b]	0 - 0	0 - 0.0001	0 - 0	0 - 0	0 - 0	0 - 0.000133	0 - 0.00016
MnO	0 - 0	0 - 0	0.0009 - 0.0011	0.00028 - 0.00385[b]	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.000005	0 - 0	0 - 0	0 - 0
Na_2O	0 - 0.005	0 - 0	0 - 0	0 - 0	0 - 0.0004[b]	0.164 - 0.17	0 - 0.0002	0 - 0	0 - 0	0 - 0	0.5831 - 0.5848	0 - 0.0011
NiO	0 - 0	0 - 0	0 - 0	0 - 0	0.0022 - 0.0052[b]	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
P_2O_5	0 - 0	0 - 0	0 - 0	0.00178 - 0.00535[b]	0 - 0	0 - 0	0 - 0	0 - 0.0007	0 - 0	0 - 0	0 - 0	0 - 0

Table 3-17 Nominal Ranges for GFC Mass Fraction Compositions [a]

Oxide or Halide	Kyanite (Al_2SiO_5)	Boric Acid (H_3BO_3)	Wollastonite ($CaSiO_3$)	Iron Oxide (Fe_2O_3)	Olivine (Mg_2SiO_4)	Borax ($Na_2B_4O_7 \cdot 10H_2O$)	Silica (SiO_2)	Rutile (TiO_2)	Zincite (ZnO)	Zircon ($ZrSiO_4$)	Sodium Carbonate (Na_2Co_3)	Lithium Carbonate (Li_2CO_3)
	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range	Range
PbO	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.000043	0 - 0	0 - 0	0 - 0
SiO_2	0.39 - 0.42	0 - 0	0.48 - 0.53	0.0084 - 0.0186[b]	0.4085 - 0.4385[b]	0 - 0	0.992 - 0.999	0 - 0.025	0 - 0	0.320 - 0.325	0 - 0	0 - 0
SO_3	0 - 0	0 - 0.0003	0 - 0	0.0006 - 0.0009[b]	0 - 0	0 - 0.0005	0 - 0	0 - 0.0007	0 - 0	0 - 0	0 - 0.0002	0 - 0.0004
TiO_2	0.005 - 0.016	0 - 0	0.00006 - 0.00033	0 - 0	0 - 0	0 - 0	0 - 0.00045	0.928 - 0.936	0 - 0	0.007 - 0.0014	0 - 0	0 - 0
UO_2	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.00077[b]	0 - 0	0 - 0
V_2O_5	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.0075	0 - 0	0 - 0	0 - 0	0 - 0
ZnO	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.993 - 0.9999[b]	0 - 0	0 - 0	0 - 0
ZrO_2	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0.025	0 - 0	0.65 - 0.67	0 - 0	0 - 0

a GFC nominal compositions are expressed as mass fractions of glass oxides or halides (grams of the specified oxide or halide per gram of the GFC). The sum of mass fractions of the oxides and halides is less than 1.0000 when the GFCs contain water or other volatile species that will not persist in glass.

b Range not given in vendor literature. Developed from ranges of components in other GFCs with similar nominal values.

Table 3-18 Coefficients of the Statistical TCLP Model

Model Term	Coefficient	Value
Al_2O_3	$b_{Al_2O_3}$	0.3257
B_2O_3	$b_{B_2O_3}$	8.0665
Fe_2O_3	$b_{Fe_2O_3}$	1.5677
Li_2O	b_{Li_2O}	11.3541
MnO	b_{MnO}	10.7633
Na_2O	b_{Na_2O}	9.3328
SiO_2	b_{SiO_2}	0.1617
ZnO	b_{ZnO}	15.4324
ZrO_2	b_{ZrO_2}	2.0438
ln(CdO)	$d_{ln(CdO)}$	0.9859

Summary Statistics (see Supplement 4, Section 6)

Statistic	Value	Notes
R^2	0.977	Fraction of variation in a modeled property accounted for by the model.
R^2 Adjusted (R^2_A)	0.975	Fraction of variation in a modeled response accounted for by the model, adjusted for the number of fitted coefficients in the model. The adjustment is for the number of parameters (p) and number of data points (n) used in fitting the model.
R^2 Predicted (R^2_P)	0.971	Leave-one-out cross-validation fraction of variability in the property data (transformed if appropriate) accounted for by the fitted model. This statistic is calculated by a method equivalent to leaving each data point out of the model fit, and then evaluating how well the model predicts the property for that data point.
RMSE	0.1818	Root mean squared error. This statistic provides an estimate of the experimental and measurement uncertainty standard deviation associated with melting glasses and measuring the associated property.

Values taken from source document as reported (see Supplement 4).

Table 3-19 Variance-Covariance Matrix Associated with the TCLP Cadmium Release Model

$$C = RSME^2 \times (A^T W A)^{-1}$$

[a]	Al_2O_3	B_2O_3	Fe_2O_3	Li_2O	MnO	Na_2O	SiO_2	ZnO	ZrO_2	ln(CdO)
Al_2O_3	1.3346	-0.254	0.2329	-0.6601	-0.1979	-0.3035	-0.0844	0.5032	-0.1503	-0.002
B_2O_3	-0.254	0.3644	-0.1725	0.2385	0.1065	0.1171	0.006	-0.1995	-0.3413	0.0031
Fe_2O_3	0.2329	-0.1725	0.6704	-0.3167	-0.1716	-0.2619	-0.0967	0.2838	0.2003	-0.0017
Li_2O	-0.6601	0.2385	-0.3167	2.6016	0.1184	0.6248	-0.1403	-0.7547	-0.5413	0.0044
MnO	-0.1979	0.1065	-0.1716	0.1184	1.0808	0.0818	0.03	-0.4537	-0.6179	0.0015
Na_2O	-0.3035	0.1171	-0.2619	0.6248	0.0818	0.5399	-0.031	-0.3733	-0.3819	0.0032
SiO_2	-0.0844	0.006	-0.0967	-0.1403	0.03	-0.031	0.0848	-0.0021	-0.2442	0.002
ZnO	0.5032	-0.1995	0.2838	-0.7547	-0.4537	-0.3733	-0.0021	1.0977	0.246	-0.0002
ZrO_2	-0.1503	-0.3413	0.2003	-0.5413	-0.6179	-0.3819	-0.2442	0.246	10.4663	0.0009
ln(CdO)	-0.002	0.0031	-0.0017	0.0044	0.0015	0.0032	0.002	-0.0002	0.0009	0.0003

[a] The variance-covariance matrix for the 10-term model is for renormalized mass fractions of oxide components Al_2O_3 to ZrO_2, and the original (not renormalized) mass fraction of CdO in ln(CdO).

Values taken from source document as reported (see Supplement 4).

Table 3-20 Theoretical Variant Glass and Predicted Cadmium TCLP Response

Oxide	Composition (wt%)	Normalized Composition (wt%)	Coefficient[a]
Al_2O_3	1.92%	2.27%	0.3257
B_2O_3	14.0%	16.6%	8.0665
Fe_2O_3	1.92%	2.27%	1.5677
Li_2O	6.00%	7.09%	11.3541
MnO	6.97%	8.24%	10.7633
Na_2O	15.0%	17.7%	9.3328
SiO_2	34.8%	41.1%	0.1617
ZnO	0.00%	4.70%	15.4324
ZrO_2	3.98%	0.00%	2.0438
CdO	0.132%	Not applicable	Not applicable
ln(CdO)	-6.82	Not applicable	0.9859

Model Predictions

Predicted ($ln(c_{Cd})$ in ln(mg/L))	-1.02
c_{Cd} (mg/L)	0.361
$t_{90,92}$	1.29
Model Uncertainty (ln(mg/L))	0.285
Upper Confidence Interval (ln(mg/L))	-0.734
c_{Cd} (mg/L) Upper Confidence Interval	0.480

Cadmium Oxide Loading Predictions

Target c_{Cd} (mg/L)	0.480
Projected CdO Loading (CdO in wt%)	0.132%
Equivalent Load in mg/kg (CdO in mg/kg)	1160

(a) Values taken from source document as reported (Supplement 4).

Table 3-21 Tests and Measurements for Qualification of Glasses

Test or Measurement	Method	Criteria or Requirement
Dangerous Waste Limitations	SW-846 Methods 1311, 3010A, 6010B, 6020, and others	Acceptable for land disposal under the State of Washington Dangerous Waste Regulations, WAC 173-303, and RCRA LDR in 40 CFR 268, and conditions established pursuant to this petition.
Product Consistency Test	ASTM C1285-02	Normalized mass loss of sodium, lithium, and boron shall be less than 6.65, 4.80, 8.35 g/m^2, respectively.
Chemical Composition	ASTM C1317-95, ASTM C1463-00, ASTM C1342-96, ASTM C1412-99, and/or other ASTM and SW-846 methodologies (as necessary)	Report elements (excluding oxygen) present in concentrations greater than 0.5 wt% and elements and compounds required to other requirements. Comply with minimum component limits for IHLW (see Table 3-22).
Radionuclide Composition	ASTM C1317-95, ASTM C1463-00, ASTM C1342-96, ASTM C1412-99, scintillation, separation and assay, mass spectroscopy methods, alpha/gamma energy analysis	Meet National Geologic Repository acceptance criteria. Report total and fissile uranium and plutonium content. Classification according to 10 CFR 61.55.
Time-Temperature-Transformation	Scanning electron microscopy (SEM) in conjunction with energy dispersive X-ray analysis (EDAX), optical microscopy, and X-ray diffraction (XRD), and transmission electron microscope (TEM) methods	Provide a time-temperature-transformation diagram that identifies the duration of exposure at any temperature that causes significant changes in either the phase structure or the phase compositions. Provide the crystalline and non-crystalline phases expected to be present and the estimated amount of each phase for the waste form.
Glass Transition Temperature	Differential thermal analysis, ASTM E 1356-91	Report transition temperature.
Liquidus Temperature	Heat treatment followed by analysis using optical and/or SEM	Below 950 °C, less than 1 vol% of crystals.
Density	ASTM D854-02, or equivalent	Report density.
Viscosity	Torque measurements at various rotation speeds using a spindle attached to a viscometer	Report viscosity as a function of temperature. Ensure processability (10 to 150 Poise at 1100 °C).
Refractory Compatibility	Modified version of ASTM C621-84	Ensure processability.
Electrical Conductivity	Impedance of the glass melt as a function of frequency using a electrode probe and impedance analyzer	Ensure processability (0.2 - 0.7 S/cm at 1100 °C - 1200 °C).

Table 3-22 Minimum Component Concentration Limits in High-Level Waste Glass

Component	Weight Percent in IHLW Glass (Meet or exceed one or more criterion below) [a]
Fe_2O_3	12.5
Al_2O_3	11.0
$Na_2O + K_2O$	15.0
ZrO_2	10.0
UO_2	8.0
ThO_2	4.0
CaO	7.0
MgO	5.0
BaO	4.0
CdO	3.0
NiO	3.0
PbO	1.0
TiO_2	1.0
Bi_2O_3	2.0
P_2O_5	3.0
F	1.7
$Al_2O_3 + ZrO_2$	14.0
$Al_2O_3 + ZrO_2 + Fe_2O_3$	21.0
MgO + CaO	8.0
Cr_2O_3	0.5
SO_3	0.5
Ag_2O	0.25
$Rh_2O_3 + Ru_2O_3 + PdO$	0.25
Any single waste oxide (exclusive of Si) not specifically identified in footnote (b).	0.2
Total of all other waste oxides (exclusive of Si) not specifically identified in this table.	8.0

a The concentration of at least one of the waste components or waste component combinations shall exceed its minimum weight percent in the table (e.g., for a high-iron waste, the waste product shall incorporate at least 12.5 wt% iron oxide from the waste into the glass). The waste loading may be reduced if necessary to comply with universal treatment standards leaching requirements.

b Al_2O_3, Sb_2O_3, As_2O_3, BaO, Bi_2O_3, B_2O_3, BeO, CaO, CdO, Ce_2O_3, Cr_2O_3, CoO, Cs_2O, CuO, F, FeO, La_2O_3, PbO, Li_2O, MgO, MnO, MnO_2, HgO, MoO_3, NiO, PdO, P_2O_5, K_2O, Pr_2O_3, PuO_2, Rh_2O_3, Rb_2O, ReO, ReO_2, SeO_2, SiO_2 , Ag_2O, Na_2O, SrO, SO_3, Ta_2O_5, Tc_2O_7, TeO_2, Tl_2O_3, Tl_2O, ThO_2, TiO_2, V_2O_5, WO_3, UO_3, Y_2O_3, ZnO, and ZrO_2.

Values taken from source document as reported (DOE 2000).

Table 3-23 Comparison of Simulated and Actual IHLW, and IHLW Test Matrix Range

Component	Simulant HLW98-61[b,c]		Active AZ-102 Glass[d]	Simulant HLW98-51R[b,c]		Active C-104 Glass[d]	Simulant HLW98-67[b,e]		Active C-106 Glass[f]	Matrix Glasses	
	Target (mass%)	Analyzed (mass%)	Analyzed (mass%)	Target (mass%)	Analyzed (mass%)	Analyzed (mass%)	Target (mass%)	Analyzed (mass%)	Analyzed (mass%)	Min (mass%)	Max (mass%)
Ag_2O	0.02	0.03	0.02	0.07	0.09	0.05	0.02	0.03	0.022	0.02	0.2002
Al_2O_3	7.7	6.65	7.74	2.38	2.82	2.64	6.97	6.89	7.137	1.924	8.5
As_2O_5	NA	0.02	NA	NA	NA	NA	NA	NA	NA	0.02	0.2002
B_2O_3	4	3.96	3.83	9	9.52	9.2	5	4.41	4.354	4.809	14
BaO	0.04	0.08	0.04	0.02	0.06	0.02	0.04	0.13	0.051	0.03	0.3002
BeO	NA	NA	NA	NA	NA	0.01	NA	NA	NA	NA	NA
CdO	1.39	1.1	1.24	0.06	0.06	0.06	0.01	0	0.021	0.05	1.6
Cr_2O_3	0.11	0.1	0.13	0.14	0.13	0.14	0.19	0.15	0.284	0.019	0.498
CuO	0.03	0.07	0.13	0.03	NA	0.03	0.06	0.08	0.228	0.01	0.1001
Fe_2O_3	12.24	9.04	12.13	4.7	4.73	4.54	12.58	11.99	12.722	1.924	14
Li_2O	5	3.83	5.3	5	4.79	5.64	4.5	4.54	4.092	1.924	6
MnO	1.03	1.12	1.36	2.58	2.71	2.44	3.53	3.71	3.385	0	6.97
Na_2O	13.91	10.15	13.66	8.6	7.32	9.05	13.11	NA	12.649	3.922	15
NiO	0.76	0.61	0.74	0.23	0.26	0.24	0.28	NA	0.294	0.096	1
PbO	0.11	0.19	0.17	0.16	0.2	0.2	0.27	0.24	0.339	0.04	0.4003
Sb_2O_3	NA	0.07	NA	NA	NA	NA	NA	NA	NA	0.02	0.3
SeO_2	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.02	0.2
SiO_2	47.08	49.61	45.45	47.83	44.84	46.94	45.26	43.75	44.25	34.807	53
Tl_2O_3	NA	0.03	NA	NA	NA	NA	NA	NA	NA	0.02	0.33
ZnO	0.04	0.13	0.04	2	2.04	1.98	0.01	0.05	0.289	0	3.979
ZrO_2	1.47	1.32	1.74	4.85	4.78	4.24	0.05	0.07	0.505	0	9.669

[a] NA = not applicable; represents components not specifically targeted in simulant glass or not measured in the sample.
[b] Kot and Pegg 2001.
[c] Target composition is for the simulant glass; the target composition for the actual waste glass is slightly different due to differences in the analyzed waste composition from that assumed by Kot and Pegg 2001.
[d] Smith et al. 2001.
[e] Schumacher et al. 2002. Formulation and testing performed by WK Kot and IL Pegg, The Catholic University of America.
[f] Schumacher et al. 2002.
Values taken from source documents as reported.

Figure 3-1 Facility Location

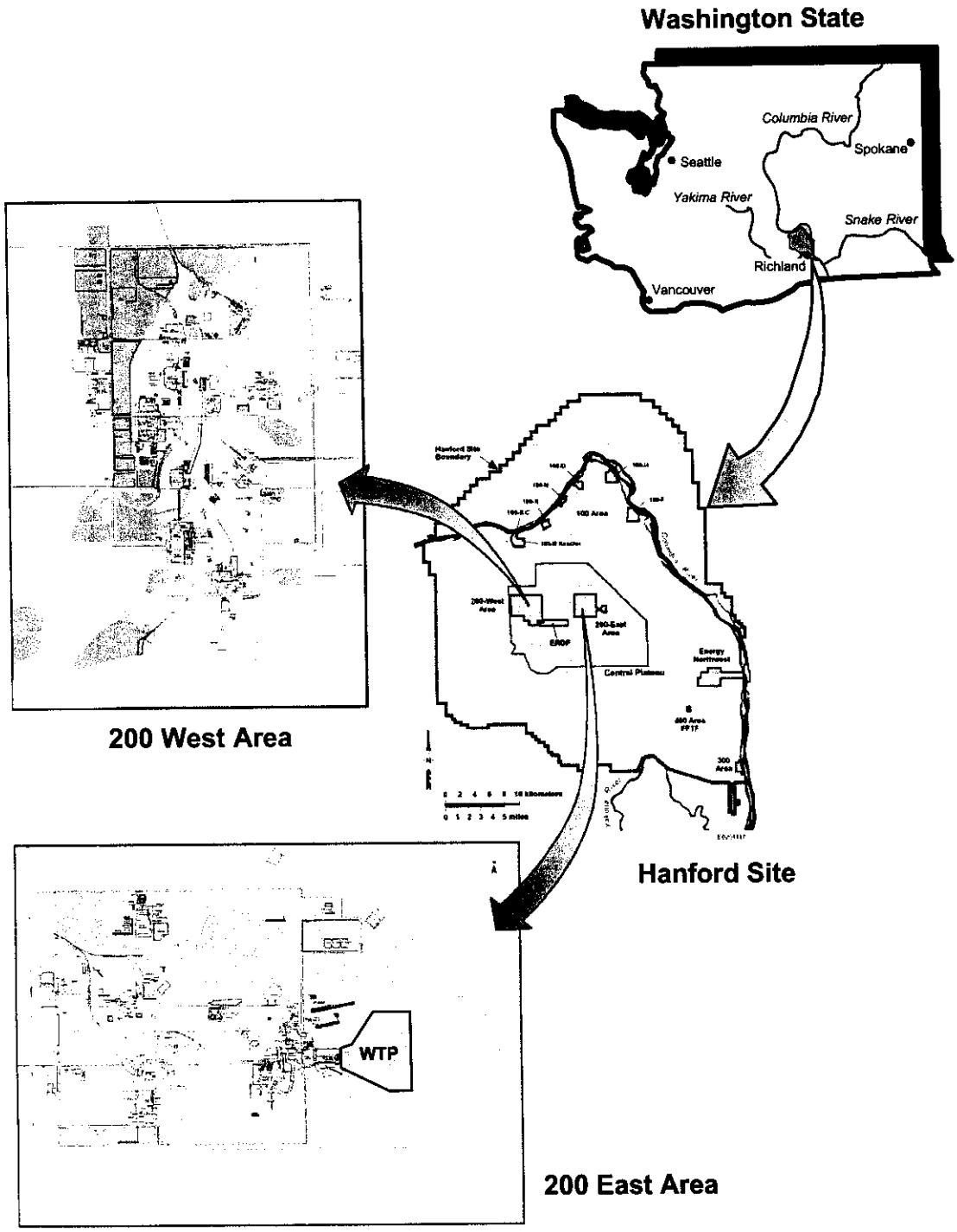


Figure 3-3 Waste Treatment Plant Construction (April 2005)
(looking West)

Figure 3-2 Facility Plan

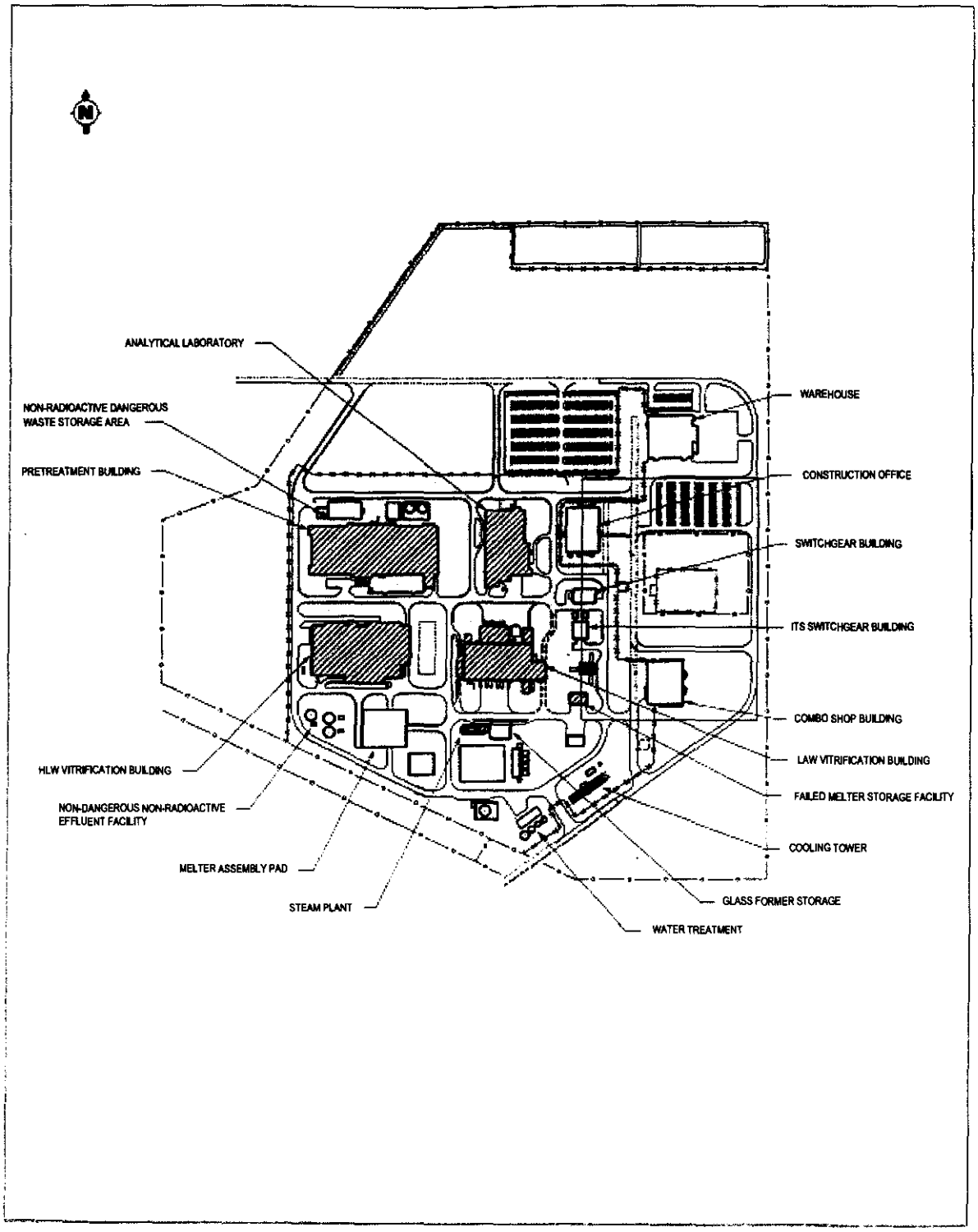
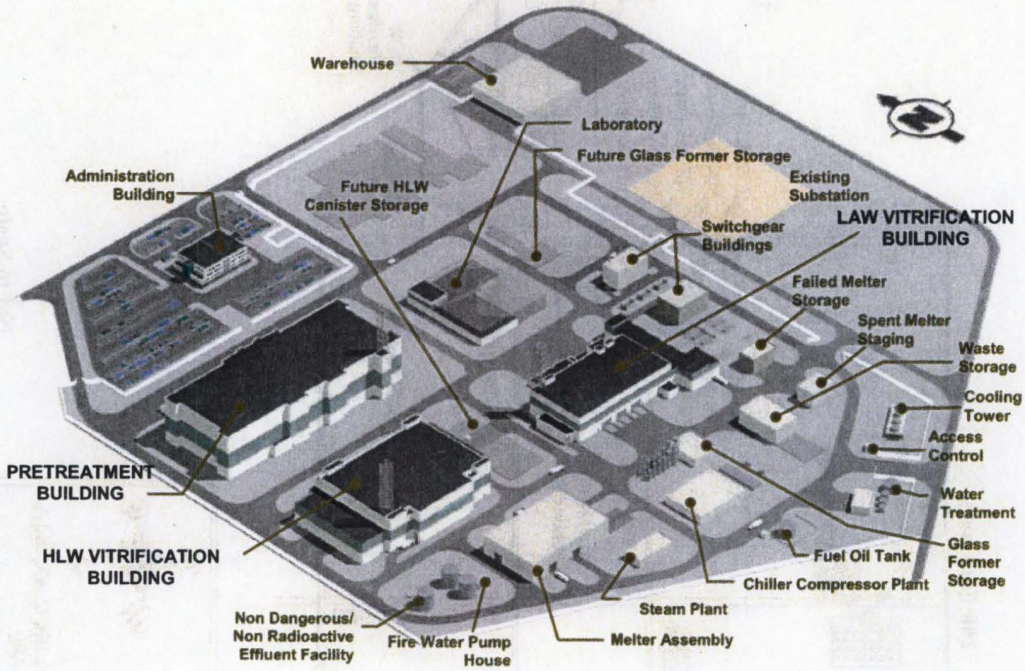


Figure 3-4 Waste Treatment Plant Isometric Rendering



Conceptual rendering, for illustrative purposes only.

Figure 3-5 Tank Farms and WTP Facility Location

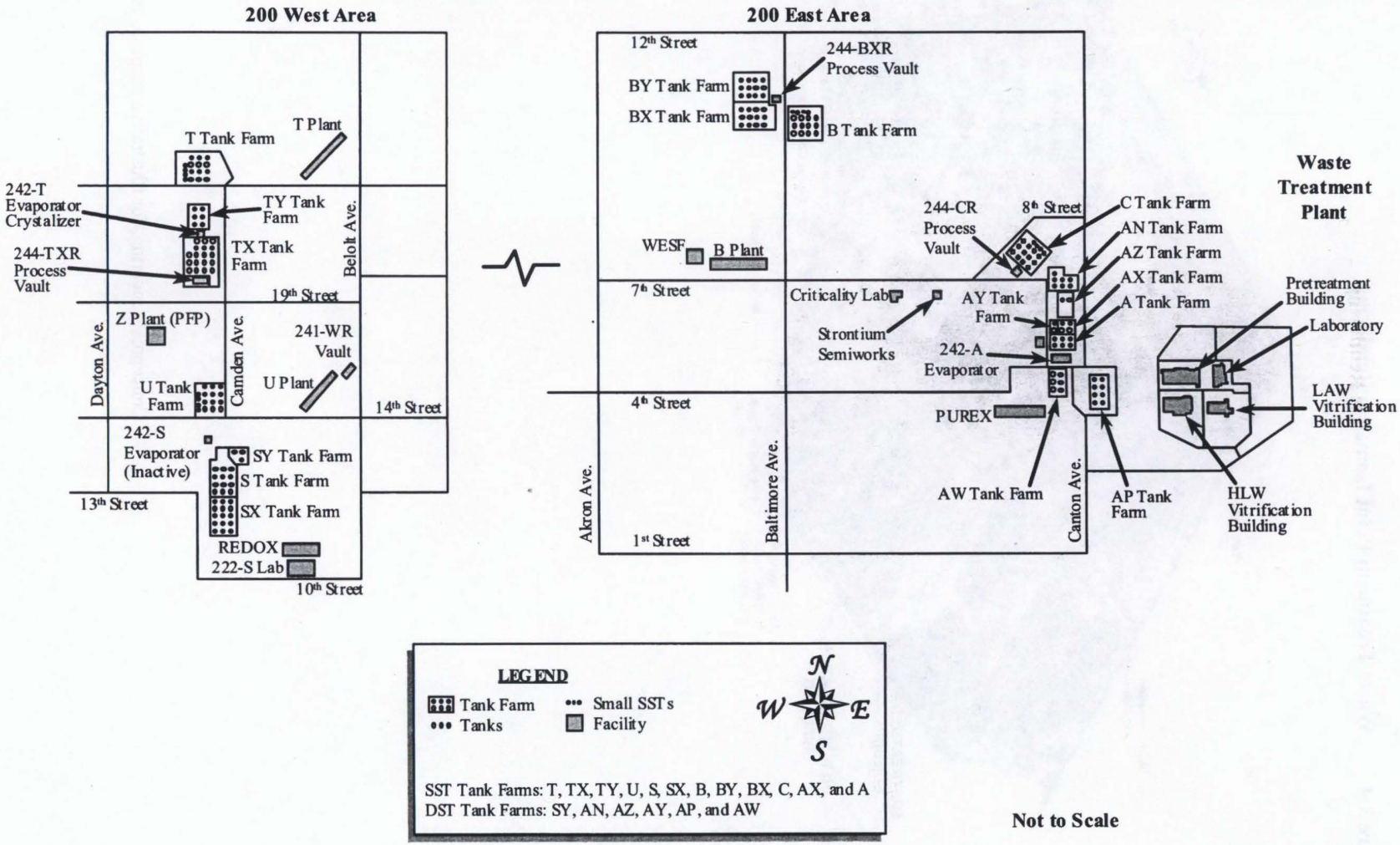


Figure 3-6 Tank Farms and Related Piping in 200 West

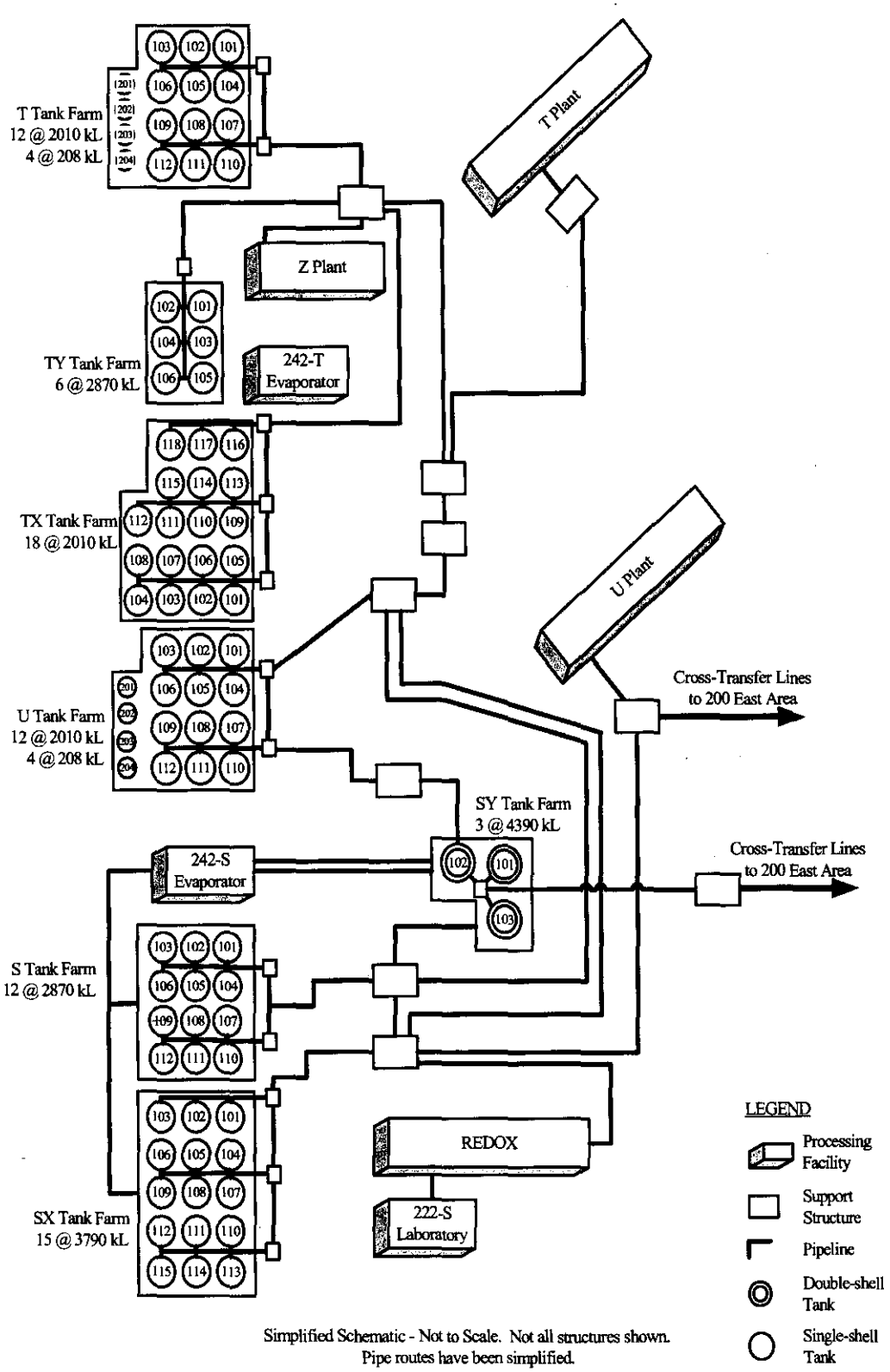
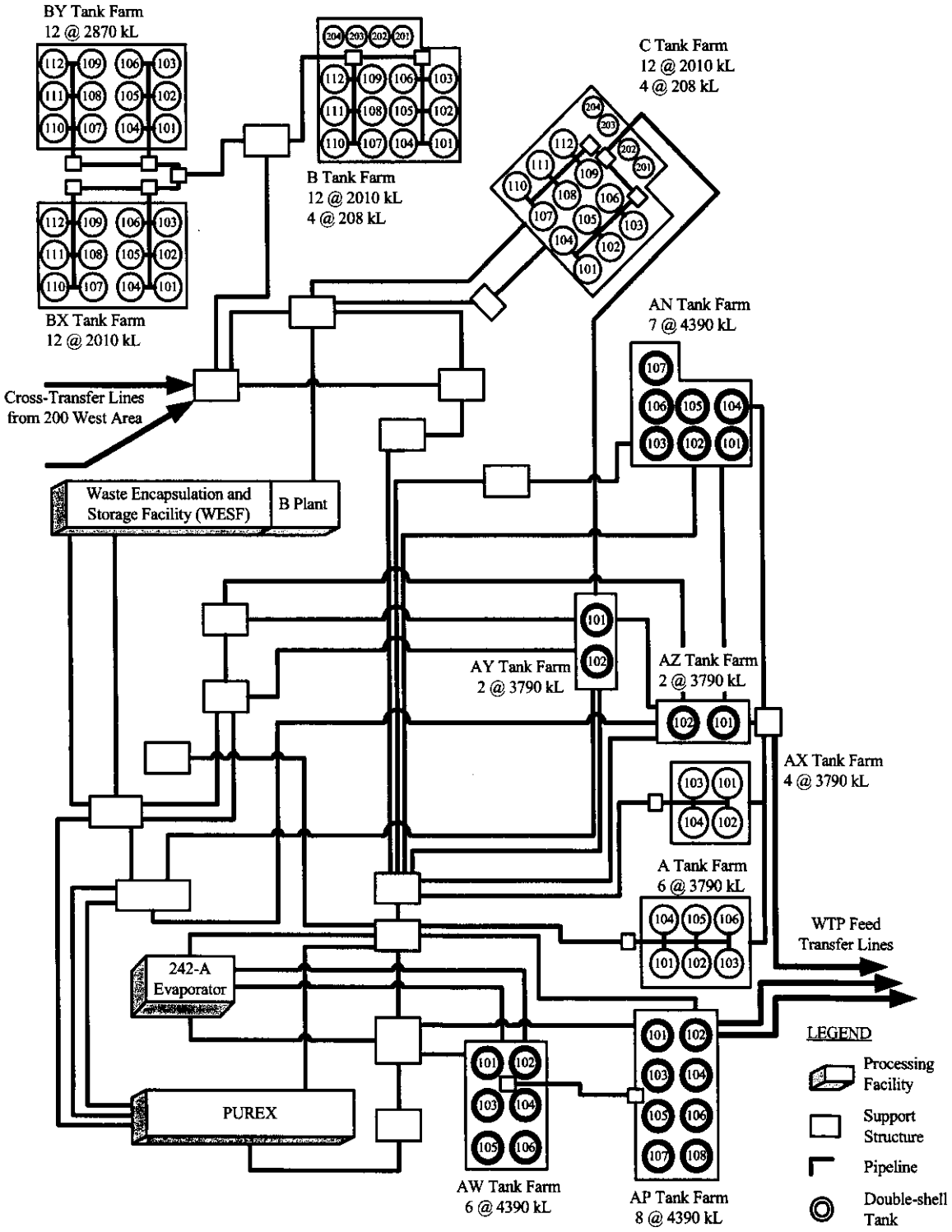
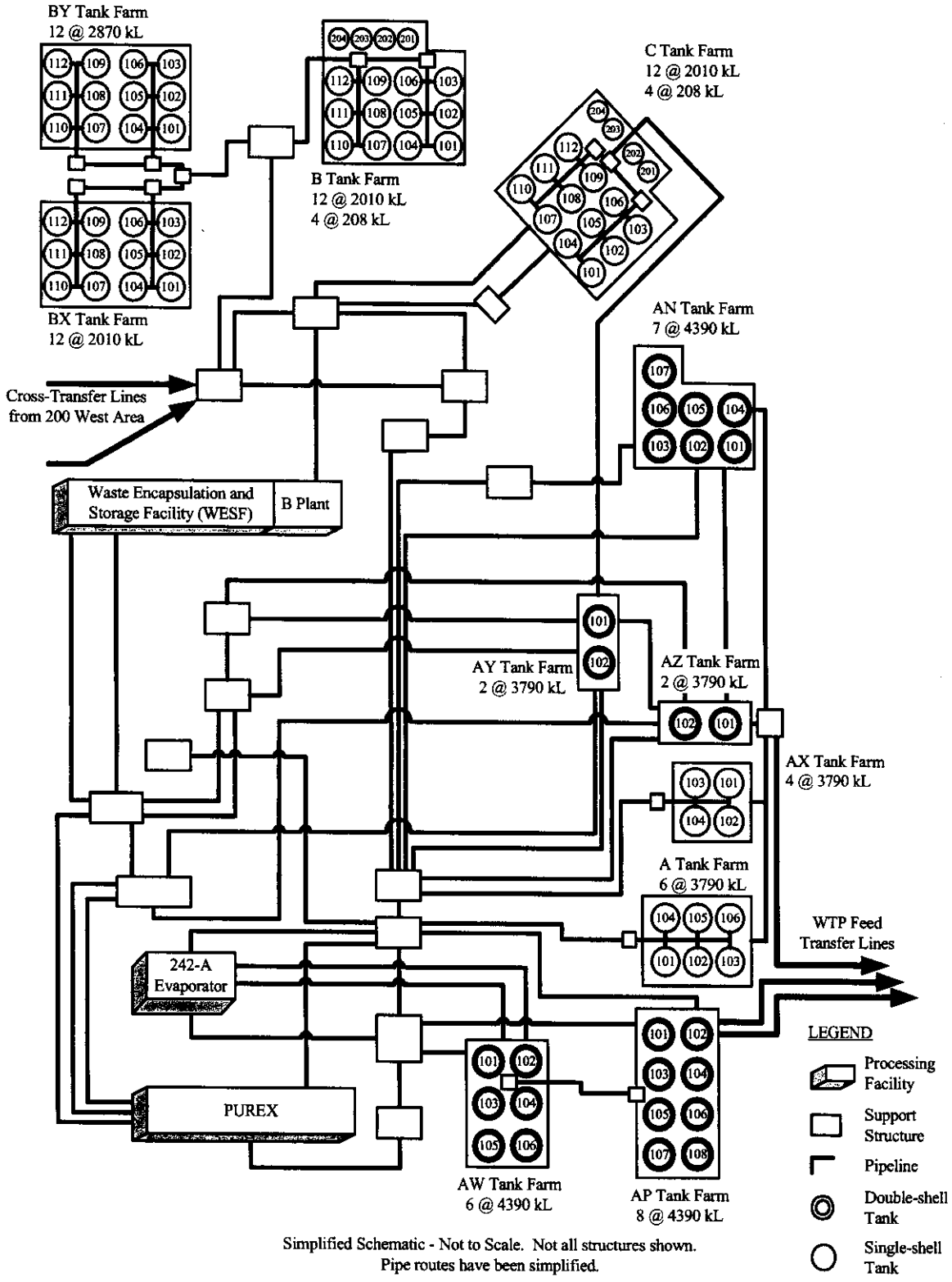


Figure 3-7 Tank Farms and Related Piping in 200 East



Simplified Schematic - Not to Scale. Not all structures shown.
Pipe routes have been simplified.

Figure 3-7 Tank Farms and Related Piping in 200 East



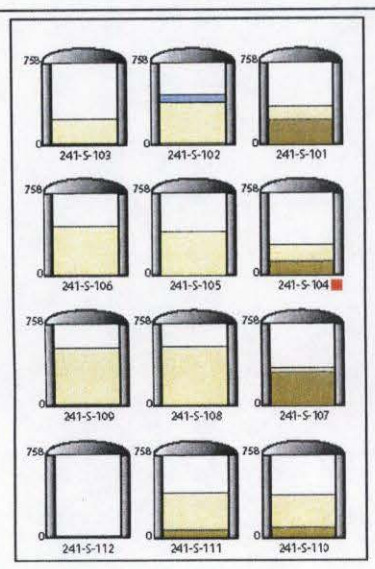
Simplified Schematic - Not to Scale. Not all structures shown.
Pipe routes have been simplified.

Figure 3-9 200 West Tank Waste Contents

200 West Tank Waste Contents

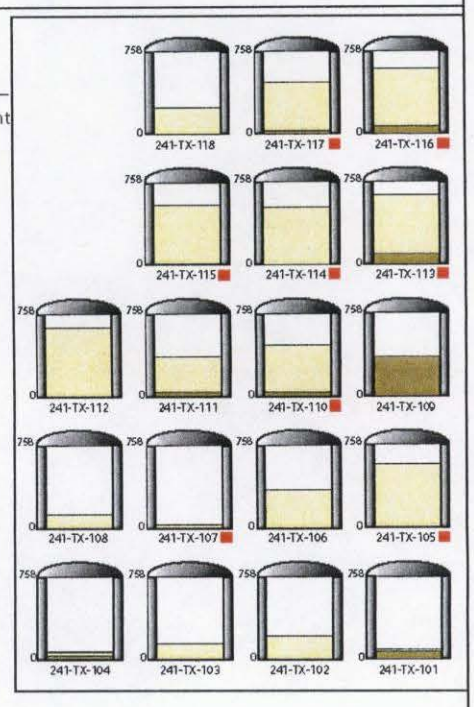
S-Tank Farm- 1950-51
12 @ 758 Kgal Tank Capacity, Single-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-S-101	235	117	0
241-S-102	22	369	73
241-S-103	9	227	1
241-S-104 ■	132	156	0
241-S-105	2	404	0
241-S-106	0	455	0
241-S-107	320	38	0
241-S-108	5	545	0
241-S-109	13	520	0
241-S-110	96	293	0
241-S-111	76	335	0
241-S-112	6	11	0



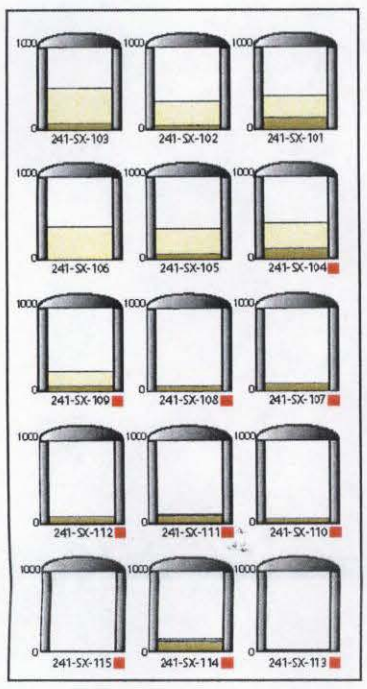
TX-Tank Farm- 1947-48
18 @ 758 Kgal Tank Capacity, Single-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-TX-101	74	17	0
241-TX-102	2	215	0
241-TX-103	0	145	0
241-TX-104	34	33	2
241-TX-105 ■	8	568	0
241-TX-106	5	343	0
241-TX-107 ■	0	29	0
241-TX-108	6	121	0
241-TX-109	363	0	0
241-TX-110 ■	37	430	0
241-TX-111	43	321	0
241-TX-112	0	634	0
241-TX-113 ■	93	545	0
241-TX-114 ■	4	528	0
241-TX-115 ■	8	545	0
241-TX-116 ■	66	533	0
241-TX-117 ■	29	451	0
241-TX-118	0	247	0



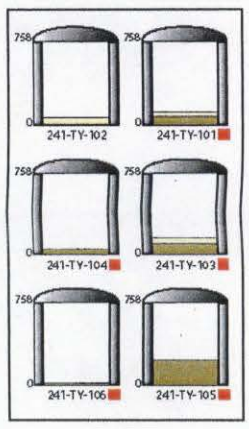
SX-Tank Farm- 1953-54
15 @ 1,000 Kgal Tank Capacity, Single-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-SX-101	144	275	0
241-SX-102	55	286	0
241-SX-103	78	431	0
241-SX-104 ■	136	310	0
241-SX-105	63	312	0
241-SX-106	0	396	0
241-SX-107 ■	94	0	0
241-SX-108 ■	74	0	0
241-SX-109 ■	66	175	0
241-SX-110 ■	49	7	0
241-SX-111 ■	98	17	0
241-SX-112 ■	75	0	0
241-SX-113 ■	19	0	0
241-SX-114 ■	126	29	0
241-SX-115 ■	4	0	0



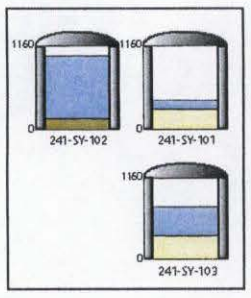
TY-Tank Farm- 1951-52
6 @ 758 Kgal Tank Capacity, Single-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-TY-101 ■	72	47	0
241-TY-102	0	69	0
241-TY-103 ■	103	51	0
241-TY-104 ■	43	0	1
241-TY-105 ■	231	0	0
241-TY-106 ■	16	0	0



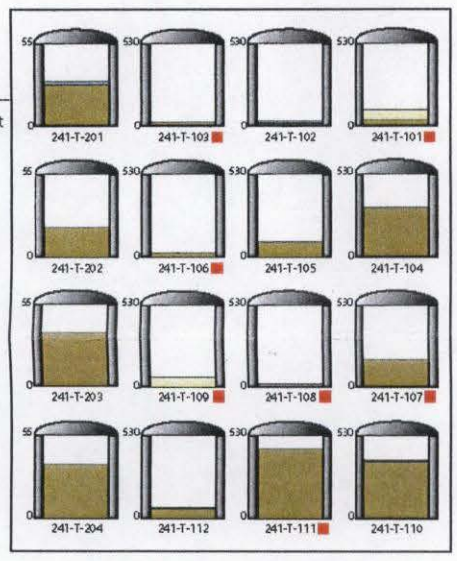
SY-Tank Farm- 1977
3 @ 1,160 Kgal Tank Capacity, Double-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-SY-101	0	275	125
241-SY-102	145	0	886
241-SY-103	0	342	399



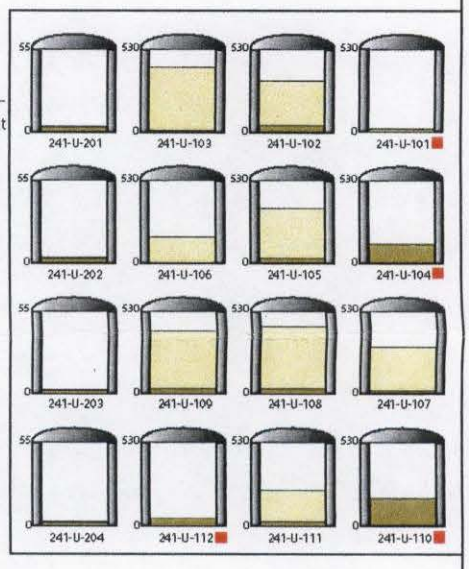
T-Tank Farm- 1943-44
12 @ 530 Kgal Tank Capacity, Single-Shell
4 @ 55 Kgal Tank Capacity, Single-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-T-101 ■	37	62	0
241-T-102	19	0	13
241-T-103 ■	23	0	4
241-T-104	317	0	0
241-T-105	98	0	0
241-T-106 ■	22	0	0
241-T-107 ■	173	0	0
241-T-108 ■	5	11	0
241-T-109 ■	0	62	0
241-T-110	369	0	1
241-T-111 ■	447	0	0
241-T-112	60	0	7
241-T-201	28	0	2
241-T-202	20	0	0
241-T-203	36	0	0
241-T-204	36	0	0



U-Tank Farm- 1946-49
12 @ 530 Kgal Tank Capacity, Single-Shell
4 @ 55 Kgal Tank Capacity, Single-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-U-101 ■	23	0	0
241-U-102	43	283	1
241-U-103	11	405	1
241-U-104 ■	122	0	0
241-U-105	32	321	0
241-U-106	0	168	2
241-U-107	15	279	0
241-U-108	29	405	0
241-U-109	35	366	0
241-U-110 ■	176	0	0
241-U-111	26	196	0
241-U-112 ■	45	0	0
241-U-201	3	0	1
241-U-202	3	0	1
241-U-203	2	0	1
241-U-204	2	0	1



LEGEND: Sludge; Saltcake; Supernatant; Available Space; Assumed/Confirmed Leaker ■

Data Derived From Waste Tank Summary Report Dated 03/31/05

Courtesy of CH2M Hill Group, Inc.

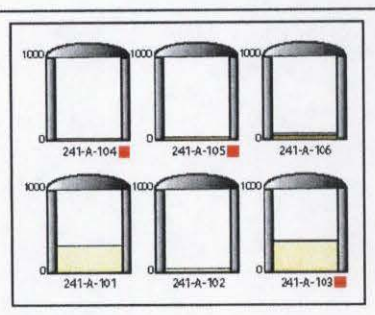
Figure 3-8 200 East Tank Waste Contents

200 East Tank Waste Contents

A-Tank Farm- 1954-55

6 @ 1,000 Kgal Tank Capacity, Single-Shell

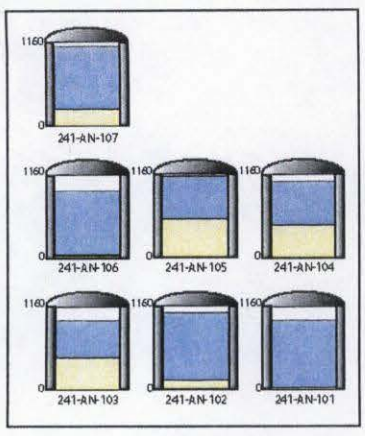
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-A-101	3	317	0
241-A-102	0	37	3
241-A-103 ■	2	364	4
241-A-104 ■	28	0	0
241-A-105 ■	37	0	0
241-A-106	50	29	0



AN-Tank Farm- 1981

7 @ 1,160 Kgal Tank Capacity, Double-Shell

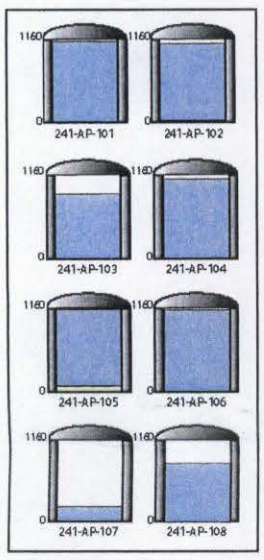
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-AN-101	0	31	927
241-AN-102	0	134	934
241-AN-103	0	459	499
241-AN-104	0	445	610
241-AN-105	0	538	587
241-AN-106	31	17	884
241-AN-107	0	230	871



AP-Tank Farm-1986

8 @ 1,160 Kgal Tank Capacity, Double-Shell

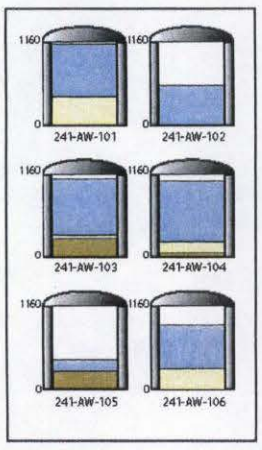
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-AP-101	0	0	1115
241-AP-102	23	0	1071
241-AP-103	0	0	893
241-AP-104	0	0	1098
241-AP-105	0	89	1049
241-AP-106	0	0	1134
241-AP-107	0	0	206
241-AP-108	0	0	1143



AW-Tank Farm-1980

6 @ 1,160 Kgal Tank Capacity, Double-Shell

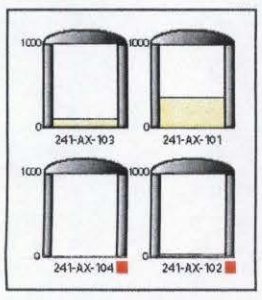
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-AW-101	0	396	732
241-AW-102	7	0	548
241-AW-103	273	40	785
241-AW-104	66	157	849
241-AW-105	263	0	156
241-AW-106	0	283	617



AX-Tank Farm- 1965-66

4 @ 1,000 Kgal Tank Capacity, Single-Shell

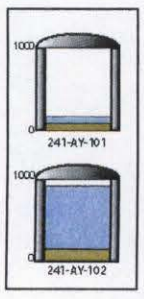
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-AX-101	3	355	0
241-AX-102 ■	6	24	0
241-AX-103	8	99	0
241-AX-104 ■	7	0	0



AY-Tank Farm- 1971-76

2 @ 1,000 Kgal Tank Capacity, Double-Shell

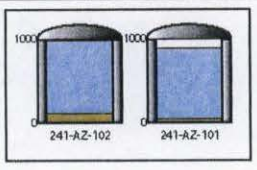
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-AY-101	96	0	81
241-AY-102	151	0	757



AZ-Tank Farm- 1975-76

2 @ 1,000 Kgal Tank Capacity, Double-Shell

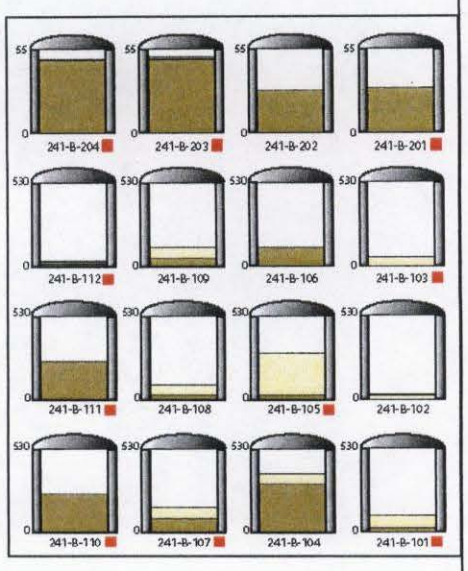
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-AZ-101	52	0	836
241-AZ-102	105	0	873



B-Tank Farm- 1945-47

12 @ 530 Kgal Tank Capacity, Single-Shell
4 @ 55 Kgal Tank Capacity, Single-Shell

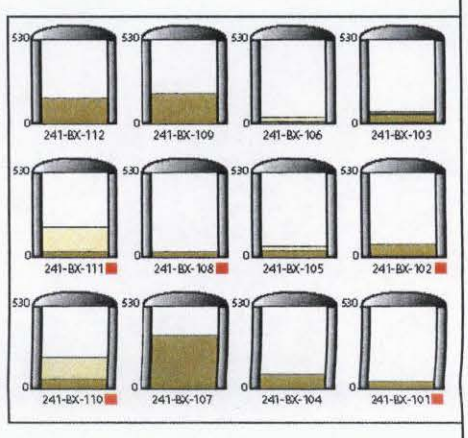
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-B-101 ■	28	81	0
241-B-102	0	28	4
241-B-103 ■	1	55	0
241-B-104	309	65	0
241-B-105 ■	28	262	0
241-B-106	122	0	1
241-B-107 ■	86	75	0
241-B-108	27	65	0
241-B-109	50	75	0
241-B-110 ■	244	0	1
241-B-111 ■	241	0	1
241-B-112 ■	15	17	3
241-B-201 ■	29	0	0
241-B-202	28	0	0
241-B-203 ■	49	0	1
241-B-204 ■	48	0	1



BX- Tank Farm- 1948-50

12 @ 530 Kgal Tank Capacity, Single-Shell

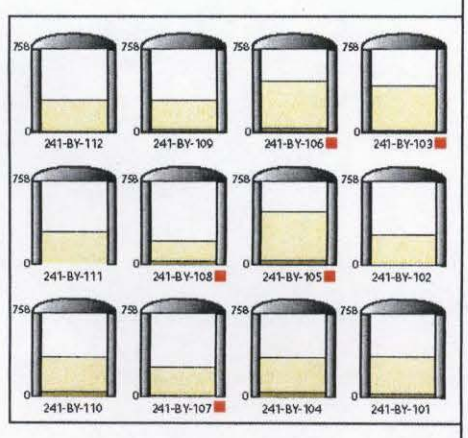
Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-BX-101 ■	48	0	0
241-BX-102 ■	79	0	0
241-BX-103	62	0	13
241-BX-104	97	0	3
241-BX-105	42	25	5
241-BX-106	10	28	0
241-BX-107	347	0	0
241-BX-108 ■	31	0	0
241-BX-109	193	0	0
241-BX-110 ■	65	139	1
241-BX-111 ■	32	157	0
241-BX-112	163	0	1



BY-Tank Farm- 1950-51

12 @ 758 Kgal Tank Capacity, Single-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-BY-101	37	333	0
241-BY-102	0	279	0
241-BY-103 ■	9	408	0
241-BY-104	45	313	0
241-BY-105 ■	48	433	0
241-BY-106 ■	32	430	0
241-BY-107 ■	16	256	0
241-BY-108 ■	40	182	0
241-BY-109	24	263	0
241-BY-110	43	323	0
241-BY-111	0	301	0
241-BY-112	2	284	0

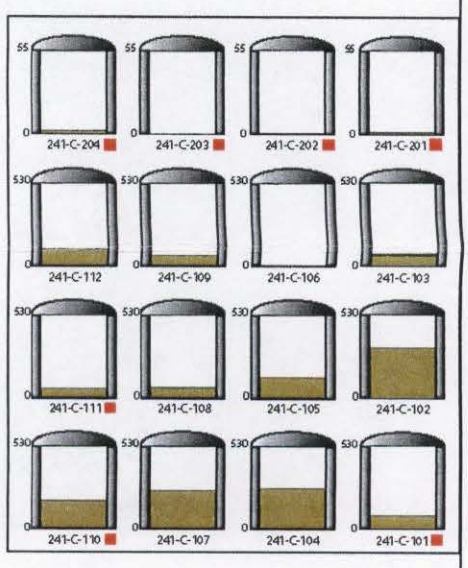


C-Tank Farm- 1946-53

12 @ 530 Kgal Tank Capacity, Single-Shell
4 @ 55 Kgal Tank Capacity, Single-Shell

Tank	Sludge (Kgal)	Saltcake (Kgal)	Supernatant (Kgal)
241-C-101 ■	88	0	0
241-C-102	316	0	0
241-C-103	71	0	4
241-C-104	259	0	0
241-C-105	132	0	0
241-C-106	3	0	0
241-C-107	247	0	0
241-C-108	66	0	0
241-C-109	63	0	0
241-C-110 ■	177	0	1
241-C-111 ■	57	0	0
241-C-112	104	0	0
241-C-201 ■	1	0	0
241-C-202 ■	0*	0	0
241-C-203 ■	0*	0	0
241-C-204 ■	2	0	0

* (Less than 500 gallons)



LEGEND: Sludge ■ Saltcake ■ Supernatant ■ Available Space ■ Assumed/Confirmed Leaker ■

Data Derived From Waste Tank Summary Report Dated 03/31/05

Courtesy of CH2M Hill Group, Inc.

Figure 3-10 Typical Single-Shell Tank

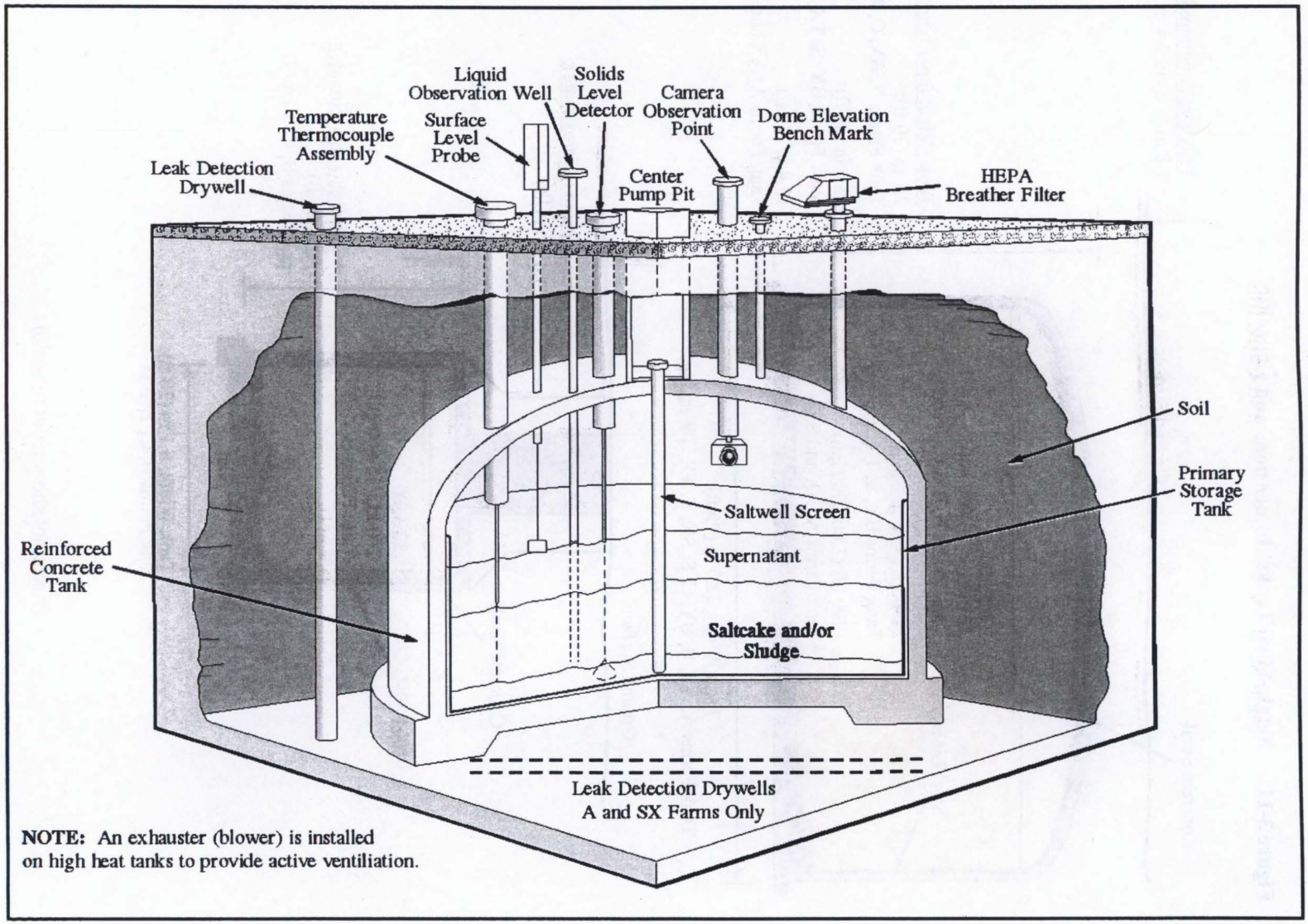
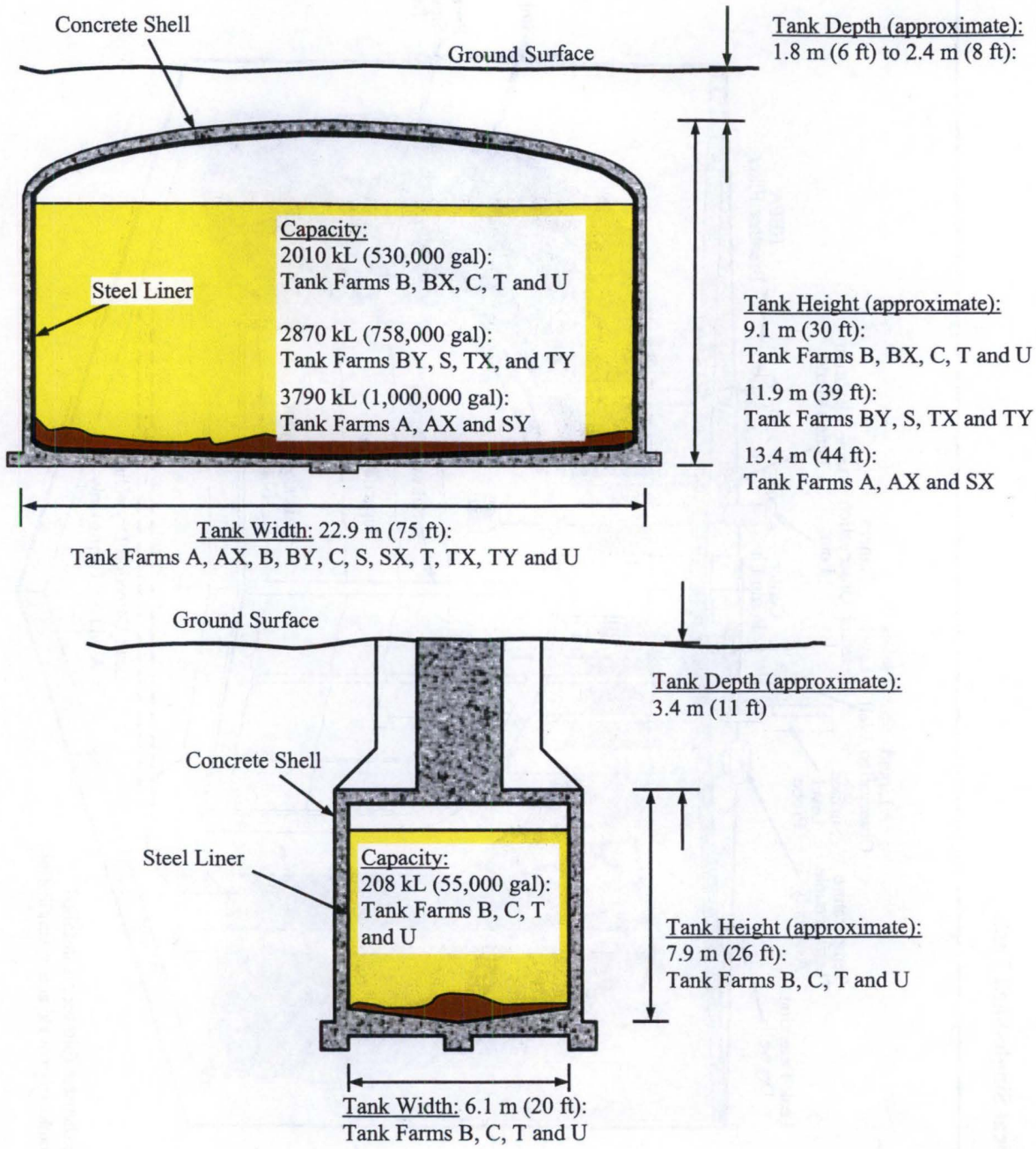


Figure 3-11 Single-Shell Tanks' Dimensions and Capacities



(risers not shown, not to scale)

Figure 3-12 Single-Shell Tanks' Construction

Figure 3-13 Typical Double-Shell Tank

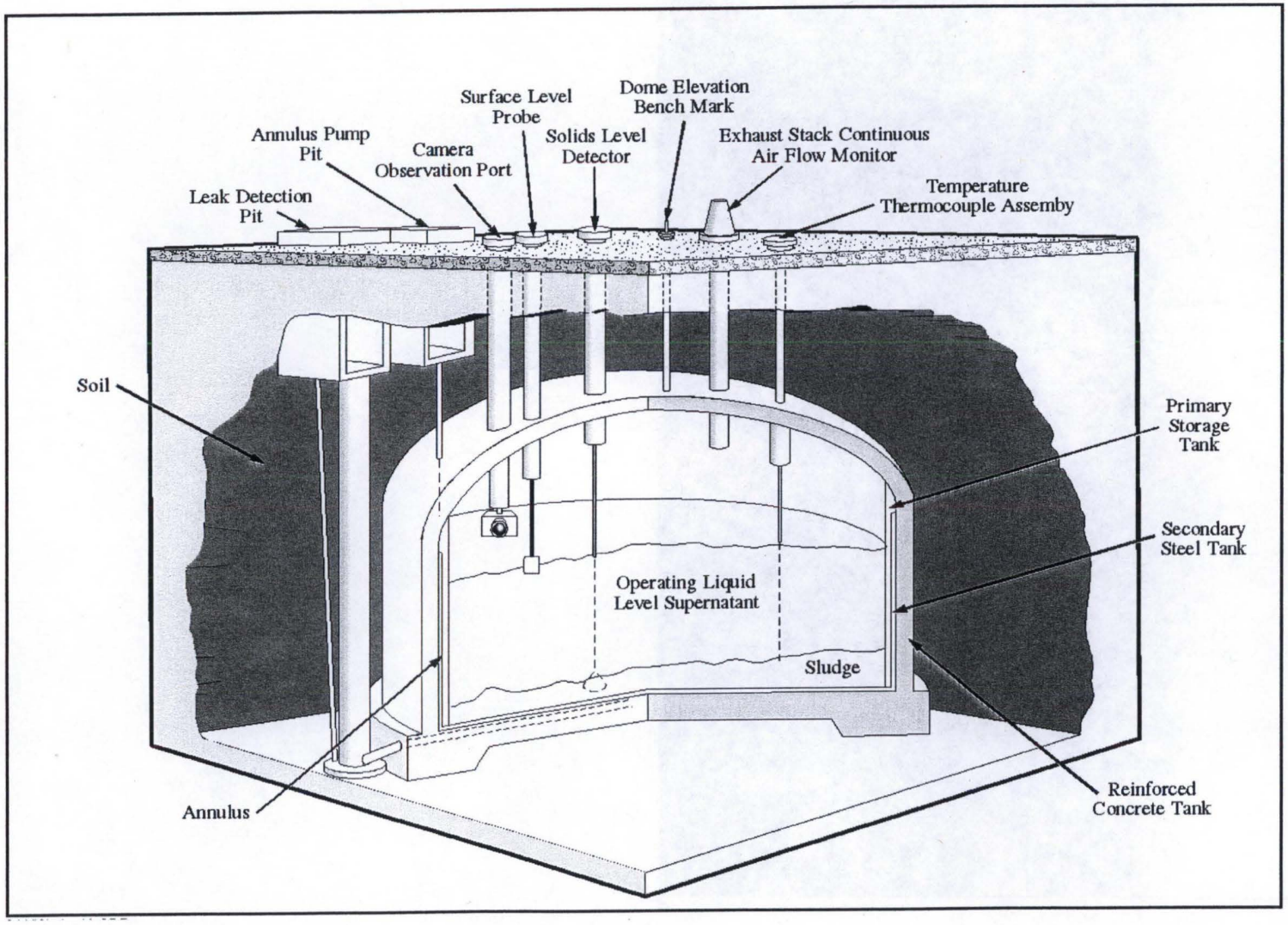
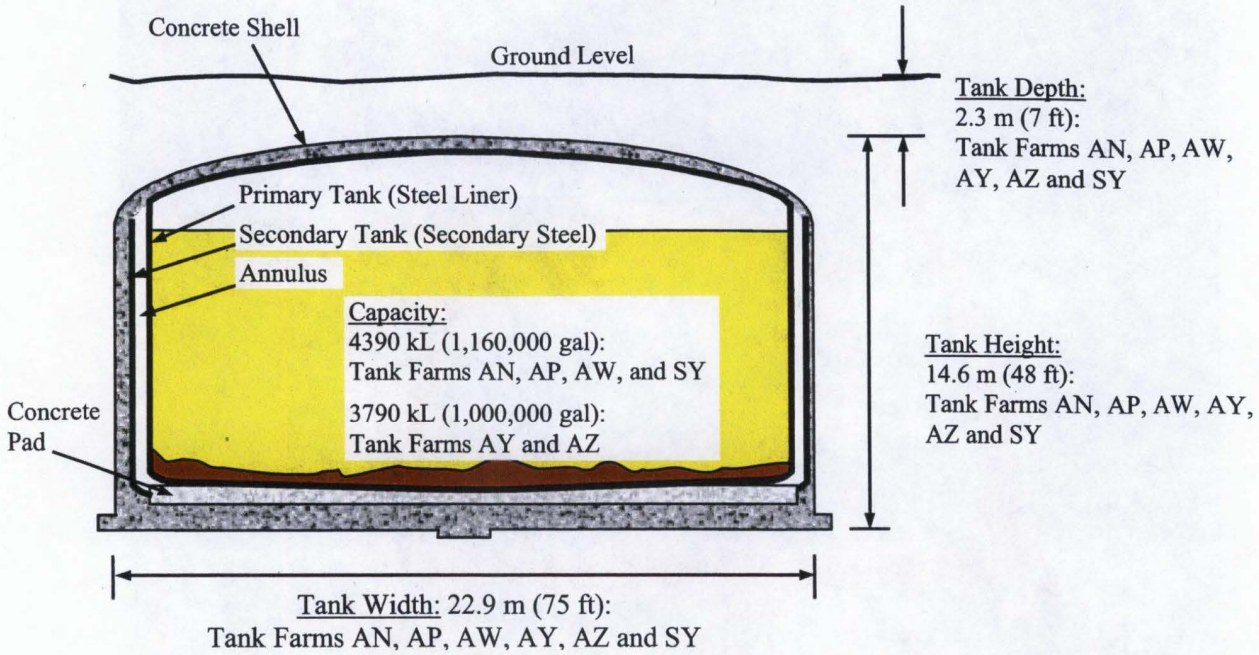


Figure 3-14 Double-Shell Tank Dimensions and Capacity



(risers not shown, not to scale)

Figure 3-15 Double-Shell Tank Construction

Figure 3-16 Simplified Process Diagram

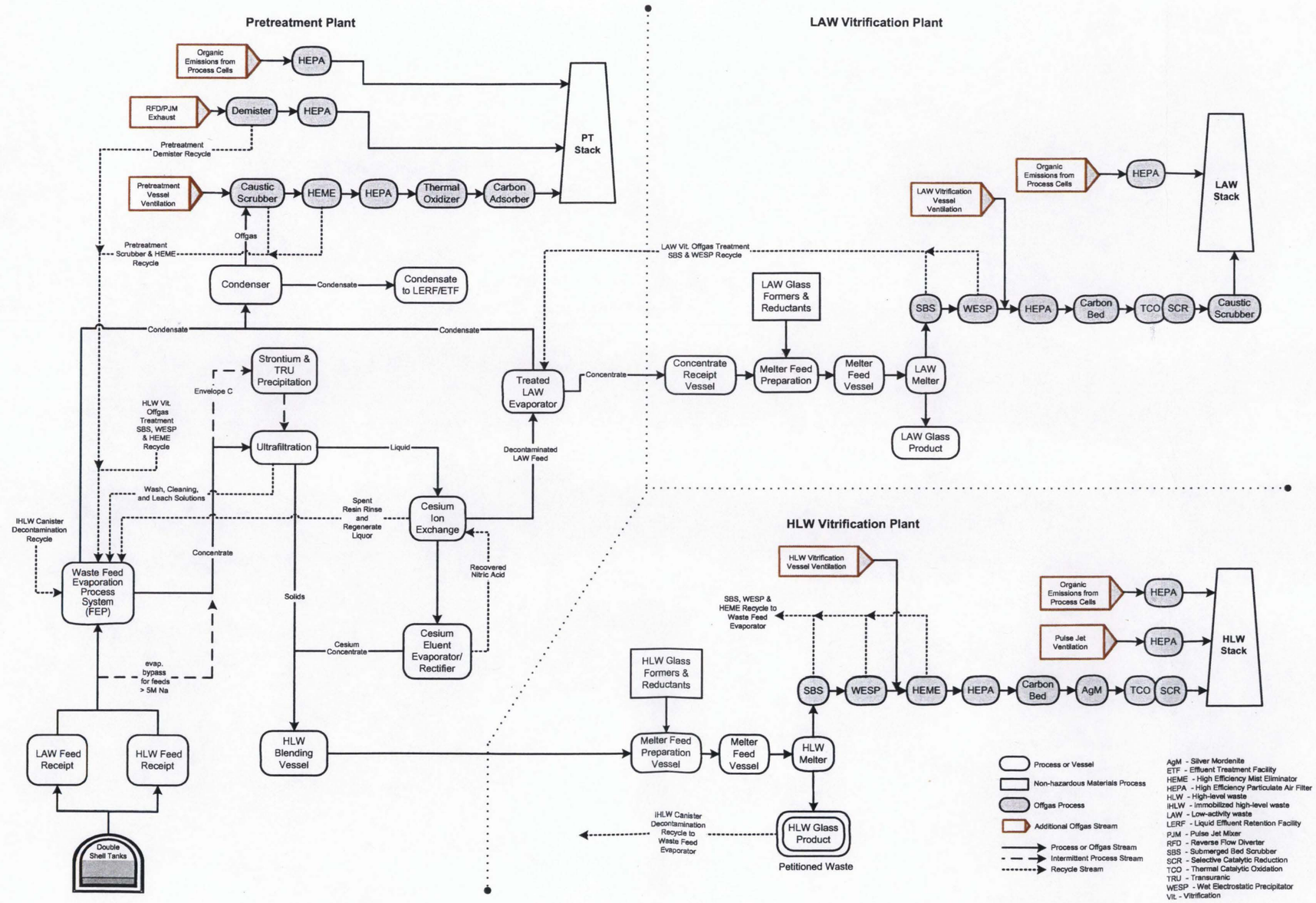


Figure 3-17 Section of the High-Level Waste Melter

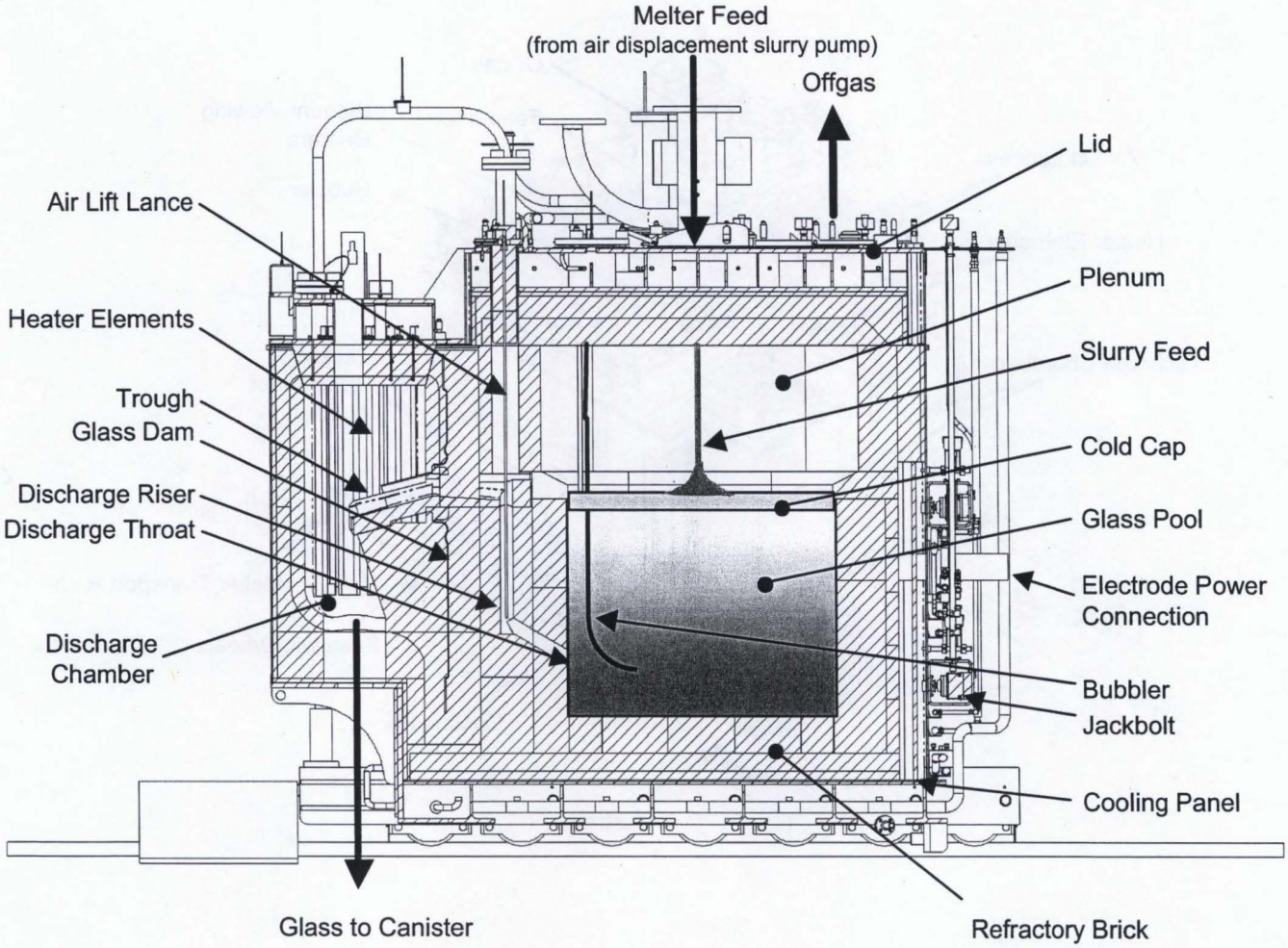


Figure 3-18 HLW Melter Isometric Rendering

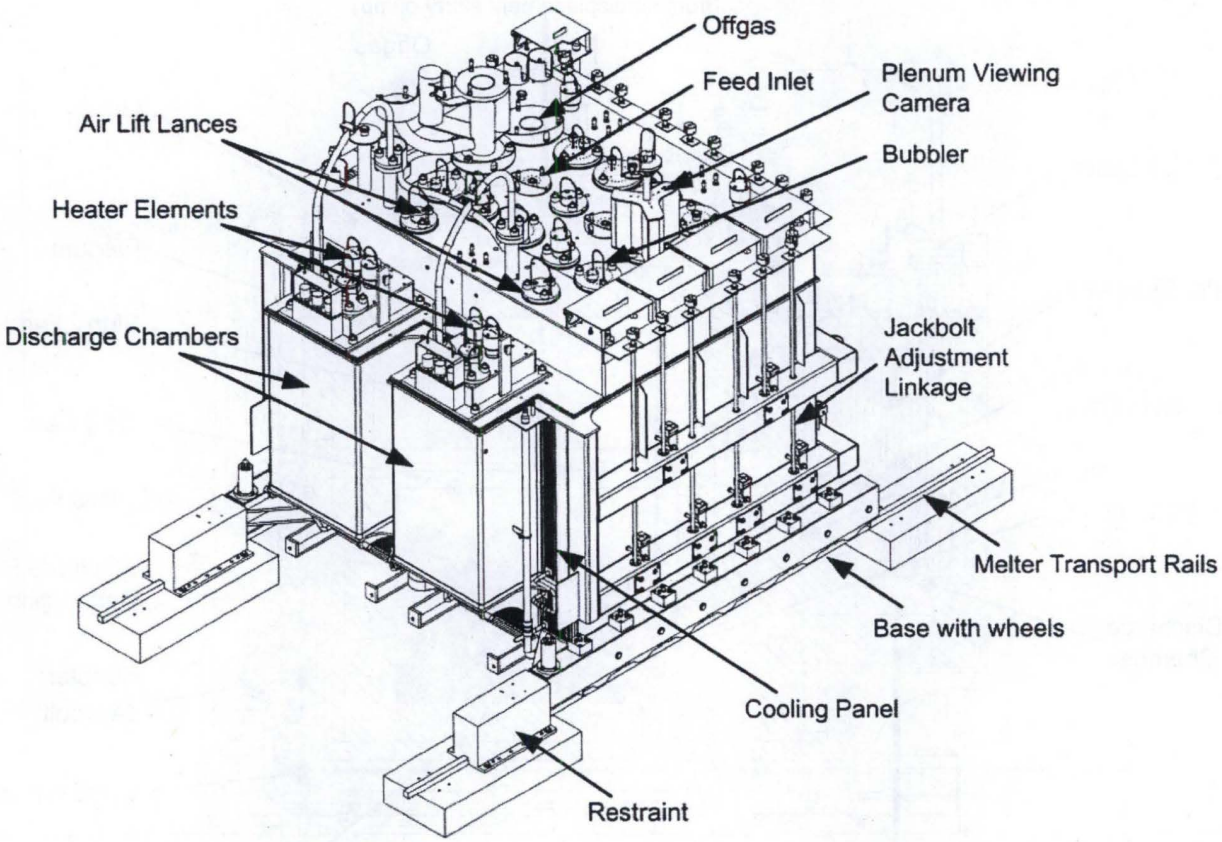


Figure 3-19 Cooling Containment of Molten Glass

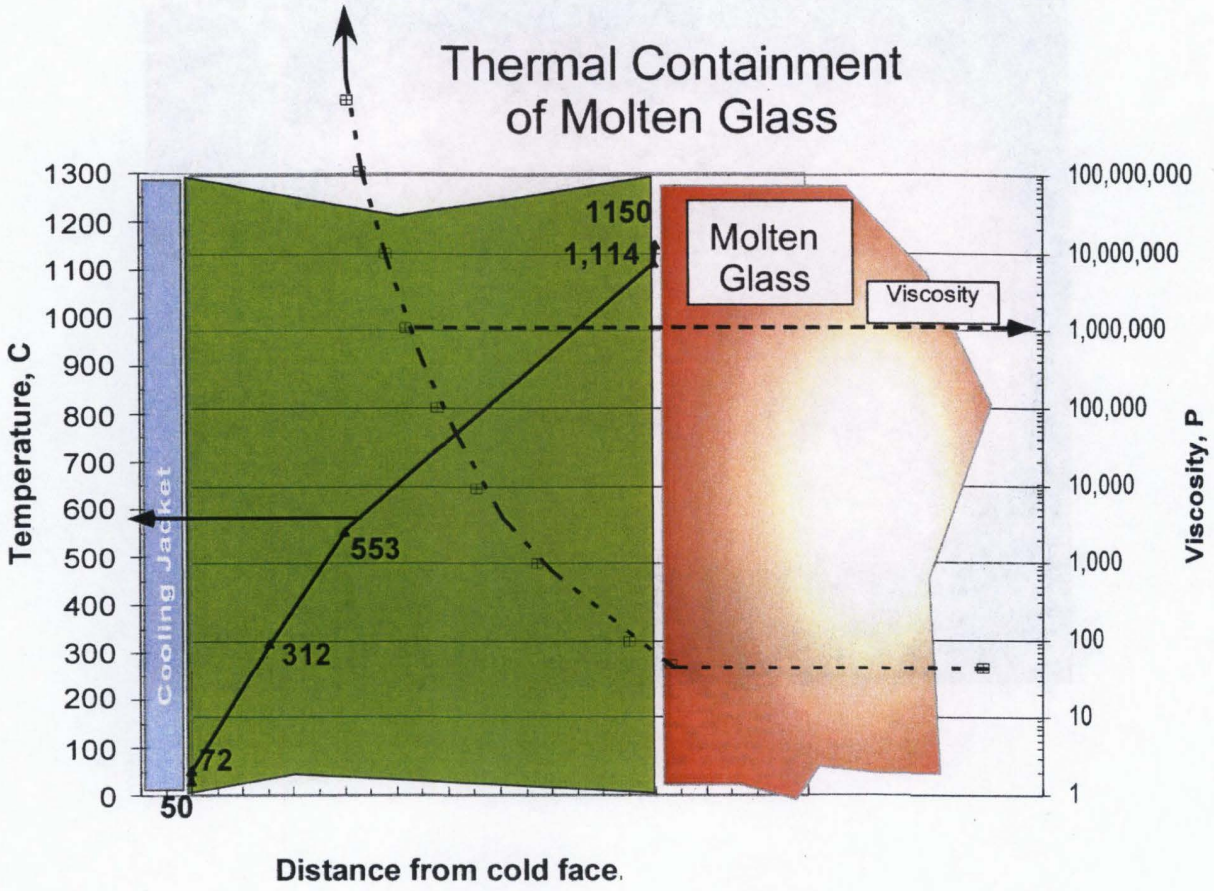


Figure 3-20 Melter Interior at Start Up (No Cold Cap)

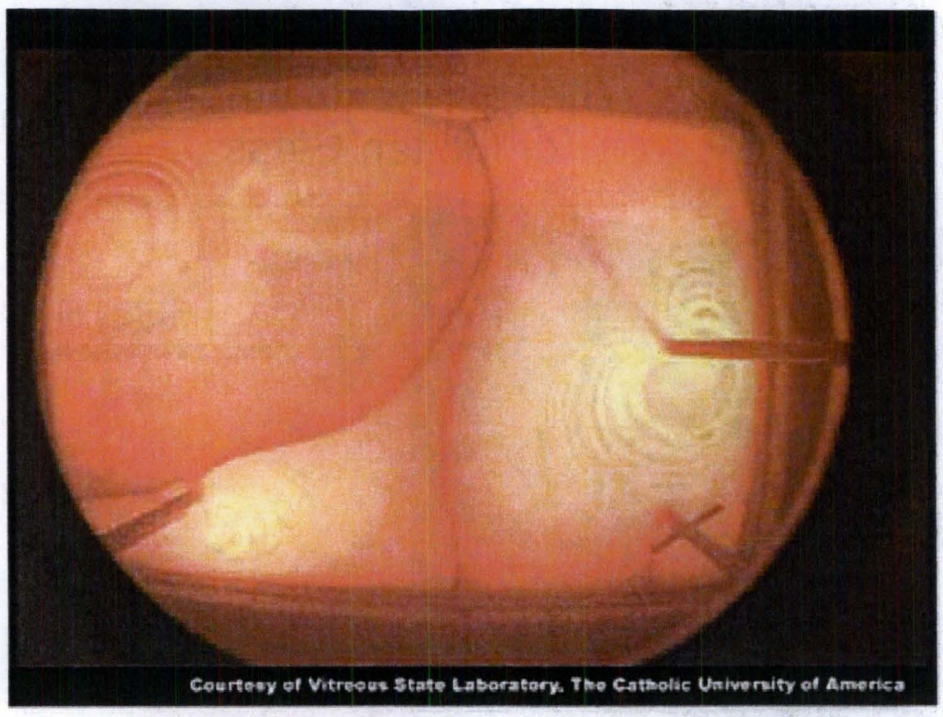


Figure 3-21 Melter Interior with Partial Cold Cap

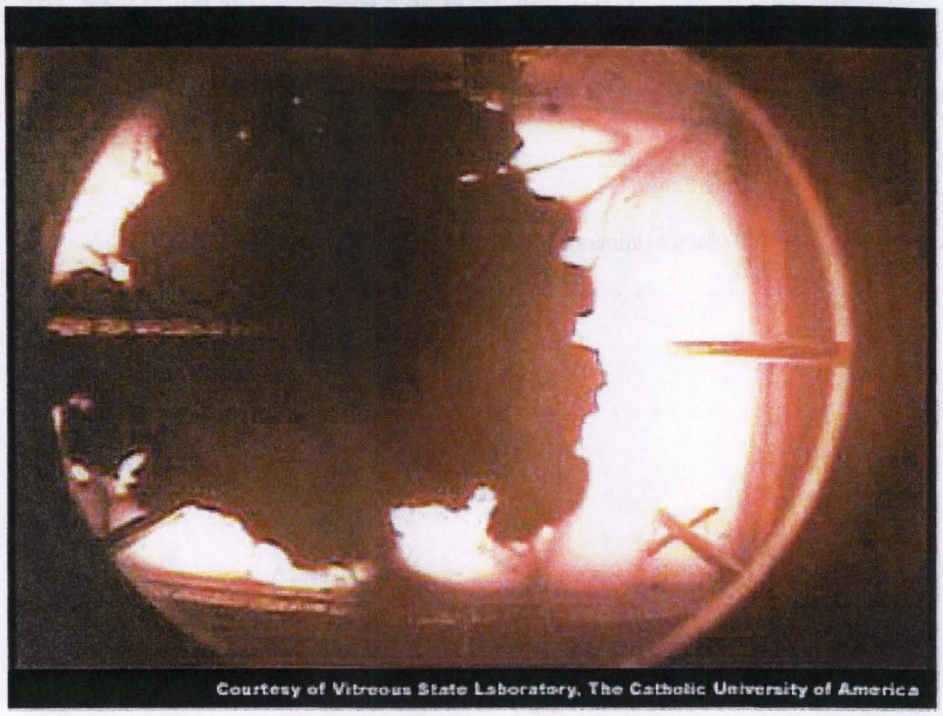
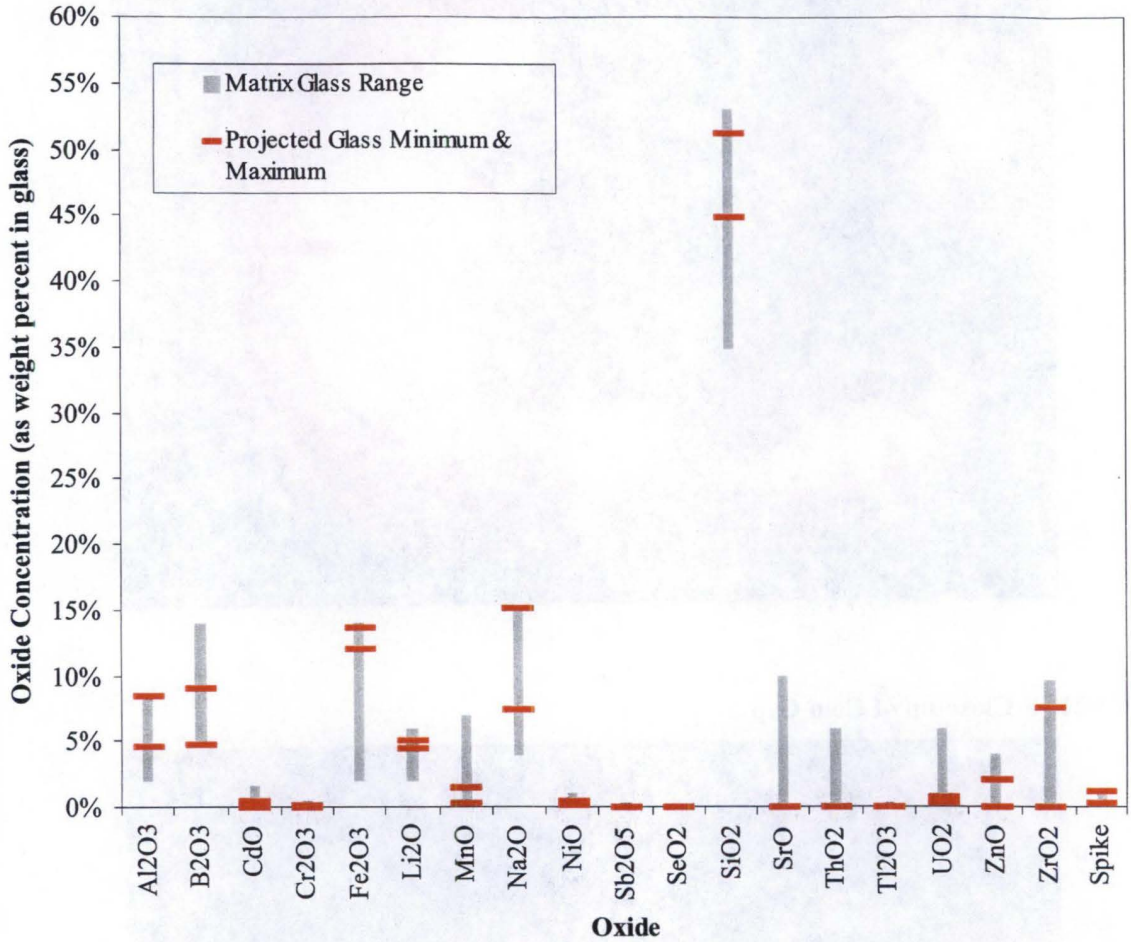


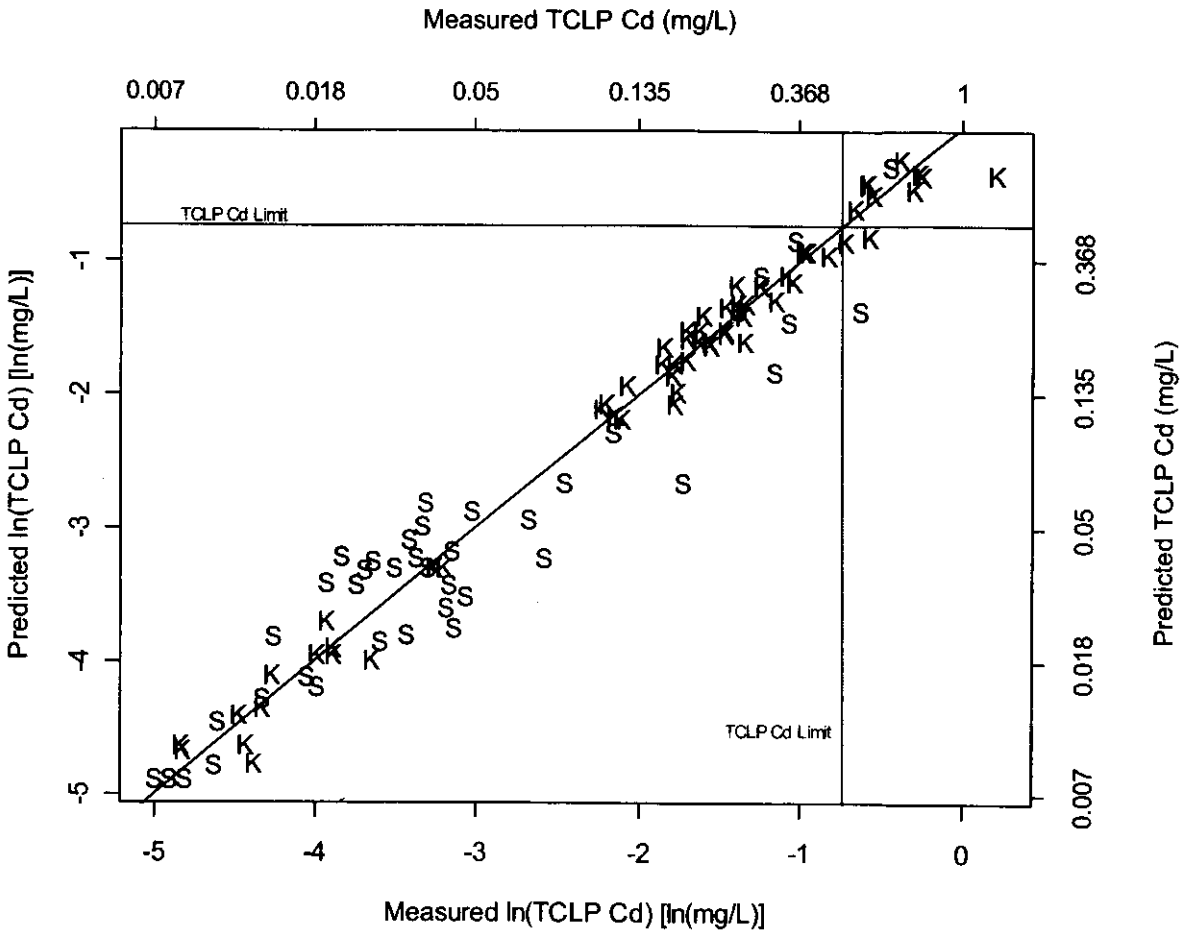
Figure 3-22 Close-up of Cold Cap

Figure 3-23 Comparison of Test Matrix and Estimated Melter Feeds for 241-AZ-101, 241-AZ-102, 241-C-106/AY-102, and 241-C-104/AY-101



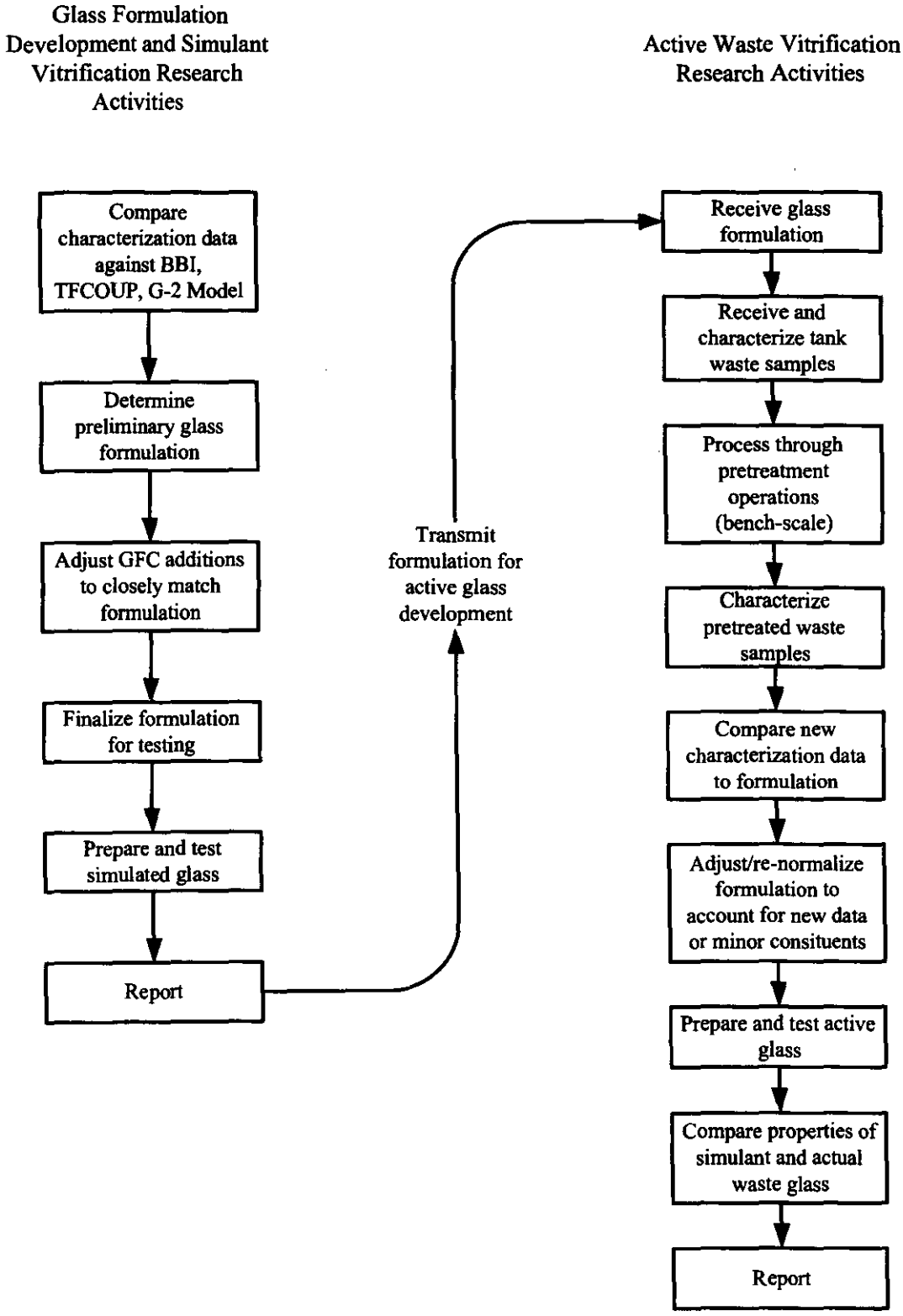
Spike = sum of contributions of Ag2O, As2O5, BaO, CuO, PbO, V2O3 (weight percent)

Figure 3-24 PvM Plot for the TCLP Response-Glass Composition Model



STL-Knoxville data denoted by "K", and STL-St.Louis data denoted by "S". (refer to section 5.3.1.2)

Figure 3-25 Glass Formulation and Testing Process



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4 Delisting Analytical Plan Development [Part 4]

4.1 Constituents of Concern [Part 4: 1]

The constituents of concern (COCs) proposed for testing in support of delisting are listed in Table 4-1. This list is a subset of the COPC starting list and includes antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, vanadium, and zinc. The vitrification process removes or destroys organics, cyanides, and mercury. The methodology for screening the starting list of COPCs to the COCs for testing in support of delisting is summarized in Section 4.3.

Additional technical details regarding target constituents and the regulatory characterization of the Hanford tank waste are in *Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project* (Wiemers et al. 1998).

4.2 Estimates for Constituents of Concern Not Analyzed [Part 4: 2]

The COCs proposed for testing (Table 4-1) have not been definitively quantitated (in the DSTs before processing) by RCRA-compliant laboratory analysis or mass-balance demonstrations. It has been difficult to definitively quantitate the COCs proposed for testing in the source tanks because of the difficulty in obtaining representative samples of the tank wastes [1]. RCRA-compliant samples are likewise not always achievable[2]. In addition, characterization to date has prioritized tank waste constituents that were viewed as important to resolution of tank safety issues.

Many non-organic COC concentrations have been estimated, within bounds, by engineering studies based on waste analysis and process history. Each of the waste tanks identified as sources of feed to the WTP have an associated tank characterization report. These reports contain Best Basis Inventory evaluations of selected tank constituent inventories, based on sampling and engineering studies. However, tank characterization reports are computer-generated and change as new information is researched and added to existing reports; therefore, they are difficult to reference. The most recent computer-generated reports are not provided with this petition for reasons of facility security; however, they will be made available to regulatory agencies upon request.

Tank characterization reports include inventories for many of the initial feed tanks and include data on aluminum, lead, mercury, nickel, potassium, sodium, total chromium, and calcium. However, data represent inventories, not concentration, and it is not always possible to partition the inventory into the liquid and solid phases of the waste.

There is relatively little characterization information on regulated, organic COCs in the waste tanks. Nearly all such information is based on unconfirmed, tentatively identified compounds measured in the vapor space of some of the SSTs. The data contain a large number of analytical artifacts that limit their utility (Wiemers et al. 1998). Some data on organics has been generated from the implementation of the

[1] Representative samples are not achievable because of a very limited number of sampling access points in the tanks; because the waste tends to form nonhomogeneous layers, piles, ledges, and/or drifts within the tanks; and because existing sampling equipment cannot always adequately sample all layers and depths of the waste.

[2] RCRA-compliant samples require procedures, such as specific seals on bottles and refrigeration requirements, that cannot be achieved because of the constraints of handling radioactive materials (Wiemers et al. 1998).

Regulatory DQO, summarized in Section 3.2.3.2.5 of this petition. In addition, the concentrations of the COCs will change as the waste feed is transferred to the WTP and subjected to pretreatment.

The COCs anticipated to be in the feed have been determined by engineering studies. As previously discussed, feed received from the tank farms will be subject to various unit operations as part of pretreatment. WTP feeds will be condensed (through evaporation), washed and leached, filtered, and subjected to cesium removal (ion exchange). Each unit operation will likely affect the composition of specific constituents in the feed stream. For instance, evaporation will reduce the overall organic content of the feed by boiling off lightweight volatile constituents. Filtration will remove solids, including conglomerated metals and some semivolatile organics, from the LAW fraction of the waste, which, in turn, will be added to the separated HLW feed stream. Ion exchange will remove ^{137}Cs from the LAW stream, which will be added to HLW stream when the ion exchange resin is reconditioned for reuse. The addition of various recycle streams will increase the overall moisture content of the feed since water is a primary component of the recycle streams. The predicted composition of the feed steams, and the impact of various unit operations in the WTP have been modeled, but have yet to be finalized. Preliminary estimates are available as a result of the *2003 Material Balance and Process Flowsheet Assessment* (24590-WTP-RPT-PO-03-050). The material balance and process flowsheet assessment presents results from the Aspen Custom Modeler (ACM) Steady-State Flowsheet Model, using operating assumptions found in 24590-WTP-RPT-PT-02-005 and 24590-WTP-RPT-PO-03-041. The model estimates the impact of WTP unit operations to 51 organics, 8 organic complexants, 30 radionuclides, and 57 inorganic constituents that are potentially present in the tank waste feed.

In addition, engineering studies of the waste at the Defense Waste Processing Facility (DWPF) at the DOE's Savannah River Site (Supplement 2, Appendix H) have determined that the treatment technology will destroy or remove (volatilize) all identified organics and cyanide. This conclusion has been endorsed by EPA in a policy paper, *Hanford Federal Facility Waste Treatment Plant High-Level Waste Delisting and LDR Compliance White Paper Organic Constituent Destruction/Removal Performance in Vitrified Glass Wastes* (Supplement 3). Therefore, the immobilization strategy for the COCs focuses primarily on inorganic compounds.

4.3 Constituents of Concern Not on List [Part 4: 3]

The LDR/Delisting DQO (Supplement 2) describes the methodology and logic used to identify and screen (narrow) the constituents of potential concern (COPCs) for delisting as discussed below. The LDR/Delisting DQO (Supplement 2, Appendix D, Table D-1) states that the COPC starting list consists of 485 inorganic, organic, and organometallic constituents from the following sources:

- Appendix VIII list from 40 CFR 261
- Universal Treatment Standards from 40 CFR 268.48
- EPA Delisting Guidance Manual (EPA 2000)
- DST portion of the Part A Hanford Facility RCRA permit (Ecology 2001)

During the LDR/delisting DQO process (Supplement 2), 308 constituents from the starting list of 485 COPCs were excluded from further consideration for delisting because they were never used at Hanford, or are unstable in the oxidizing, caustic, and high-radiation tank environment. The remaining 177 constituents, consisting of 46 inorganics, 6 organometallics, and 125 organics, were further evaluated as discussed below.

Appendix D of the LDR/Delisting DQO (Supplement 2) discusses the screening logic in greater detail.

4.3.1 Organic Constituents

The EPA Handbook, *Vitrification Technologies for Treatment of Hazardous and Radioactive Waste* (EPA 1992), makes the following observation:

> "Pyrolysis in the intense heat within the molten bath generally destroys organic wastes. Organic wastes not destroyed by pyrolysis are generally destroyed by combustion in a region separate from the melt." (EPA 1992)

In the late 1990's DOE began publishing a series of studies that demonstrate that organic constituents of potential environmental concern are absent from vitrified waste forms. This conclusion applies to Hanford wastes produced from the vitrification of HLW, as well as vitrified wastes from Savannah River's DWPF and the West Valley Demonstration Project (WVDP). The work reported by DOE tested organic compound survivability in small-scale and pilot-scale (one-third of actual design) vitrification experiments conducted with waste simulants and select organic compounds, as well as with small-scale experiments conducted with actual Hanford waste streams. Within the limits of analytical detectability, all experiments consistently resulted in 100 % removal/destruction of the organic compounds from the resultant vitrified products. In isolated cases, ultra-low levels of some organics (far below the limits of regulatory concern) were found. The ultra-low levels of some organics were traceable to background contamination in the analytical laboratory.

The results of all studies supported the basic premise of organic destruction in vitrification processes; that is, at sufficiently high temperatures (950 °C to 1250 °C) and long enough residence times, organic compounds were destroyed by kinetic processes (reaction between two or more chemical species). Actual molten glass temperatures in the WTP melters will be 950 °C to 1250 °C. Because the glass must heat in the melters long enough to become pourable, no organic compounds will survive the glass melting process.

Studies support the position that vitrification effectively eliminates the organics from the vitrified glass wastes (Supplement 2, Appendix H). In a letter to the DOE, the EPA transmitted a policy document, *Hanford Federal Facility Waste Treatment Plant High-Level Waste Delisting and LDR Compliance White Paper Organic Constituent Destruction/Removal Performance in Vitrified Glass Wastes* (EPA 2003, enclosed as Supplement 3), that "establishes EPA's position that vitrification units, such as that constructed as part of WTP are expected to provide effective destruction or removal of organics from vitrified high-level waste." The EPA states that organic waste constituents in the glass matrix are removed or destroyed through mechanisms distinct from those that result in formation of a glass matrix, and are not incorporated into, nor immobilized by, the final glass matrix. These destruction and removal efficiencies are based on chemical kinetics (pyrolysis and combustion), which are well established through basic chemical principles. The EPA notes specifically that vitrification takes place at sufficiently high temperatures to effectively destroy or remove organics from the vitrified residual.

Therefore, organic COPCs will not be tested or considered further in this petition.

4.3.2 Cyanide

In the glass, the anions will not be closely bonded to any single element, as they will associate with various alkali or alkaline earth metals. The cations will normally be in the oxide or silica form and will be in the tetrahedral bond system. These anion/cation forms are not listed in the EPA's Delisting Risk Assessment Software (DRAS), with the possible exception of cyanide. Cyanide is the only anion that has

a delisting level applicable to this project in the DRAS model. Cyanide has been reported in the tanks. The EPA vitrification technology handbook (EPA 1992) indicates "compounds such as cyanide...decompose to their constituent molecules and atoms, and then follow the path typical of inorganics"; that is, cyanide decomposes to carbon and nitrogen.

Although cyanide is generally not considered an organic constituent, it is amenable to vitrification, and its behavior is considered equivalent to organics with respect to the physical and chemical organic destruction and removal. For added conservatism, however, cyanide was evaluated as part of the testing described in Section 5 of this petition. As with organics, within the limits of analytical detectability, all experiments consistently resulted in 100 % removal/destruction of cyanide from the resultant vitrified products.

Therefore, cyanide will not be tested or considered further in this petition.

For more detail, see *Hanford Federal Facility Waste Treatment Plant High-Level Waste Delisting and LDR Compliance White Paper Organic Constituent Destruction/Removal Performance in Vitrified Glass Waste* (Supplement 3).

4.3.3 Mercury

Mercury is a volatile metal, and its behavior is considered equivalent to organics with respect to the physical removal. Mercury was evaluated as part of the testing described in Section 5 of this petition. As with organics, within the limits of analytical detectability, all experiments consistently resulted in 100 % removal of mercury from the resultant vitrified products; however, since mercury has been detected in the tank waste, it is retained as a COC.

4.3.4 Ignitability, Corrosivity, and Reactivity

Ignitability (D001) and corrosivity (D002) codes have been assigned to the waste. Because the final glass waste form will be produced by processing at temperatures above 1000 °C (1830 °F), it cannot be ignitable or corrosive under standard conditions. Therefore, no testing was conducted to confirm the IHLW should not retain these codes. In addition, the feed materials have been determined to not possess the characteristic of reactivity (D003) based on process knowledge (Appendix 3A [Section 3.6] of Attachment 51 of Chapter 10 of the Hanford Facility RCRA Permit [WA7890008967]). Because the feed will be subjected to the temperatures described above and, when cooled, will form an extremely stable waste form, the final glass waste form will not designate for reactivity, and no testing is planned for this characteristic.

4.3.5 Inorganic and Organometallic Constituents

The 46 inorganic and 6 organometallic COPCs were evaluated in the LDR/Delisting DQO (Supplement 2) for potential exclusion from testing in support of delisting. Organometallics were evaluated based on the cation (metal) component of the compound. Table 3-2 in Supplement 2 provides detailed logic and references for exclusion of various cations and anions. Rationales for exclusion include extreme volatility (e.g., ammonia), unavailability of data required for the DRAS input (Section 4.4) (i.e., bromide), and a determination that the analyte was not used at the Hanford Site (i.e., osmium).

During TCLP testing of the glass, sodium buffers must be added. Because sodium is not itself listed as a hazardous constituent but only appears in 40 CFR 261, Appendix VIII, as part of a compound where the anion causes the hazard, and sodium does not have a DRAS value, it is not logical to analyze for the

metal. The same argument applies to oxides of aluminum, calcium, potassium, and phosphorous[3], which do not have DRAS values and thus have no proposed delisting levels.

4.4 Delisting Levels and Hazardous Waste Characteristics [Part 4: 4]

Eight TC metals and seven underlying hazardous constituents remain on the final list of anions and metals proposed for testing in Section 4.1: arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and antimony, copper, beryllium, nickel, thallium, vanadium, and zinc, respectively.

As discussed above, the petitioned waste treatment process removes organic COCs, producing IHLW. Therefore, the only hazardous waste characteristics remaining are the TCs. The petitioned waste will not exhibit the characteristic of toxicity if the eight TC metals are successfully immobilized, such that their respective proposed delisting levels are not exceeded (the TC levels are the same or higher than the calculated delisting levels). The methodology used to determine proposed delisting levels for the COCs described in this petition is summarized below. (This summary includes all COCs, not just the TC metals.)

The proposed delisting levels were determined using DRAS and the TC concentrations (40 CFR 261.24). Input into the DRAS model is as follows:

Cancer Risk Level:	10^{-5}
Hazard Quotient:	0.25
Waste Management Unit Type:	Landfill
Waste Management Unit Active Life:	40 years
Annual Volume:	765 m^3 (1000 yd^3)
Constituents:	Antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc

Model inputs (e.g., cancer slope factors, reference doses, bio-concentration factors) were the standard inputs from the database that is part of the model, with one exception. The maximum contaminant level (MCL) for arsenic in the model database is 0.05 mg/L; this was changed to 0.01 mg/L to reflect the recent reduction in the arsenic MCL (66 FR 6975, 22 January 2001).

For the waste management and disposal scenario for the waste that is the subject of this petition, analysis of the groundwater scenario is relevant. The waste will be glass encased in stainless steel canisters, and no volatile organics will be associated with the waste form. Therefore, exposures during or shortly after the disposal of the waste via air particulate or volatile inhalation, soil ingestion, or fish or surface water ingestion are not pathways of concern[4]. Thus, only delisting levels calculated based on the groundwater pathway will be described.

[3] These metals will be present in the IHLW in oxide form.

[4] Further, with the exception of mercury, all total concentrations allowable are greater than 10,000 mg/kg (and for cadmium, it is 26,400 mg/kg). The allowable level of mercury is only 0.644 mg/kg based on a fish ingestion pathway. However, runoff of soluble compounds or particulates containing mercury into a surface water body containing fish is not a realistic pathway for exposure for this waste. Finally, as noted elsewhere in this petition, mercury is expected to volatilize and not be in the final waste form (see waste sample spike and analytical results presented in Section 5.8.5.3).

The DRAS output provides the delisting level, which is calculated by multiplying the constituent-specific MCL by the dilution attenuation factor (DAF). MCLs are drinking water standards set by EPA under the authority of the *Safe Drinking Water Act* (42 USC 300h et seq.). MCLs are at 40 CFR 141, *National Primary Drinking Water Regulations*. The DAF is used as a scaling factor to calculate a maximum allowable concentration of the constituent for delisting.

The proposed groundwater pathway delisting levels for COCs in this petition have been determined using the following rules:

- The proposed delisting level is the DRAS model calculated maximum allowable TCLP concentration based on the MCL.
- If no MCL exists for the hazardous constituent, the proposed delisting level is the DRAS calculated maximum allowable TCLP concentration based on toxicity information in the DRAS model. This delisting level is based on the most restrictive (lowest) level derived from health-based concentrations based on groundwater ingestion, inhalation, or absorption.
- All proposed delisting levels are checked against the TC; if a TC level exists and is more restrictive, then the proposed delisting level is the TC level.

Table 4-1 presents the constituent-specific proposed delisting limits. Table 4-2 shows the various DRAS output and the TC levels considered in the development of the proposed delisting levels in Table 4-1. All numbers except for the DAF and Chemical Abstract Service (CAS) numbers in Table 4-2 represent concentrations in the TCLP leachate.

IHLW will comply with LDR requirements for hazardous waste components (listed and characteristic) and will not itself exhibit a hazardous characteristic. LDR compliance for the IHLW will be demonstrated separately from the proposed delisting action by obtaining a site-specific treatability variance under 40 CFR 268.44(h).

Section 5 presents data collected to support this petition. The data include TCLP results from simulated (non-radioactive) IHLW fabricated to represent the compositional range of HLW feed to be processed by vitrification. The data presented are compared to the proposed delisting levels in Section 5 to further substantiate the basis for granting an upfront, conditional exclusion for IHLW.

Table 4-1 Constituents of Concern Proposed for Testing in Support of Delisting

Constituent of Concern	CAS Number	Proposed Delisting Limit (mg/L, TCLP)
Chromium $^{+6}$	18540-29-9	4.95[a]
Lead	7439-92-1	5.00
Mercury	7439-97-6	0.200
Nickel	7440-02-0	22.6
Silver	7440-22-4	3.07
Thallium	7440-28-0	0.282
Antimony	7440-36-0	0.659
Arsenic	7440-38-2	0.616
Barium	7440-39-3	100
Beryllium	7440-41-7	1.33
Cadmium	7440-43-9	0.480
Copper	7440-50-8	29,200
Vanadium	7440-62-2	16.9
Zinc	7440-66-6	225
Selenium	7782-49-2	1.00

a Cr^{+6} limit was selected as it is the most conservative. Note that most waste will be Cr^{+3}.

CAS = Chemical Abstract Service

TCLP = Toxicity Characteristic Leachate Procedure

Table 4-2 Proposed Delisting Levels. Derivations are based on EPA Delisting Risk Assessment Software (DRAS)

CAS Number	Chemical Name	DRAS Calculated Waste Volume Adjusted DAF	DRAS Max. Allowable TCLP Conc. Based on GW Ingestion (mg/L)	DRAS Max. Allowable TCLP Conc. Based on GW Inhalation (mg/L)	DRAS Max. Allowable TCLP Conc. Based on Adult GW Dermal Absorption (mg/L)	DRAS Max. Allowable TCLP Conc. Based on Child GW Dermal Absorption (mg/L)	DRAS Max. TCLP Conc. Based on GW scenario (mg/L)	Max. Allowable TCLP Conc. Based on MCL (mg/L)	Toxicity Characteristic Levels, TCLP Conc. (mg/L)	Proposed Delisting Level, TCLP Conc. (mg/L)
7439-92-1	Lead	1.60E+04	--	--	--	--	2.40E+02	2.40E+02	5.00E+00	5.00
7439-97-6	Mercury	2.39E+02	2.24E-01	6.51E-02	--	--	6.51E-02	4.77E-01	2.00E-01	0.200
7440-02-0	Nickel	1.21E+02	2.26E+01	--	--	--	2.26E+01	--	--	22.6
7440-22-4	Silver	6.55E+01	3.07E+00	--	--	--	3.07E+00	--	5.00E+00	3.07
7440-28-0	Thallium	1.41E+02	1.06E-01	--	--	--	1.06E-01	2.82E-01	--	0.282
7440-36-0	Antimony	1.10E+02	4.12E-01	--	--	--	4.12E-01	6.59E-01	--	0.659
7440-38-2	Arsenic	6.15E+01	3.00E-02	--	--	--	3.00E-02	3.08E+00	5.00E+00	0.616[a]
7440-39-3	Barium	8.91E+01	5.86E+01	--	--	--	5.86E+01	1.78E+02	1.00E+02	100
7440-41-7	Beryllium	3.33E+02	6.25E+00	--	--	--	1.33E+00	1.33E+00	--	1.33
7440-43-9	Cadmium	9.61E+01	4.51E-01	--	--	--	4.51E-01	4.80E-01	1.00E+00	0.480
7440-47-4	Chromium	1.23E+04	1.74E+05	--	--	--	1.23E+03	1.23E+03	5.00E+00	5.00
18540-29-9	Chromium $^{+6}$	4.95E+01	1.39E+00	--	--	--	1.39E+00	4.95E+00	5.00E+00	4.95
7440-50-8	Copper	2.24E+04	8.42E+03	--	--	--	8.42E+03	2.92E+04	--	29,200
7440-62-2	Vanadium	2.57E+02	1.69E+01	--	--	--	1.69E+01	--	--	16.9

Table 4-2 Proposed Delisting Levels. Derivations are based on EPA Delisting Risk Assessment Software (DRAS)

CAS Number	Chemical Name	DRAS Calculated Waste Volume Adjusted DAF	DRAS Max. Allowable TCLP Conc. Based on GW Ingestion (mg/L)	DRAS Max. Allowable TCLP Conc. Based on GW Inhalation (mg/L)	DRAS Max. Allowable TCLP Conc. Based on Adult GW Dermal Absorption (mg/L)	DRAS Max. Allowable TCLP Conc. Based on Child GW Dermal Absorption (mg/L)	DRAS Max. TCLP Conc. Based on GW scenario (mg/L)	Max. Allowable TCLP Conc. Based on MCL (mg/L)	Toxicity Characteristic Levels, TCLP Conc. (mg/L)	Proposed Delisting Level, TCLP Conc. (mg/L)
7440-66-6	Zinc	7.97E+01	2.25E+02	--	--	--	2.25E+02	--	--	225
7782-49-2	Selenium	3.71E+01	1.74E+00	--	--	--	1.74E+00	1.86E+00	1.00E+00	1.00

"--" Indicates data not available.

a The arsenic delisting level has been reduced by a factor of five (from the MCL output from DRAS) to adjust for a recent change in its MCL (66 *Federal Register* 6975, to go into effect 23 January 2006).

CAS = Chemical Abstract Service

DAF = Dilution Attenuation Factor

TCLP = Toxicity Characteristic Leaching Procedure

GW = Groundwater

MCL = Maximum Concentration Limit

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5 Delisting Sample and Analysis Information [Part 5]

Sample and analysis information in this section focuses on the bench-scale testing program developed and executed to demonstrate adequate immobilization of COCs in IHLW.

5.1 Delisting Sample and Analysis Information [Part 5: 1]

The DQO process (Supplement 2) was used to develop a sampling design to generate data supporting the delisting petition. DOE, EPA, Ecology, and WTP staff participated in the process and agreed upon the resulting approach. The final sampling plans are presented in Appendices P and Q of Supplement 4 of this document. The sampling design that resulted from the DQO process was used to derive the data that provide the technical basis for this petition. The basic sampling design applicable to delisting is summarized here.

The sampling and analysis plan (research program to support delisting) was designed to (1) identify COCs that will not affect glass quality (i.e., leach above applicable proposed delisting levels) and (2) identify COCs that will affect glass quality and warrant process controls (e.g., feed acceptance limits). The primary objective was to develop data to demonstrate that, for the expected range of inorganic COC concentrations in the feed to the WTP HLW facility and for the expected range of glass product compositions, the IHLW meets proposed delisting levels.

The glass-testing program was designed to provide data over the expected composition range to support the development of glass durability models to accurately predict the TCLP leaching characteristics. The experimental design focused on testing bounding glass compositions and developing statistical models from those tests.

The bases of the research program to support delisting are described in Supplement 2. Details of the testing and results described in this portion of the petition are in Supplement 4, as summarized below.

5.2 Waste Sampling Information [Part 5]

The following subsections provide sampling and analysis organizational information.

5.2.1 In-House Sampling Staff [Part 5: 2]

In-house staff did not perform Sampling and analysis.

5.2.1.1 External Sampling Organizations [Part 5: 2a]

Vitrified test samples were created by:

Vitreous State Laboratory (VSL)
The Catholic University of America
620 Michigan Ave. NE
Washington, DC 20064

5.2.1.2 Sampling Staff Qualifications [Part 5:2b]

Qualifications for VSL staff are provided in Supplement 4, Appendix O.

5.3 Sampling Strategy [Part 5]

5.3.1 Selection of the Glass Matrix or Simulant

The LDR/Delisting DQO (Supplement 2) prescribes a phased approach to testing that requires different experimental designs, numbers of glasses, and numbers of replicates (samples per glass) according to the COC classifications. Prior to the collection of test data, the leach rate category for any given COC was a hypothesis to be tested. The LDR/Delisting DQO (Supplement 2) grouped the inorganic COCs according to the required level of TCLP testing into three cases: Case 1, Case 2, and Case 3, as follows:

- Case 1 COCs are those that, when loaded at their highest expected concentration in WTP glasses, are not expected to leach at their respective proposed delisting levels. Eleven COCs are classified as Case 1 in the test guidance (CCN 060291).
- Case 2 COCs may reach the proposed delisting levels in TCLP leachates of WTP glasses if loaded to concentrations near their maximum expected concentrations in glass. Their maximum allowable concentrations are experimentally determined.
- Case 3 COCs are components that are likely to be present in concentrations sufficient to exceed their respective proposed delisting levels in TCLP leachates of some possible glasses. Their concentrations must be controlled through the use of glass composition TCLP response models.

The test glasses are divided into two categories based on the TCLP testing they were designed to support: spiked glasses and matrix glasses. Spike test glasses supported the testing of Case 1 and Case 2 COCs, which were spiked into the glass composition(s) in replicates either at a single spike level (Case 1) or at multiple spike levels (Case 2). Sixteen spike glasses, including replicates, were prepared and tested in this work. The purpose of preparing and testing spike glasses is to identify or confirm COCs that will not affect glass quality. Glasses are intentionally spiked with high levels of COCs. TCLP results for glasses made with high concentrations of COCs (higher than anticipated feed levels) and glasses with variant compositions are tested to provide data that demonstrate that some COCs are sufficiently bounded in the glass matrix to meet proposed delisting levels without the need for strict composition control during production.

Testing of Case 3 COCs involves substantially more samples. The approach is to develop a quantitative statistical model that relates glass compositions to TCLP response. Glasses developed for this purpose are termed *matrix glasses* and consist of an "initial matrix" and "augmentation matrix." The initial matrix and the augmentation matrix were separate sets of glasses statistically designed to support the development of the TCLP durability model. The initial matrix consisted of 57 glasses (including duplicates), whereas the augmentation matrix consisted of 45 glasses (including duplicates). Although designed primarily for statistical model development for Case 3 COCs, glasses from both matrices also generated data to support evaluation of Case 1 and Case 2 COCs (Supplement 4, Section 3, and Appendices P and Q).

5.3.1.1 Spike Glass Compositions

Vitreous State Laboratory spiked the target COCs into a typical ("nominal" or "normal") glass and a "bounding" glass (bounding in terms of its TCLP leachability). In other words, the WTP is not expected to produce glasses that will leach COCs more rapidly than this bounding glass. The bounding glass should **not** be interpreted as being bounding in terms of any single constituent concentration. In addition to the bounding glass, a nominal IHLW glass was selected for spiking with the same COCs. Testing with the nominal IHLW glass was performed to demonstrate that the expected TCLP leachability of COCs is significantly lower than for the bounding glass.

The bounding glass was selected from an extensive data set spanning a wide range of glass compositions collected during previous HLW glass formulation efforts (Kot and Pegg 2001). The advantage of selecting a glass from a previous data set is that actual TCLP measurements are available on which to base the selection. The bounding glasses tested, HLW99-03E through HLW99-03H, are modified versions of glass HLW99-03. The tested glasses are significantly different in composition from expected WTP actual production glasses; however, they represent a very conservative bounding case. The bounding glass normalized TCLP boron release (a convenient indicator of glass dissolution during TCLP analysis) is more than an order of magnitude greater than that of current WTP expected production glass compositions.

Glass HLW98-77, developed for the vitrification of tank 241-AZ-101 Envelope D feed blended with cesium products from the pretreatment of LAW streams, was selected as the nominal glass. This glass composition is typical in the sense that its properties have been determined to meet all processing and product performance requirements. In addition, the nominal glass composition is comparable to expected IHLW glass compositions in the future. At the VSL HLW pilot melter, extensive testing has been conducted on glass HLW98-77 as a target composition for tank 241-AZ-101 waste. Table 5-1 presents the spike levels used to create the spike glasses. Table 5-2 and Table 5-3 present the target composition of glasses HLW99-03E through HLW99-03H and HLW98-77E through HLW98-77H, respectively.

Supplement 4, Section 3, further details the differences between the nominal and bounding glasses tested.

5.3.1.2 Matrix Glass Composition Design

The matrix glasses were both actively (based on chemistry principles and experiments) and statistically designed. That is, the development of target matrix glass compositions took into consideration both previous work and glass science chemistry and applied a statistical approach to develop 102 glass compositions that would sufficiently encompass the glass composition region anticipated for HLW feeds that are blended with cesium and Sr/TRU materials removed from LAW feeds during pretreatment. In order to develop property-composition models, adequate property-composition data covering the experimental glass composition region of interest are required. Inputs included historical tank characterization data, bench-scale active waste test results, current WTP working compositions, and waste loading constraints (aluminum, iron, thorium, and zirconium loading limits).

The matrix design employed a layered approach, where compositions were constrained by maximum and minimum component concentrations. The layered design approach provided for collecting data on a larger glass composition region (the outer layer), as well as on a smaller glass composition region (the inner layer) and on a center glass composition. The oxides used to develop glass compositions were classified as "constants," "variables," or "spikes" depending on the propensity of an oxide to affect glass quality or its importance to TCLP leachability. Classification of oxides was also required in order to

group oxides and limit the total number of variables to the maximum that could be processed by the mixture design statistical software. Statistical software was used to generate the outer-layer vertices (over 200,000) and inner-layer vertices (over 110,000) representing corner points of the theoretical glass compositions defined by the outer- and inner-layer constraints. The layered design approach provides for collecting data on a larger glass composition region (the outer layer), as well as a smaller glass composition region (the inner layer). The layered design approach is also well-suited for the IHLW test matrix because the objectives involve: (1) covering the glass composition region likely to be associated with the addition of Sr/TRU materials removed from LAW feeds during pretreatment, and (2) spanning the wider transition region between the initial and augmented test matrices (Sections 5.3.1.2.1 and 5.3.1.2.2).

The statistical software selected subsets of possible matrix glass compositions. The number of glass compositions was further reduced by optimization. The design points were selected to minimize uncertainties for the property-composition model. The process for developing the model addresses the nonlinear blending effects of important glass components if needed. The experimental design tools select design points within a specified multi-dimensional composition space so that a given statistical criterion is optimized. Three optimality criteria were considered: D-optimal, G-optimal, and V-optimal. The D-optimal criterion seeks to minimize the uncertainty in coefficients of models developed from the resulting data. The G- and V-optimal criteria seek to minimize, respectively, the maximum and average uncertainty in predictions made with the model developed from the resulting data. Ultimately, optimal or near optimal design statistics, and good distributions of predicted property values over the property ranges, were derived that required a 102-glass test matrix. Glass matrix design is complex; for detailed discussion, see *Summary Report: Test Matrix to Support TCLP Model Development for RPP-WTP HLW Glasses* (Piepel et al. 2002) and *Summary Report: Augmentation Test Matrix to Support TCLP Model Development for RPP-WTP HLW Glasses* (Cooley et al. 2003), which are available upon request. These documents describe the development of an initial and augmented test matrix. As explained below, the initial and augmented test matrices represent compositions typical of the Envelope D waste feed, without or with the addition of ^{90}Sr/TRU LAW pretreatment byproducts, respectively. The augmented matrix was necessary to expand the experimental glass composition region beyond the range of constituents initially envisioned in early planning efforts, namely, to account for increased strontium, thorium, and uranium loading.

5.3.1.2.1 Initial Matrix Glass Compositions

Design of the HLW initial glass matrix began with the development of constraints to define the glass compositional regions to be covered by the test matrix. The focus of the initial matrix was on the first three HLW feed tanks: 241-AZ-101, 241-AZ-102, and 241-C-106/241-AY-102[1] (with LAW pretreatment products added). The expected compositions of wastes from these tanks were supplemented with waste loading and glass property constraints (e.g., viscosity and electrical conductivity as functions of temperature, liquidus temperature, density, glass transition temperature, product consistency test response, and crystallinity after canister centerline cooling). The composition region was bounded by 39 glass components that were varied by applying statistics to generate a representative test matrix.

Table 5-4 lists the 15 components that were varied in the initial test matrix, as well as the component limits for the inner and outer layers of the design. In the initial test matrix, 15 oxide components totaling 95.8 wt% are varied, as well as a group of "constant" components totaling 4.2 wt%. One of the 15

[1] Double-shell tank 241-AY-102, to which retrieved waste from SST 241-C-106 has been added.

components is a "spike" component consisting of several components that are important for regulatory purposes.

Preliminary property-composition models were used to constrain the initial test matrix (Piepel et al. 2002). The design constraints define a 14-dimensional, polyhedral-shaped glass composition region. The region is 14-dimensional because the 15 oxide components varied in the test matrix must sum to 95.8 %. This constant-sum constraint reduces the dimensions of the region.

The test matrix was generated using the MIXSOFT (Piepel 1999) and ACED (Welch 1987) software packages. The D-, G-, and V-optimal criteria were used to select the optimal glass compositions. For the selection of the 24 inner-layer glasses, a 30-term partial quadratic mixture model plus 5 squared terms was used. For the selection of the 26 outer-layer glasses, a 25-term partial quadratic mixture model was used. The initial test matrix consisted of 57 glass compositions: 26 outer-layer glasses, 24 inner-layer glasses, a center glass, and 6 replicate glasses.

Supplement 4, Section 3.2 further details the statistical design of the initial matrix glasses.

5.3.1.2.2 Augmentation Matrix Glass Compositions

The HLW augmentation glass matrix was designed to include the projected glass composition region for the fourth WTP feed tank (241-C-104/241-AY-101)[2] and to expand the range of concentrations of ^{90}Sr/TRU pretreatment products incorporated into glass formulations beyond the range in the initial matrix. In addition to the 39 components in the initial matrix, ThO_2 and UO_2 (thorium dioxide and uranium dioxide) were added, bringing the total to 41 components. Thorium and uranium are radioactive and are present in significant concentrations in tank 241-C-104/241-AY-101 waste.

Table 5-5 lists the 19 components (each variable component, plus "spike") selected to be varied in the augmentation test matrix, as well as the component limits for the outer and inner layers of the design. In comparison, the initial test matrix varied 15 components, with the difference being the addition of ThO_2, UO_2, Cr_2O_3, and ZnO for the augmentation test matrix. Along with the 19 oxide components to be varied in the augmentation test matrix, there is a group of constant components totaling 2.2 wt% (denoted "constant"). In the initial test matrix, Cr_2O_3 was included in the spike component, and ZnO was included in the constant component. Table 5-5 provides the composition constraints of the "new" spike and constant components, respectively, used for the design of the augmentation test matrix. Note that Cr_2O_3 and ZnO are design variables for the augmentation matrix, and are not included in the new spike and constant components, respectively. In the initial test matrix, ZnO was in the constant component at 2 wt%. Because ZnO is treated as a design variable for generating the augmentation test matrix, the new constant component is fixed at 4.2 – 2 = 2.2 wt%.

Of the 19 components (excluding the constant component) in Table 5-5, 14 are listed as "base glass components" and 5 (including the spike) are listed as "selected RCRA components." During the development of the augmentation test matrix, the 14 base glass components (Al_2O_3 to ZnO) were treated as mixture components constrained to sum to 97.8 wt% (the constant component made up the remaining 2.2 wt%). The five selected RCRA components were treated as nonmixture components and were allowed only to have values corresponding to their respective lower or upper limits. This "14 mixture component + 5 nonmixture component format" (hereafter referred to as the "14+5" format) used in constructing the augmentation test matrix was not employed in constructing the initial test matrix. In the

[2] Double-shell tank 241-AY-101, to which retrieved waste from SST 241-C-104 will be added.

initial test matrix, all 15 components (excluding the constant component) listed in Table 5-5 were treated as mixture components.

As was the case for the initial test matrix, the augmentation test matrix was generated using MIXSOFT and ACED. For selection of the 20 inner-layer glasses and 20 outer-layer glasses, a 34-term property-composition model was initially assumed to implement the optimality criteria. The augmented test matrix consists of 45 glass compositions: 20 outer-layer glasses, 20 inner-layer glasses, a center glass, and 4 replicate glasses.

Supplement 4, Section 3.3 further details the statistical design of the augmentation matrix glasses.

5.3.1.2.3 Combined Matrix Glass Compositions

The statistical software, R (Ihaka and Gentleman1996), was used to combine the 57 glass compositions from the initial test matrix and the 45 glass compositions of the augmentation test matrix into a single file containing all 102 "combined test matrix" glass compositions (Cooley et al. 2003) with a 19-component format. The compositions in the normalized combined matrix represented the actual weight percentages used in producing the glasses. With the constant component fixed at 2.2 wt%, each "20-component" composition will sum to 100 wt%. The glass formulations are presented in "19-component" format in Table 5-6.

5.3.2 Strategy for Collection of Representative Samples [Part 5: 3]

5.3.2.1 Sample Selection [Part 5: 3a]

Data used to develop glass durability models were based on samples of simulated Hanford tank waste created in bench-scale tests. Bench-scale tests were used for the following reasons:

- The need to develop and verify models would require sampling, vitrifying, and analyzing many highly radioactive samples, thus exposing workers to radiation in violation of the ALARA radiation safety principle.
- A full-scale melter is currently not available to process the waste; thus, DOE is developing this upfront petition.
- Vitrified mixed wastes produced by a full-scale melter would not have a disposal pathway (they would remain listed and could not be stored in the National Geologic Repository).

Waste simulant was spiked with various combinations of the COCs, vitrified in platinum or gold alloy crucibles, and then the glass was removed from the crucible. Multiple samples representing various glasses spiked with the COCs selected for testing (Section 4) were generated. The glass types are discussed in Section 5.3.1. Once removed from the crucibles, the glass samples were broken and a portion of each was submitted for TCLP analyses.

The bench-scale crucible studies described in this section indicate that vitrification immobilizes inorganic COCs sufficiently to meet their associated proposed delisting levels (Table 4-1). A summary of the Delisting Risk Assessment Software (DRAS) model process and selection of proposed delisting levels, as performed for this petition, is in Section 4.4.

Previous work (Gan et al. 2002: Fu and Pegg 1999) has shown that when TCLP concentrations are normalized by the amount of the constituent in the test glass, elements fall into three groups:

- Advanced elements – These elements exhibit normalized TCLP release higher than that of elements in the other two groups. These elements may include the alkalis, alkaline earths, divalent transition metals, boron, silver, cadmium, and uranium.
- Retarded elements – These elements exhibit normalized TCLP release lower than that of elements in the advanced group but higher than elements in the slow or irregular group. This group may include silicon, thallium, selenium, antimony, and lead.
- Slow or irregular elements – These elements exhibit normalized TCLP release significantly lower than that of elements in the other two groups. This group may include arsenic, chromium, aluminum, iron, and zirconium.

The normalized TCLP release of any of the elements in the advanced group can be used to provide a convenient and conservative measure of the TCLP leachability of the glass. Accordingly, the LDR/Delisting DQO process (Supplement 2) required testing to be performed in a phased approach tailored to testing particular constituents in the vitrified waste form. During vitrification, constituents such as cyanide are destroyed or volatilized and treated by the emissions control system (Section 5.8.5.3). Metals are volatilized (and released to the emissions control system) or immobilized in the glass matrix. Metals leach from the glass matrix at different rates, dependent on the composition of the matrix. The test guidance (CCN 060291) specified the test program for each release rate group (Case 1, 2, or 3 [see Section 5.3.1]).

The test results for IHLW (Supplement 4) show that antimony and thallium are Case 2 and only cadmium is Case 3; all other COCs are Case 1. Mercury and cyanide form an additional group of "volatile" constituents (CCN 060291). Mercury is expected to exit the melter through the offgas and be effectively treated by the emissions control system. Cyanide will either be destroyed in the melter or exit the melter and be captured in the offgas emission control system. Therefore, the volatiles are classified as Case 1 COCs, bringing the total number of Case 1 constituents to thirteen[3]. Cyanide is tested differently than the other Case 1 COCs in that it is characterized with respect to total cyanide in the glass rather than in the TCLP leachate (CCN 060291).

5.3.2.2 Sampling Point Selection [Part 5: 3b]

The bench-scale testing resulted in one crucible for each test glass or replicate (Tables 4.1, 4.2, and 4.3 of Supplement 4). Each crucible was sampled and subjected to TCLP; sample points and location are not directly relevant to glass composition, the parameter of interest with respect to glass TCLP leachability. Testing was intended to document the TCLP leachability of vitrified waste representative of the range of wastes to be processed at the WTP.

After the vitrified simulated waste cooled and hardened, it was removed from the crucible and broken into pieces. Glass pieces for TCLP analyses were selected at random and sent to the laboratory for TCLP testing and analyses.

[3] In the context of research and testing, mercury and cyanide are included as COCs; however, evaluation of the test results indicates that these constituents are removed or destroyed during vitrification (much like organics constituents).

The simulant compositions and spiking are discussed below.

5.3.2.3 Sampling and Subsampling [Part 5: 3c]

Glass production and subsampling of bench-scale production glasses are summarized in the following subsections. Glass fabrication and data collection comply with NQA-1 requirements. The WTP *Quality Assurance Manual* (24590-WTP-QAM-QA-01-001) also imposes other requirements, such as 10 CFR 830 Subpart A, DOE Order 414.1A, and NQA-2a, Part 2.7. The DQO (Supplement 2) specifies the number of samples required.

5.3.2.3.1 Glass Production for Bench-Scale Testing

Initial batching procedures were the same for all glasses. The VSL fabricated all of the IHLW surrogate test glasses to support the delisting evaluation using reagent-grade chemicals and solutions of known purity. Supplement 4 provides full traceability documenting the purity of chemicals, vendor, and amounts used in each batch (Supplement 4, Appendices A1, A2, A3, and C), and calibration of balances and scales (Appendix B of Supplement 4). The VSL identification numbers for each chemical are provided in Supplement 4, Appendix C. The required glass former and COC mass for each batch considers both purity and volatility characteristics of the materials.

After reagent-grade chemicals were weighed and batched, they were mixed and homogenized with a blender. Then they were loaded into crucibles, each engraved with individual identification numbers. Following crucible loading, glass was generated using two methods, one method for the spike glass, including both nominal and bounding glasses, and a second method for initial and augmentation glasses.

5.3.2.3.2 Glass Production for Spike Glasses

For spike glass testing, glasses were spiked with additional material containing COCs. Sodium cyanide was added either directly to the mixture or after the mixture was dried at about 110 °C (230 °F). The mixture was blended again before the loaded crucibles were placed inside a commercial metal retort furnace and connected to a custom offgas treatment system. Three to four crucible melts were prepared at one time.

During glass melting, the retort was sealed and continuously purged, back to front, with a slow stream of ambient air entering and exiting through HEPA filters. The target melt temperature for both LAW and HLW glasses was 1100 ± 50 °C (2010 ± 120 °F) and the melt time was 2 hours. These parameters compare to an expected production melt temperature of 950 °C to 1250 °C (1740 °F to 2280 °F) and an expected average melt time of 3 days. Average ramping time to reach the target temperature was 4 hours, and the highest temperature reached was 1140 °C (2080 °F).

The molten glass was poured onto a graphite plate to cool before recovery (Figure 5-1). Traceability of each sample was maintained using the Material Inventory Control (MIC) forms (Supplement 4, Appendix D1). Supplement 4, Table 3.17 lists the spike glasses prepared with their associated MIC numbers, recovered weights, and visual descriptions of the as-melted glasses. Figure 5-2 is a photograph of a representative glass.

5.3.2.3.3 Matrix Glass Production

For IHLW matrix glasses, noble metal solution was added to the batching chemicals, which were then blended and dried. Preparation of the matrix glasses followed the VSL technical procedure TPC-CM, "Crucible Melts" (VSL 2002) (Supplement 5, VSL and Severn Trent Laboratory Procedures and VSL Quality Assurance Manual). Preparation was performed in a random order with the exact sequence of melts determined by assigning a random number (generated using Microsoft Excel®) to each test glass and then placing the test glasses in ascending order according to the associated random number. The melt order was recorded in the batching sheets. The order is recorded in Supplement 4, Tables 4.2 (Initial Matrix) and 4.3 (Augmentation Matrix).

After the melt order was determined and the batching completed, the loaded platinum/gold alloy crucibles were placed inside a Deltech DT-28 (or DT-29) furnace. A Eurothem 2404 temperature controller controlled the furnace temperature. The melt was kept for 2 hours at a melting temperature of approximately 1150 °C (2100 °F). Beginning 20 minutes after the furnace temperature reached approximately 1150 °C (2100 °F) and continuing for the next 100 minutes, the melt was mixed mechanically with a platinum stirrer. At the end of the 2-hour melt time, the molten glass was poured from the crucible onto a graphite plate to cool before sample recovery (Figure 5-1). Traceability of each sample was maintained using the MIC forms (Appendices D2 and D3 of Supplement 4). Supplement 4, Tables 3.18 and 3.19, respectively, provide the initial and augmentation matrix glasses with the associated MIC numbers, recovered weights, and visual descriptions of the as-melted glasses.

5.3.2.3.4 Post-Glass Production and Subsampling

After cooling to room temperature, glasses were recovered in one piece by tapping on the outside of the graphite mold. The recovered glasses were then weighed and the weights recorded on VSL's MIC forms to maintain traceability of the sample. Distribution of the prepared glass is recorded on the MIC form, which indicates the date, glass amount, purpose, and the associated references (Supplement 4, Appendices D1, D2, and D3).

As discussed above, batching information used in glass preparation forms the primary basis for compositional determination of the actual test glasses. Compositional analyses of the glasses were performed at the VSL as a verification check. However, the compositional analyses results are not intended to be used as regulatory data. With some exceptions, analytical data for COC oxides in the tested simulants generally show good agreement with the target values (Supplement 4, Appendix E).

5.3.2.4 Sampling and Subsampling Equipment [Part 5: 3d]

Glasses prepared from crucible melts were broken into sizes suitable for placement in the shipping containers (approximately 5 to 30 g pieces) using a stainless steel hammer (Figure 5-2). Visual inspection of the glass pieces confirmed there were no undissolved materials in the melted glass. The glass pieces were then loaded into clean plastic sample bottles (Nalgene high-density polyethylene, 125 mL).

The amount of glass placed in the container was at least 100 g for each sample. This information was recorded on VSL's MIC forms and on bottle labels. The MIC forms were maintained in a VSL logbook (VSL-1143-03); copies of the MIC forms for all of the regulatory samples are in Supplement 4, Appendices D1, D2, and D3. The sample bottles were then sealed with plastic tape and tamper-resistant tape.

The performing analytical laboratories, Severn Trent Laboratories (STL), Knoxville, Tennessee (STL Knoxville), and St. Louis, Missouri (STL St. Louis), provided a chain-of-custody form. The chain-of-custody form was completed and attached to the sample package. Copies of the chain-of-custody forms are in Appendix F of Supplement 4. Glass sample information was recorded in the VSL shipping logbook (Supplement 4, Appendix G).

After receipt of each sample shipment, STL notified the VSL with a sample confirmation report to document that samples were received in good condition and that there were no discrepancies between the samples shipped and received. Supplement 4, Appendix H contains copies of the sample confirmation reports.

STL used a hammer to break pieces of glass larger than the TCLP method particle size/diameter requirements. Once the particle size met TCLP requirements, the leaching process was started.

5.3.3 Deviations from Original Sampling Plan [Part 5: 3e]

The LDR/Delisting DQO (Supplement 2) outlines the general sampling design approach in Step 7. The WTP project prepared test instructions for VSL based on the DQO (CCN 060291). Additional sampling detail was provided by VSL (Supplement 4, Appendices P and Q).

Three deviations have occurred since the original test plans were developed, as follows:

- The proposed delisting levels (as derived from DRAS) for arsenic and chromium have been lowered since they were published in the LDR/Delisting DQO (Supplement 2).
- The number of test glasses used for Case 1 and 2 COCs was increased from the LDR/Delisting DQO recommended number.
- Thallium testing was revised from its original test plan (CCN 060291) recommendation (Case 3 COC) to its actual testing as a Case 2 COC.

These deviations are discussed below.

5.3.3.1 Changes to the Delisting Limits

The proposed delisting levels were recalculated for two COCs. The arsenic limit changed due to an update of the MCLs published by EPA, decreasing the delisting limit from 3.08 mg/L to 0.616 mg/L. The chromium limit was changed from the trivalent chromium limit (5.00 mg/L) to the hexavalent chromium limit of 4.95 mg/L in order to be more conservative. Derivations of the DRAS delisting limits are in Table 4-2.

5.3.3.2 Changes to the Number of Test Samples

Table 5-7 compares the proposed number of samples from Table 7-2 of the LDR/Delisting DQO (Supplement 2) to the number actually tested. In each Case 1, 2, and 3, more samples were collected than were proposed. The larger number of glasses and replicates used ensures a larger data pool, leading to more accurate predictions of TCLP leachate concentrations and a better understanding of glass models.

5.3.3.3 Changes to the Test Cases

The last deviation is that thallium was tested as a Case 2 COC, not a Case 3 COC, as directed by the original test plan (CCN 060291). This direction was revised when it was determined that thallium could be managed as a Case 2 COC.

The thallium Case 2 logic is based on maximum constituent concentration expected in the WTP HLW feed. The expected maximum thallium concentration in Envelope D feed is 0.45 g per 100 g of waste oxides, or 0.16 wt% of Tl_2O_3 in the IHLW assuming 35 wt% waste loading. However, the thallium concentrations in the DST insoluble solids are lower than 0.16 wt% based on the TFCOUP inventories. The data for thallium from the Case 2 COCs indicate that the proposed delisting levels will be met using the 0.517 wt% or lower spike level for normal production glass; therefore, treating thallium as a Case 2 COC is appropriate.

5.3.4 Representativeness of Samples [Part 5: 3f]

This discussion addresses how the waste tested at the bench/crucible scale represents the waste that will be fed to the melter in the WTP facility and how the specific samples analyzed represent the bench-scale samples. Given the nature of the WTP composition control strategy, one-to-one surrogate-to-waste (feed) correspondence is not necessary, but rather bounding the anticipated range and variability of potential WTP feeds is the relevant consideration.

HLW waste feed, in the waste tanks and in the WTP process, cannot easily be sampled to meet RCRA sampling requirements. Representative samples are difficult to obtain, and the highly radioactive waste makes sampling and analysis an undesirable approach to characterization because it may violate the ALARA criteria. The use of crucible testing has precedents, and was successfully implemented at the two US nuclear waste vitrification sites, the West Valley Demonstration Project (WVDP) in West Valley, New York (WVNS 1996), and the Defense Waste Processing Facility (DWPF) near Aiken, South Carolina (Amerine 1995).

5.3.4.1 Bounding Approach to Representative Samples

A more realistic and conservative approach to evaluating constituent leach potential is to establish bounding concentrations of analytes of interest and to conduct studies to ensure that the behavior of the analytes, at the most conservative bounding levels, is acceptable. In this case, the approach is to establish concentrations of COCs that are, within a high level of confidence, as much as may be expected in the IHLW, and to demonstrate that, even at these high levels, the TCLP leachates for COCs will not exceed their proposed delisting levels. The approach also provides data to better define and validate a glass composition region that adequately represents the behavior of the COCs in the waste glass form. To this end, statistical sampling designs were established for each of the three COC cases defined in this petition (Steps 6 and 7 of the LDR/Delisting DQO [Supplement 2]).

The maximum concentrations expected in HLW glass were calculated for all constituents that were tested, based on one of the following methods (CCN 060291):

- Maximum expected feed concentrations, based on TFCOUP assuming a waste loading of 35 wt%. This method was used for antimony, barium, beryllium, cadmium, copper, nickel, selenium, silver, and zinc.

- Maximum output from the *Dynamic G2 Model Version 3.0* (Gensym 2003) (G2) model validation and verification test run available at the time (24590-WTP-VV-PT-02-007). This method was used for chromium, thallium, and vanadium. The maximum concentration for cyanide was derived from the G2 LAW output. Because cyanide testing is expected to cover both HLW and LAW evaluation, the maximum concentration from LAW is used. Since the TCLP is not required for cyanide, the total cyanide concentrations are limited to values determined by SW-846 Method 9010 (EPA 1999).
- Maximum concentration used in emission estimates available at the time (24590-WTP-RPT-PT-02-002), assuming a waste loading of 35 wt%. This method was used for arsenic and mercury.
- Composition estimates for Envelope D wastes (CCN 040672). This method was used for lead.

The WTP project developed other criteria to determine maximum spike levels in the test glasses (CCN 060291). Examples of these criteria are (1) augmented cyanide levels since cyanide is not well characterized in tank waste, (2) ensuring that COC leachate concentrations are above detection limits of analytical instruments, and (3) maintenance of glass composition to optimize information gained. Using these maximums, VSL generated actual spike concentrations as shown in Table 5-1.

The compositional range of the matrix glasses was designed to encompass the projected IHLW compositions currently under development by the WTP, within the waste loading constraints for glass production (Gan et al. 2002, also see Tables 3-5 through 3-8). The composition region subject to testing was defined by Envelope D waste compositions from tanks 241-AZ-101, 241-AZ-102, 241-C-106/241-AY-102, and 241-C-104/241-AY-101 together with LAW pretreatment products (most notably the material from Sr/TRU precipitation). The composition region was designed to be broad enough to encompass glasses that would be produced from the full range of waste compositions represented in Envelope D waste feeds.

WTP has modeled the projected waste feed composition using the G2 model (Gensym 2003), a graphical, object-oriented, customizable software platform for building manufacturing applications. G2's primary output is the process dynamic flowsheet, which dynamically represents WTP operation so that the utilization of vessels and operational strategies can be evaluated and optimized. It provides information on process flow rates, batch cycle times, operating logic, and volumes of materials as a function of time through the WTP unit operations. The WTP currently uses the flowsheet results to confirm that plant performance objectives are met and for evaluating operating logic and process vessel and equipment utilization[4]. The flowsheet is separated into equipment-oriented areas that represent the various unit operations of the WTP. Pretreatment modeling primarily consists of separation processes utilizing the technologies of evaporation, ultrafiltration, and ion exchange. LAW and HLW vitrification primarily consist of staging and preparation vessels to prepare the pretreated feed for vitrification. Offgas treatment systems are included in the dynamic process flowsheet. Refer to *Flowsheet Bases, Assumptions, and Requirements* (24590-WTP-RPT-PT-02-005) for specific flowsheet details regarding requirements and descriptions. The process flow model was subject to verification and validation in accordance with WTP procedures (24590-WTP-VV-PT-02-007). In Figure 3-23, the projected pretreated feed content (24590-WTP-MRQ-PO-03-090) is matched with glass formers at an assumed waste loading of 28 wt% to create a range of the projected melter feed concentration for several major glass components. Figure 3-23

[4] The G2 model is the current process model for predicting process flow rates, batch cycle times, and operating logic. Inputs are updated as new information becomes available. The model is subject to revision, or replacement by other software bundles, and is not necessarily the process model to be utilized during WTP commissioning or operation.

shows the range for major components in the matrix glasses relative to the current projected range of HLW melter feeds for the first four HLW waste tanks.

5.3.4.2 Obtaining Representative Samples

Another aspect of representativeness is whether representative samples of the test glasses were obtained. The bench-scale process includes extensive mechanical stirring during glass formation as discussed in Section 5.3.2.3.3 of this petition and in VSL technical procedure TPC-CM, *Crucible Melts* (VSL 2002), included in Supplement 5. This stirring ensures a homogeneous sample will result. The glass samples were easily recovered in one piece by tapping on the crucibles. As discussed in section 5.3.2.4, the glasses were visually examined for heterogeneous characteristics (also see Supplement 4, Sections 3.5.1 and 3.5.2).

As previously mentioned the glasses were tapped with a hammer to break them. Sufficient sample (100 g) were shipped under chain of custody to the STL laboratories in Knoxville and St. Louis. Each laboratory was responsible for ensuring that the glass sample was broken into pieces that met the TCLP Method 1311 section 7.1.3 particle size requirements (EPA 1999). Both laboratories have TCLP methods that cover assessment of the particle size per the TCLP criteria.

5.4 Sample-Specific Information [Part 5]

5.4.1 Number of Samples Collected [Part 5: 4]

Table 5-7 presents the number of samples collected, excluding VSL control samples. Sixteen spike glasses and 102 matrix glasses were sampled and analyzed. This included 10 replicate glass samples (equivalent of field duplicate samples). In addition, a total of 13 VSL control samples were sent to the laboratories as blind control samples. One spike control sample was sent to STL Knoxville (Supplement 4, Table 4.1). Six VSL control glasses were sent to STL Knoxville and six to STL St. Louis (Supplement 4, Tables 4.2 and 4.3).

5.4.2 Sample Information [Part 5: 5a]

For each sample, the following are presented in Appendix C of this petition:

- VSL glass sample number (client ID).
- Date collected by VSL (collection date).
- Type of sample (sample origin and composition space). This includes the various glass types. Any control glass submitted to a laboratory is labeled as VSL Control.

The VSL sample identification does not necessarily correspond directly with the glass from which the sample was made. Likewise, STL sample identification has no direct reference to its corresponding client (VSL) sample identifier. Table 5-8 provides the VSL sample identification, associated glass, sample type, sample delivery group number, and STL sample identification for each sample.

5.4.3 Sample Collection [Part 5: 5b]

Section 5.3.2.3 describes the creation and collection of each glass sample by removing it from the crucible/graphite mold, breaking the glass into pieces using a hammer, collecting the pieces in a sample

bottle, and shipping the sample to the laboratory for further particle size reduction/subsampling, if necessary. Size reduction required was performed as discussed in STL Knoxville standard operating procedure (SOP) *Toxicity Characteristic Leaching Procedure and Synthetic Leaching Procedure* (KNOX-OP-0012, Rev 0, 20 September 2001); or STL St. Louis SOP, *Toxicity Characteristic Leaching Procedure (TCLP) Synthetic Precipitation Leaching Procedure (SPLP) and the California Wet Leach Procedure (CWET) for Metals* (STL-IP-0016, Rev 0, 5 May 2003). These procedures are included in Supplement 5.

5.4.4 Sample Location and Description [Part 5: 5c]

Once the glass from the mold was broken into pieces, the pieces were randomly selected for submission to the laboratory.

5.4.5 Compositing Samples [Part 5: 5d]

No composite samples were collected. No blending between crucible samples was performed.

5.4.6 Sample Physical Descriptions [Part 5: 5e]

Supplement 4, Tables 3.17, 3.18, and 3.19, provide physical descriptions of each sample of glass. Most glasses are fairly homogenous, amber, brown, or black, with some irregularities and minor amounts of crystalline phases. Such irregularities do not impact glass quality. Refer to Supplement 6, Section 4.1 for additional details.

5.4.7 Compositing Information [Part 5: 5f]

Composite samples were not collected. Therefore, this information is not applicable.

5.4.8 Handling and Preparation Techniques and Preservatives [Part 5: 5g]

Section 5.3.2.3 discusses the production of the glass samples and the subsampling for TCLP or total mercury/cyanide analyses. All methods followed SW-846 (EPA 1999) for handling, digestion/preparation, and analyses. Methods for preparation and analysis are listed in analytical result summary tables in Appendix C. Standard operating procedures from VSL and STL are included in Supplement 5. The following procedures cover the glass preparation, sampling of the glass, shipping and receipt, and chain of custody:

- TPI-CM, *Crucible Melts*
- TPI-SH, *Receiving Radioactive, Shipping and Handling of Radioactive and Non Radioactive Materials*
- STL-QA-0006, *Sample Receipt and Chain of Custody*
- KNOX-SC-0003, *Receipt and Log In of Commercial Samples*
- KNOX-SC-0004, *Internal Chain of Custody*

The unique identities of each glass sample are traceable from generation to receipt by the laboratory to reporting of the data. Appendix C lists the sample identities from production and laboratory analysis.

Glass samples require no preservation. After TCLP leaching, the leachate was digested, and the digestate was preserved with nitric acid to pH<2 until metals analysis was performed. For cyanide analysis, the glass solid was combined with water and distilled; the distillate was analyzed for cyanide. Thus, no preservation of the solid was needed.

5.5 Other General Information [Part 5]

5.5.1 Weather Conditions [Part 5: 6]

All glass sample generation and analyses were done indoors; thus, weather conditions do not affect the results.

5.5.2 Facility Activities Affecting Sample Representativeness [Part 5: 7]

No facility activities were noted that negatively affect glass quality during production. With each batch of glass submitted, a VSL internal standard (control sample) was submitted (Section 5.4.1). Laboratory method blanks were analyzed with each sample batch processed. The laboratory blank results for COCs were below the estimated quantitation limit (EQL) (or the laboratory reporting limit), which is below the proposed delisting level.

5.5.3 Sampling Device Decontamination [Part 5: 8]

VSL's internal control samples did not indicate contamination. VSL placed the samples in new, clean Nalgene bottles for shipment. The laboratories used properly cleaned glassware as evidenced by the method blanks with either nondetects at the EQL or results below the EQL.

5.5.4 Chain-of-Custody Procedures [Part 5: 9]

Chain-of-custody procedures were in accordance with SW-846 methodology (EPA 1999). VSL generated the samples and shipped them using both the TPI-SH Rev 6 procedure in Supplement 5, and the STL chain-of-custody forms (Supplement 4, Appendices F and J).

5.5.5 Sample Tracking and Sample Integrity [Part 5: 10]

VSL maintained traceability from the generation of the glass to the shipping. VSL assigned unique identity numbers to each sample. The two STL laboratories (Knoxville and St. Louis) assigned unique sample numbers to each incoming sample. The STL laboratories maintained custody from receipt through leaching, digestion/preparation, metals and cyanide analyses, to reporting. The data were returned with both the laboratories' and VSL's identity information to maintain the traceability of the data from glass generation to data receipt. Both VSL and STL sample numbers are provided on the data in Appendix C. The following procedures related to tracking were used and their location in this report is identified:

- TPI-CM Rev 0, *Crucible Melts*: This procedure discusses how glass is generated. It includes the tracking of the identity of the glass on MIC forms. Glasses are all uniquely numbered. The glass identities begin with "HLW," the designator for Hanford high-level waste. The MIC forms are in Supplement 4, Appendices D1, D2, and D3. This procedure is in Supplement 5.

- TPI-PGA Rev 0, *Preparation of Glass for Analysis*: VSL followed the part of the procedure that dictates the traceability of the samples and labeling. The glass was provided to STL in chips/chunks. STL generated glass that meets the TCLP particle size diameter/surface area. This procedure is in Supplement 5.
- TPI-SH Rev 6, *Receiving, Shipping and Handling Radioactive and Non Radioactive Materials*: VSL followed this procedure to maintain the numbering system between the melt and the labeling of bottles and shipping forms. In addition, VSL completed the chain-of-custody forms required by STL. This procedure is in Supplement 5 and the completed chain-of-custody forms are in Supplement 4, Appendix F.
- Knox-SC-003 Rev 4, *Receipt and Log In of Commercial Samples*: This procedure is in Supplement 5.
- STL-QA-0006 Rev 5, *Sample Receipt and Chain of Custody*: This procedure is in Supplement 5.

5.6 Localized Area of Contamination [Part 5: 11-15]

In the bench-scale tests, the input chemicals are mixed, and the glasses thoroughly stirred during production (Section 5.3.2.3) to eliminate hot spots (heterogeneity within glass). The bench-scale crucibles are visibly examined for uniformity and are subsampled for TCLP analysis. No hot spots are anticipated as a result of sampling, shipping, and analyzing the samples.

5.7 Multiple Waste Treatment Facility [Part 5: 16-20]

The WTP is not a multiple waste treatment facility; the only wastes to be treated have been generated at the Hanford Site, stored in SSTs and DSTs, and transferred to the DST system for staging and delivery to the WTP.

5.8 Waste Analysis Information [Part 5]

The following subsection provides information regarding the sample and analysis organization that developed the supporting data for this petition. Table 5-9 provides a crosswalk to elements of EPA's *RCRA Delisting Program Guidance Manual for the Petitioner*, Appendix A, "Framework for Delisting Petitions" (EPA 2000) to the information presented in this section.

5.8.1 In-House Laboratory Staff [Part 5: 21]

In-house staff did not perform sample analysis.

5.8.1.1 Organization Addresses [Part 5: 21a]

The principal investigator for the research performed was VSL. The address of the research facility is:

Vitreous State Laboratory
Catholic University of America
620 Michigan Ave. NE
Washington, DC 20064

Commercial laboratories performed the sample analysis. The addresses of the laboratories are:

Severn Trent Laboratory Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921-5947
(865) 588-6401

Severn Trent Laboratory St. Louis
13715 Rider Trail North
Earth City, MO 63045
(314) 298-8566

Eastern Research Group performed data validation. The address of the validator is:

Eastern Research Group, Inc.
1600 Perimeter Park Drive
Morrisville, NC 27560

5.8.1.2 Laboratory Staff Qualifications [Part 5: 21b]

Resumes and/or qualifications are presented for each organization as follows:

- VSL qualifications are summarized in Supplement 4, Appendix O
- STL Project Manager resumes and qualifications are in Supplement 4, Appendix I
- Validator resumes and qualifications are in Supplement 4, Appendix K

5.8.2 Laboratory Data Reporting Forms [Part 5: 22]

Supplement 4, Appendix J, contains the data packages from the laboratory including the quality control results.

5.8.3 Sample and Analysis Information [Part 5: 23a-l]

Appendix C of this petition provides the following:

a. VSL glass sample number (Client ID) and the laboratory sample number (Lab ID).
b. Type of sample (Sample Origin and Composition Space).
c. Date of sample receipt by the laboratory (Receipt Date).
d. Sample workup and reference for the methods (Leach/Prep Method and Analysis Method).
   Note: Glass was leached by SW-846 Method 1311, followed by Method 3010A for metals digestion. Select glass samples were prepared for analysis for total mercury and cyanide in accordance with the preparation protocols in Methods 7471A and 9012A (EPA 1999), respectively. The feed simulant was not analyzed by SW-846 methods to establish constituent concentrations. The oxide concentrations in the feed are based on the documented reagent-grade chemicals added by weight to the feed mixture.
e. Dates of TCLP leaching (Leach Date), leachate digestion (Prep Date), and analysis (Analysis Date).
f. The initials of the person conducting analysis (Sample Analysis Analyst).

g. Date of digestion of the leachate or digestion of the solid glass (Prep Date).

h. Methods for metals analyses (Leach/Prep Method and Analysis Method). Note: Metals other than mercury were analyzed by SW-846 Method 6010B; mercury was analyzed by SW-846 Method 7470A for the leachate and Method 7471A for the glass; total cyanide was analyzed by SW-846 Method 9012A (EPA 1999).

i. The analytes (Analyte). The analytes are the constituents tested: antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, vanadium, and zinc; additional glass samples were spiked with mercury and cyanide.

j. The concentrations of the analytes and units for leachates: µg/L or mg/L, and for total cyanide or mercury, mg/kg.

k. The basis for the analysis (Basis). TCLP leachates were buffered leachate samples; the samples analyzed for total mercury and total cyanide were based on 100 % solids, as the glass is a dry solid.

l. The quantitation limits (EQL and MDL). EQL and the method detection limit (MDL) as calculated by Chapter 1 of SW-846 (EPA 1999) or 40 CFR 136 Appendix B.

5.8.4 Laboratory Equipment Information [Part 5: 24]

STL Knoxville used the following laboratory equipment:

- TJA 61-E SuperTrace ICP for TCLP metals
- Leeman Hydra Atomic Absorption for mercury
- Lachat Quickchem Automated Flow Injection Analyzer with Midi for distillation and subsequent analysis of cyanide

STL St. Louis used the following laboratory equipment:

- Coupled Argon Plasma Vacuum Spectrometer (Model 61E), manufactured by Thermo Jarrell Ash, for aluminum, boron, lithium, phosphorus, potassium, and silicon
- Inductively-Coupled Argon Plasma Vacuum Spectrometer (Model 61E [trace]), manufactured by Thermo Jarrell Ash, for antimony, arsenic, barium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, selenium, silver, strontium, thallium, titanium, vanadium, and zinc

5.8.5 Test Results [Part 5: 25]

Test results are presented in this section to provide the information necessary to interpret the test procedures or results.

The objectives described in LDR/Delisting DQO (Supplement 2) were also the subject of a previous study (Kot et al. 2004a). However, a sub-set of the TCLP data collected in the previous work was subject to data quality and bias issues. As a result, all of the affected tests have been repeated and the subsequent statistical analyses presented below have been performed on the revised data set. The affected data subset involved TCLP tests of radioactive glass samples that were performed at a different laboratory from the tests performed on the nonradioactive samples. Note that all test glasses were simulated and not actual waste glasses even though some glasses were radioactive due to the inclusion of oxides of thorium and uranium (two components of the augmented matrix design, refer to Section 5.3.1.2.2). The radioactive

samples were tested on a reduced scale (i.e., about 50 g of samples leached). This was in contrast with the TCLP testing of nonradioactive samples, for which a sample size of about 100 g was used, according to SW-846 Method 1311. This difference may have contributed to the observed bias between the two data sets (Kot et al. 2004a). Kot et al. (2004a) previously reported in detail all test results, bias corrections of the biased data, and the property-composition models that were developed using the previous results. In the present work, TCLP testing of the radioactive glasses was repeated on 100-g samples of unused material from the same glass melts. No data quality or bias issues were identified with the revised data set. The new test results are reported herein together with the earlier results from TCLP testing of non-radioactive samples (Kot et al. 2004a). The combined data (i.e., new data on radioactive samples and earlier data on non-radioactive samples) are used to develop the property-composition model, which is discussed Section 3.6.1.2 and Section 5.8.5.7.

5.8.5.1 Summary of Testing Results

The principal conclusions from this testing are presented below.

The TCLP data for Case 1 COCs (nonleachable metals: silver, arsenic, barium, beryllium, chromium, copper, mercury, nickel, lead, selenium, vanadium, and zinc) for all nominal and bounding glasses were well below the respective proposed delisting levels.

The TCLP data for antimony and thallium in IHLW glasses (spikes of the bounding and typical glasses) supported the hypothesis that these are Case 2 COCs for IHLW glasses. The proposed delisting level for antimony was marginally exceeded only by one of the replicates of the bounding glass. That glass was spiked with the highest antimony content. Additionally, the data indicate that a bounding glass can contain 0.205 wt% Tl_2O_3 and not exceed the proposed thallium delisting level. Performance for the typical glass composition was exceptional and did not approach the proposed delisting levels at the maximum expected feed concentration for either antimony or thallium.

Cadmium was found to leach from nominal IHLW compositions at levels that could potentially approach or exceed proposed health-based delisting levels.

The discussions below provide supplemental detail.

5.8.5.2 Supplemental Information Regarding Testing Results

Based on past research and projected TCLP results, 13 of the COCs tested were identified as nonleachable relative to their respective proposed delisting levels (Case 1 test constituents; Table 5-1). Cyanide and mercury, while considered Case 1 COCs, were tested separately due to their volatility. Antimony and thallium were initially identified as Case 2 COCs relative to their respective proposed delisting levels and were added to glasses over a range that spanned and exceeded their anticipated maximum expected concentrations. Cadmium is likely to be released in TCLP concentrations sufficient to exceed its proposed delisting level for improperly formulated glasses (Case 3).

The Case 1 COCs were tested at a single, relatively high feed concentration. The Case 2 COCs, thallium and antimony, were spiked at four combinations of concentrations selected over ranges expected to yield TCLP results bracketing their respective delisting limit.

Cadmium, a Case 3 constituent, was spiked at a single level. Cadmium is a significantly more complex case than the other COCs (Section 5.8.5.7).

For Case 1 and Case 2 testing, a nominal glass (HLW98-77) and a bounding glass (HLW99-03E) were selected. These two glass compositions were simultaneously spiked with all COCs at the levels listed in Table 5-1. All COC spike concentrations were constant except for the antimony and thallium spikes, which were added at opposing magnitudes (i.e., the highest antimony spike concentration was paired with the lowest thallium spike concentration).

Antimony and thallium affect the response of other constituents sufficiently that the base glass composition may be affected; therefore, the opposing magnitude spiking was selected to minimize their combined impact on other constituents' TCLP response. For Case 2 COCs (antimony and thallium), three replicates of the bounding glass were fabricated for each antimony/thallium spiking combination. The DQO (Supplement 2) prescribed six replicates at the single spiking level for each Case 1 COC in the bounding glass. However, the three replicates at each of the four Case 2 spiking level combinations resulted in 12 glasses for the single Case 1 COC spiking level.

In accordance with the LDR/Delisting DQO (Supplement 2), the three replicates of each spiked bounding glass composition were individually carried through the entire process of batching, melting, TCLP leaching, preparation, and analysis via SW-846 methods (EPA 1999) in order to encompass all applicable sources of variation (crucible fabrication, sampling, and analysis error). The bounding glass is a very conservative representation of a highly leachable (i.e., least durable) glass that is designed primarily as a glass to confirm, through limited testing, that certain nonleachable COCs (Case 1 and Case 2) do not leach from the glass at or above their respective proposed delisting levels, even when added to glass at levels well in excess of anticipated melter feed concentrations.

In addition, a single replicate of a nominal glass was fabricated at each of the four spiking combinations in order to provide better information about TCLP response and for use in model development. The nominal glass tested was specifically designed as a potential target formulation for processing HLW during early research studies and can be considered representative of typical WTP glass TCLP response.

Section 5.3.1.1 discusses spike glass formulation.

To test Case 3 COCs, the LDR/Delisting DQO (Supplement 2) specifies testing multiple glasses at multiple constituent levels. Leach resistance is a function of glass composition. Therefore, in order to establish a relationship between glass composition and leachate levels, data are needed regarding the overall composition of the glass. Multiple glasses at multiple constituent levels, termed test matrix or matrix glasses, were formulated to specifically provide this information (Section 5.3.1.2).

Section 5.8.5.3 presents results for the two volatile Case 1 COCs, mercury and cyanide. Section 5.8.5.4 presents the results for the nonvolatile Case 1 COCs (arsenic, barium, beryllium, chromium, copper, nickel, lead, selenium, silver, vanadium, and zinc). Section 5.8.5.5 presents the results for the two Case 2 COCs, antimony and thallium, in the bounding glass. Section 5.8.5.6 provides additional analyses of the two Case 2 COCs, antimony and thallium, in the nominal glass. The development, validation, and application of a property-composition model for Case 3, cadmium, results are presented in Section 5.8.5.7.

5.8.5.3 Results for Volatile Nonleachable Constituents of Concern

Most cyanide and mercury in the melter feed is expected to volatilize at melter temperatures and be treated in the air pollution control system. There should be very little, if any, mercury or cyanide

remaining in the IHLW glass. Accordingly, total cyanide and mercury were analyzed in the glass. The glass TCLP leachate was also analyzed for mercury so that data would be available for direct comparison to proposed delisting levels.

Table 5-10 presents the analytical results for cyanide and mercury in the spiked IHLW glasses and mercury in the TCLP leachate. As expected, neither total cyanide nor mercury was detected in any glass samples. In addition, more than half of the TCLP results for mercury were below the MDL of 0.00003 mg/L. All of the remaining TCLP results for mercury were below the EQL of 0.002 mg/L, which is well below the limit of 0.2 mg/L. Because all or most of the volatile inorganic data are below the detection limit, they are not amenable to statistical analysis.

These results support the expectation that both cyanide and mercury behave as volatile constituents that are destroyed and/or lost to the offgas during vitrification, leaving extremely low concentrations in the glass product. Neither cyanide nor mercury will be subjected to process sampling at the MFPV during actual IHLW production because of this result.

5.8.5.4 Results for Nonvolatile Case 1 Constituents of Concern

The analytical results from the TCLP leachate for the nonvolatile Case 1 COCs are in Table 5-11. Simple plots of the TCLP results are in Supplement 4, Figure 5.1.

Antimony and thallium have chemical properties that cause them to be bound in the glass matrix in a manner that affects the leachability of other COCs. Based on process records, neither element is expected to be found in significant quantities in the waste feed. However, for conservatism, the leachability behavior of Case 1 COCs as a function of thallium and antimony concentrations was investigated.

For the nonvolatile Case 1 COCs in the IHLW bounding glass composition, the data indicate leachability is a function of glass composition (leachability is related to the amount of the target constituent and other constituents of the glass). The statistical evaluation specified for Case 1 COCs assumed independence between COC concentrations. However, the analytical results for nonvolatile Case 1 COC results did not support this assumption. As an alternative, 90 % UCIs[5] for the Case 1 COCs were constructed by using the maximum mean across the four Case 2 spiking combinations, along with statistical estimates of variation[6].

Table 5-12 summarizes the proposed delisting levels, glass spiking levels, TCLP results, and range of projected (90 % UCI) TCLP values for Case 1 COCs in bounding and nominal glasses.

Figure 5-3 graphically depicts Table 5-12 data as a percentage of the proposed delisting levels. The data substantiate that these COCs qualify as Case 1 (nonleachable) constituents. These COCs will not affect the quality of IHLW during production, and quantification of these constituents (beyond what is required for modeling cadmium leachability) is not planned.

[5] The upper confidence interval is a statistically derived number that represents the amount of substance that can be in the glass, but still give a certain confidence (in this case, 90 % confidence) that the mean TCLP leachate concentration will not exceed delisting limit.

[6] Variation was based on a pooled estimate of the standard deviation obtained from an analysis of variance.

Constituent TCLP releases from the four spiking combinations of the nominal glass were expected to be much lower than the proposed delisting levels. Therefore, replicates and statistical analyses were determined to be unnecessary, and UCIs were not computed.

The complete statistical analysis is in Supplement 4, section 5.2.

The Case 3 COC cadmium is included with the nonvolatile Case 1 COC data set. It was spiked only at a single level in the bounding glass and exceeds its proposed delisting level as expected. Cadmium is addressed further as a Case 3 COC in Section 5.8.5.7.

5.8.5.5 Results for Case 2 Constituents of Concern in Bounding Glass

The analytical results from the TCLP leachate for the IHLW Case 2 COCs (antimony and thallium) are in Table 5-13. Simple plots of these TCLP results are in Supplement 4, Figure 5.3. As expected, thallium exhibits Case 2 behavior with TCLP results increasing with thallium spiking level and bracketing[7] its limit. Antimony, which also increased with increasing spiking levels, generally had TCLP results around 25 % of the predicted levels and therefore barely bracketed its limit (all but one antimony result were less than the corresponding limit).

Basic statistical quantities such as the number of results, the maximum reported value, the mean, the standard deviation, and the percent relative standard deviation (%RSD)[8] were calculated (Supplement 4, Table 5-7). The data for each Case 2 COC were used to:

(1) Develop a regression line[9] relating the TCLP results for the COC to its spiking levels
(2) Calculate a 90 % UCI curve for the regression line
(3) Determine the intersection of the 90 % UCI curve with the corresponding COC proposed delisting level; the COC level at the intersection represents a theoretical maximum acceptable value for that COC in the glass composition tested

In general, the results showed that the TCLP behavior of both antimony and thallium in bounding glass could be modeled with a simple linear regression model with a high degree of confidence. Thallium approached its proposed delisting level at a spiking concentration of 0.17 wt%. Furthermore, thallium leachability became more difficult to predict using a linear model when TCLP results corresponding to a spike concentration of 0.35 wt% were used. The TCLP thallium results at this spike level show large variation and may possibly depart from the linear relationship exhibited at the lower spiking levels. The large variation and possible nonlinear behavior at Tl_2O_3 = 0.35 wt% may influence TCLP behavior near the proposed delisting level. An alternative analysis was conducted in which the results for Tl_2O_3 spike concentrations of 0.35 wt% were not used. This analysis of the thallium spiking data is considered more appropriate for determining where the regression equation and its 90 % UCI will intersect the proposed delisting level, because it better fits the data nearest the proposed delisting level.

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7 Data that bracket the limit show a distribution of values both over and under the limit.
8 Standard deviation and relative percent standard deviation are statistical measures of the variability of a data set.
9 A regression line is a statistical technique in which a variable may be predicted if one knows the value of other variables upon which the predicted variable is dependent. The prediction is based on sample data that demonstrate the relationships among the variables. The prediction is bounded by a confidence level (often an upper confidence interval) that determines how well the data predict the actual values.

Table 5-14 provides predicted TCLP release concentrations corresponding to the theoretical loading (90 % UCI) for the Case 2 COPCs, antimony and thallium. The table also presents results with or without a zero intercept for the linear regression data fit. Some of the Table 5-14 results are for a "bounding" glass, an extreme composition unlike any anticipated WTP production glass. For the bounding glass tested, the data indicate that antimony could be processed at concentrations up to 759 times the corresponding proposed delisting level, and thallium could be processed at concentrations up to 555 times the corresponding proposed delisting level, before the TCLP leachate concentration would approach the limit (Supplement 4, Section 5.3 and Appendix M).

5.8.5.6 Results for Case 2 Constituents of Concern in Nominal Glass

The IHLW nominal glass composition was spiked with the same four spike combinations as the IHLW bounding glass composition.

The TCLP releases for the Case 2 COCs (antimony and thallium) from the four spiked combinations of the IHLW nominal glasses are shown in Table 5-13. For the two Case 2 COCs:

- The TCLP releases of antimony range from nondetectable at the lowest spiking level of Sb_2O_3 (0.10 wt%) to 0.103 mg/L at the highest spiking level of Sb_2O_3 (1.20 wt%). All of these results are below the EQL of 0.18 mg/L and far below the proposed delisting level of 0.659 mg/L.
- The TCLP releases of thallium range from nondetectable at the lowest spiking level of Tl_2O_3 (0.03 wt%) to 0.153 mg/L at the highest spiking level of Tl_2O_3 (0.35 wt%), below the proposed delisting level (0.282 mg/L).

Because the largest of the thallium TCLP releases exceeds 50 % of its limit, a Case 2 statistical analysis of thallium releases from the four spiked combinations of the nominal glass was performed. The Case 2 statistical analysis consisted of extrapolating a fitted regression line and developing the 90 % UCI curve to determine the theoretical maximum concentration of Tl_2O_3 that can be in a typical glass and meet the thallium proposed delisting level. However, in accordance with the test guidance (CCN 060291), only one replicate each of the four spiked typical glass compositions was made and tested. The Case 2 statistical analyses for thallium releases from the spiked typical glass are presented in Table 5-14.

Because the range of antimony releases for the nominal glass was significantly below the proposed delisting level, Case 2 statistical analyses for antimony were not performed.

Because of limitations associated with a four-point data set[10], an alternate method of computing the UCI was explored. The data for the lower three spiking levels for the bounding glass are in the range of those observed for the nominal glass, so it is reasonable to assume the error structure is similar in both glasses. The UCI for a linear regression of the nominal glass data was computed using uncertainty estimates from the nine values corresponding to the lower spiking levels for the bounding glass. The UCI obtained from this method of data analysis did substantially differ from the UCI using conventional linear regression analysis. Table 5-14 presents data for both computational methods, along with the results of regression modeling with and without a zero intercept.

[10] After fitting the regression to the four data points, only two degrees of freedom remain for estimating the uncertainty in the zero intercept case and three degrees of freedom in the no-intercept case. With so little information for estimating uncertainty, resulting confidence curves would generally be expected to be quite wide. This could lead to the 90 % UCI maximum allowable Tl_2O_3 concentration being overly restrictive (high UCI) to compensate for the high degree of uncertainty (due to a limited amount of data).

The statistical model indicates that 0.517 wt% is a conservative estimate of the theoretical maximum allowable Tl_2O_3 concentration for the typical glass. This 0.517 wt% maximum allowable Tl_2O_3 concentration for the typical glass is approximately 2.5 times larger than the 0.205 wt% value for the bounding glass. Further, 0.517 wt% is nearly three times the maximum concentration of Tl_2O_3 in IHLW expected by the WTP (Supplement 4, Section 5.4 and Appendix M).

5.8.5.7 Results for the Case 3 Constituent of Concern, Cadmium

Because cadmium at approximately 1.0 wt% oxide (CdO) tends to leach from vitrified wastes at TCLP concentrations approaching proposed delisting levels, a multidimensional statistical model was developed.

A total of 102 glasses were tested to establish a model for the allowable glass formulations that would not release cadmium above the proposed delisting level. The 102 glasses were formulated to test the glasses predicted to be typical of the WTP process as well as those that were unlikely to ever actually be produced (such as bounding glass compositions, see Section 5.3.4.1). The glass formulations are discussed in Supplement 4, Section 3; rationale for the compositions chosen for matrix glasses is in Supplement 4, Appendix Q. The TCLP cadmium release data for samples HLW03-01-2 and HLW03-08-2 were not used to develop models. Diagnostic plots showed the TCLP cadmium releases for these two glasses were extreme outliers, and regression plots suggested that the results were inadvertently switched. However, an evaluation of associated quality controls and sample handling protocols did not yield evidence of sample switching. Excluding control glasses (Section 5.4.1), this left 100 glasses, including the 10 replicate glasses (for 51 initial matrix glasses with 6 replicates, and 39 augmented matrix glasses with 4 replicates).

Several statistical models were fit to the cadmium data to find the most appropriate. Seventeen base models and modifications to those models were evaluated. Two relatively simple models fit the data, a 10-term model and a 20-term model. The 10-term model is a reduced form of the 20-term model. Unnecessary model terms were dropped from the 20-term model using the statistical process of backward elimination. The model was also fit to two combinations of glass oxides, or presumed oxide valence states. Original matrix glasses were designed with the assumption that arsenic and thallium were primarily trivalent (Tl_2O_3 and As_2O_3). Revised oxide forms used for recent composition predictions and G2 modeling assume thallium is monovalent and that arsenic is pentavalent (Tl_2O and As_2O_5) (Table 2-2).

Section 6 of Supplement 4 details the model development and evaluation process.

The model goodness-of-fit statistics are comparable for both the 10-term and 20-term models in (Table 5-15), so the 10-term model is preferred for process control since it is simpler and requires fewer inputs. The models and their underlying statistical bases are described in Supplement 4, Appendix R. Further evaluation was performed on the two models that best fit the data (Supplement 4, section 6.4).

The model is a linear mixture model with generalized normalization and has the following form:

$$\ln(c_{Cd}) = \sum_{i=1}^{N} b_i x_i + d \ln(m_{CdO})$$

where:

x_i = the normalized mass fraction of component i (Al_2O_3, B_2O_3, Fe_2O_3, Li_2O, MnO, Na_2O, SiO_2, ZnO, and ZrO_2), such that the sum of their mass fractions equals one, for the 10-term model

x_i = the normalized mass fraction of component i (Al_2O_3, B_2O_3, CdO, Cr_2O_3, Fe_2O_3, Li_2O, MnO, Na_2O, NiO, Sb_2O_3, SeO_2, SiO_2, SrO, ThO_2, Tl_2O_3, UO_2, ZrO_2, ZnO, and spike), such that the sum of their mass fractions equals one, for the 20-term model

and

N = the number of components in the model

c_{Cd} = concentration of cadmium in the TCLP leachate

b_i = coefficient of the ith term

d = coefficient of the $\ln(m_{CdO})$ term

m_{CdO} = unnormalized mass fraction (actual mass fraction) of CdO in the glass

The TCLP glass durability model predicts the value of cadmium in the TCLP leachate based on the mass fraction (weight percent in the glass) of other glass components and on the mass fraction of cadmium oxide in the glass. The model assumes that:

- The leach rate of cadmium is more sensitive to the mass fraction of cadmium oxide in the glass than the mass fraction of the other glass components
- Each glass component has a different effect on the leach rate of cadmium, and that the effect of each one is independent of the others
- That the overall impact of other constituents not used in the model is negligible

The result is that even though cadmium oxide loading itself is the most influential factor in predicting cadmium release, all model terms must be defined in order to predict cadmium release since cadmium release is a function of glass composition.

5.8.6 Quality Control Analysis [Part 5: 26]

Laboratory control samples, method blank matrix spikes (MSs), and matrix spike duplicates (MSDs) were both defined and generated at the frequency specified by Chapter 1, SW-846 (EPA 1999). In addition, the initial and continuing calibration standards and calibration blanks as specified in the SW-846 methods were used. The raw data in Supplement 4, Appendix J provide the calibration standard and blank results.

5.8.6.1 Analytical Batch Quality Control Sample Results [Part 5: 26a-h]

The percent recoveries and RPDs for the MS/MSDs were calculated. Table 5-16 presents the following information:

a. Name of the spike (e.g., analyte spiked) – "Analyte"
b. Concentration of the spike in the unspiked sampled – "Conc. Of Spiked Sample"
c. Amount of spiked analyte added – "Spike Level"

d. Measured amount of the spike in the actual samples for both the MS and MSD – "Conc of Spiked Sample"
e. Percent recovery based on the method used in SW–846, Chapter 1 – "%Rec"
f. Acceptance criteria[11] for the spikes, 75 % to 125 % (not in table; always this range)
g. Relative percent difference (RPD) between the MS and MSD pairs – "% RPD"
h. Acceptance criteria for the RPD, 0 % to 20 % (not in table; always this range)

The results from analysis of laboratory control samples (LCSs) are in Table 5-17, including the analyte concentration, units, EQL, MDL, dilution factor, and spike level. The LCS is evaluated by calculating the percent recovery, which is the amount measured divided by the amount spiked, expressed as percent. All the LCS recoveries were within the 80 % to 120 % limits for these analytes.

Table 5-18 presents the results from analysis of method blank samples, including the analyte concentration, units, EQL, MDL, and dilution factor. Therefore, both leaching and digesting are assessed for any added laboratory contamination. For the analytes of interest, all blank results were below the EQL. For select analytes the method blank result is above the MDL and below the EQL. Information in Tables 5-16, 5-17, and 5-18 summarize the analytical batch quality control sample results, however, for simplicity, significant figures are not shown.

5.8.6.2 Glass Control Samples

In addition to the spike test samples, discussed above, VSL internal control samples (MIC number 1104-02D180) were included in each sample package. These control samples are not themselves part of the spike test set and were taken from a supply of control glass produced on the VSL pilot-scale melter. They were sent "blind" to STL (without marking to delineate them as control samples). Sampling, packaging, control, and testing of these samples were identical to those of the test samples. The TCLP data for these samples are summarized in Appendix C.

These control samples were included such that batch-to-batch variability of TCLP results and any bias between the two STL laboratories could be evaluated. Table 5-19 shows the STL-St. Louis average TCLP results on the internal standard glass for detected constituents. Results were both above and below the average results on the internal standard glass tested at STL-Knoxville. The differences in average results between the labs were within typical lab-to-lab differences in performing the TCLP, particularly in cases where a portion of the results are estimated values or were detected in laboratory blanks. The elements not shown were undetected in one or more control samples (e.g., only comparable detected constituents are shown), thus, a data comparison for censored (undetected) data is not provided.

5.8.6.3 General Quality Assurance and Quality Control

The individual quality assurance (QA) documents relevant to VSL's production of glass in support of this petition are listed in Table 5-20. Select procedures are provided in Supplement 5 and are identified with an asterisk in the table. Other procedures are available upon request.

[11] Percent recovery acceptance criteria of 75 % to 125 % were agreed upon during the LDR/Delisting DQO process (Supplement 2).

5.8.6.4 General Laboratory Quality Assurance

The STL laboratories each have a QA manual and laboratory-specific SOPs for sample receipt, login, analysis, and data review and generation (Table 5-21).

5.8.7 Analytical Data Correction [Part 5: 27]

No data presented in Appendix C were corrected. Validation qualifiers and minimum detectable quantities were identified in the data validation process as described in Section 5.8.8.

5.8.8 Data Inconsistencies or Deviations [Part 5: 28]

This section describes the results of an independent validation of the data used to support this petition.

Full data packages from STL-Knoxville and STL-St. Louis were forwarded to Eastern Research Group, Inc., for data validation. Data validation was performed for all data packages presented in this petition (Supplement 4, Appendix J). The validation criteria (Supplement 4, Appendix L1) are based on the EPA functional guidelines (EPA 2002b). The validation reports are in Supplement 4, Appendices L2, L3, and L4. The results of the data packages were flagged by the independent validator in accordance with the validation statement of work with either a "U" (undetected constituent) or a "J" (estimated quantity) if required. None of the data were rejected by the validator. The data interpretation (Section 5.8.5) was not impacted as a result of validation findings.

The QC program implemented to support the delisting evaluation was based on SW-846 (EPA 1999) requirements and criteria specified during the LDR/Delisting DQO process (Supplement 2). Validation findings are summarized below for each data package (also called sample delivery group) or electronic data deliverable. Table 5-22 summarizes the validated data for spiked glasses with appropriate data qualifiers for comparison with data as reported by the analytical laboratory. Table 5-23 provides similar information for the matrix glasses.

5.8.8.1 Summary of Validation of Spike Glasses

Refer to Supplement 4, Appendix L2.

<u>Data Package H3D070127</u>

No major or minor deficiencies were encountered that resulted in the qualification of sample data as unusable. Following is a summary of additional items noted:

- All LCSs were within criteria.
- Percent recoveries for one of the two MS/MSD pairs for cyanide were low, 19 % and 33 %; criteria are 75 % to 125 %. The RPD for the same MS/MSD pair was 55 %; criteria are 0 % to 20 %. The associated cyanide results were all nondetects at a reporting limit of 0.50 mg/kg, and well below the proposed delisting level of 230 mg/kg. The unacceptable results for the MS/MSD are attributed to matrix effects and lack of sample homogeneity.

5.8.8.2 Summary of Validation of Initial Matrix Glasses

Refer to Supplement 4, Appendix L3.

Data Package H3B110210

No major deficiencies were encountered that resulted in the qualification of sample data as unusable. The following notes were provided:

- All LCSs were within criteria.
- Percent recoveries for all MS/MSDs were within the criteria of 75 % to 125 % and RPDs were within the 0 % to 20 % criteria.
- Several analytes in the method blanks were above the MDL but below the reporting limit (boron, calcium, strontium, lithium, and COPCs barium and zinc, which were far below the proposed delisting levels). Associated results were qualified where appropriate[12]. None of the detected blank constituents were above method reporting limits.

In the manual verification of calculations, some erratic functioning of the data system was observed with regard to rounding. Some data were truncated; some were rounded. Rounding to a final reported value was inconsistent (in some instances data were truncated instead of rounded). The inconsistency in rounding appears to be erratic. The same rounding inconsistencies were observed in the calibration control samples and calibration verification samples. The numbers are small, and these inconsistencies either had no impact on the subsequent calculation steps or may have changed a unit in the last decimal place. However, in the case of values near the MDL, this change of a decimal could decide whether a value is above the MDL (and, hence, reported) or below the MDL (and, hence, not reported). The validation documentation identifies the MDL (for nondetected analytes) and any instances where the reported value is below the target reporting limit[13] for antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, vanadium, and zinc. This situation was documented as a minor deficiency in the validation report, but did not result in qualification of the data.

Data Package H3B110213 (Revised)

The validation report notes that one sample, HLW02-19, was incorrectly analyzed. To correct the deficiency, all the samples and associated QC samples were reanalyzed. The revised data were used in this petition and all subsequent assessments.

The validation report states that, originally, the incorrect method blank was reported. Barium, lithium, and zinc were reported as not detected (ND), when they should have been reported as estimated values between the MDL and the reporting limit. The "J" qualifier was incorrectly used for barium, lithium, and zinc in the original data package. A revised method blank shows these analytes at a reportable level (Supplement 4, Appendix J). The revised data are validated and used in this petition.

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[12] Where the preparation blank results fall between the MDL and reporting limit, all associated undetected results were qualified as estimated, and associated detected sample results less than 5 times the highest blank concentration are qualified as undetected. Other associated detected results that were less than 10 times the value of the preparation blank were qualified as estimated.

[13] The target reporting limits established for this project were the proposed delisting limits documented in Supplement 2. Although the proposed delisting limits of chromium and arsenic have been revised, analytical MDLs are still substantially lower than the proposed delisting limits of this petition.

No major deficiencies were encountered that resulted in the qualification of sample data as unusable. The following observations were made:

- All LCSs were within criteria; however, the laboratory narrative states that in the LCS FMHTPC, aluminum, silver, and boron are outside QC limits. The LCS prepared with prep batch #3052096 reported in the summary/QC package shows all analytes within control limits.
- Percent recoveries for all MS/MSDs were within the criteria of 75 % to 125 % and RPDs were within the 0 % to 20 % criteria.
- Several analytes in the method blanks were above the MDL but below the reporting limit, and far below the proposed delisting level (barium, lithium, and zinc). Associated results were qualified where appropriate (footnote 12, page 5-28). None of the detected blank constituents were above method reporting limits.

As was the case for data package H3B110210, some erratic functioning of the data system was observed with regard to rounding. This was noted as a minor deficiency in the validation report, but did not result in qualification of the data.

Data Package H3B270125

No major deficiencies were encountered that resulted in the qualification of sample data as unusable. Following is a summary of observations:

- All LCSs were within criteria.
- Percent recoveries for all MS/MSDs were within the criteria of 75 % to 125 % and RPDs were within the 0 % to 20 % criteria.

As was the case for data package H3B110210, some erratic functioning of the data system was observed with regard to rounding. This was noted as a minor deficiency in the validation report, but did not result in qualification of the data.

Data Package H3C100111

No major deficiencies were encountered that resulted in the qualification of sample data as unusable. The following observations were recorded:

- All LCSs were within criteria.
- Percent recoveries for all MS/MSDs were within the criteria of 75 % to 125 % and RPDs were within the 0 % to 20 % criteria.
- Several analytes in the method blanks were above the MDL but below the reporting limit (lithium, manganese, strontium, and the COPCs barium, cadmium, and zinc, which were far below the proposed delisting levels). Associated results were qualified where appropriate (footnote 12, page 5-28). None of the detected blank constituents were found in excess of method reporting limits.

As was the case for data package H3B110210, some erratic functioning of the data system was observed with regard to rounding. A rounding error in the laboratory data system resulted in samples HLW98-82

and HLW98-88R2[14] for titanium and barium respectively, not being reported (below the MDL); however, the correct result is at the MDL for each constituent. This was noted as a minor deficiency in the validation report.

5.8.8.3 Summary of Validation of Augmentation Matrix Glasses

Refer to Supplement 4, Appendix L4.

Data Package H3D100122[15]

Data Package H3D100122 included glasses HLW03-19A and HLW03-19M (control samples), and augmentation matrix glasses HLW03-02, HLW03-03, and HLW03-42. Other glass analyses in data package H3D100122 are not associated with the petition. No major deficiencies were encountered that resulted in the qualification of sample data as unusable. The following observations were recorded:

- All LCSs were within criteria.
- Percent recoveries for all MS/MSDs were within the criteria of 75 % to 125 % and RPDs were within the 0 % to 20 % criteria.
- Several analytes in the method blanks were above the MDL and below the reporting limit. Aluminum, barium, calcium, lead, lithium, strontium, and zinc were detected higher than 5% of measured sample concentration in HLW03-19A and HLW03-19M (control samples, Section 5.8.6.2). Strontium and zinc were detected higher than 5% of measured sample concentration in HLW03-02. Lithium, strontium, and zinc were detected higher than 5% of measured sample concentration in HLW03-03. Zinc was detected higher than 5% of measured sample concentration in HLW03-42. Other samples associated with the blank, but not used to support this petition, have similar issues. Associated results were qualified where appropriate (footnote 12, page 5-28). None of the detected blank constituents were above method reporting limits.

Other minor deficiencies were noted. As was the case for data package H3B110210, some erratic functioning of the data system was observed with regard to rounding.

The serial dilution of sample HLW03-19A (a control sample) was outside control limits for boron, barium, silicon, and zinc because of physical or chemical matrix interferences, as reported in the narrative. Associated sample results greater than the reporting limit after a five-fold dilution are qualified as estimated.

Data Package F4D070174

No major deficiencies were encountered that resulted in the qualification of sample data as unusable. Following are additional observations:

- All LCSs were within criteria.

[14] Samples HLW98-82 and HLW98-88R2 are not directly related to this petition. Data for HLW98-82 and HLW98-88R2 are for another project and were not used in development of the TCLP response model.

[15] The data validation for H3D100122 is not in Supplement 4, Appendix L3, but was originally published by Kot and others (2004a). However, for completeness, the data validation for H3D100122 has been attached to Supplement 4.

- MS/MSD recoveries for zinc, strontium, silicon, and manganese were outside the established QC limits: the analyte concentration in the original sample was greater than 4 times the amount spiked, making percent recovery information difficult to determine. The MS/MSD recovery for silver was outside the established QC limits, but the RPD was within limits, indicating a possible matrix interference. Other MS/MSD recoveries were within the 75 % to 125 % criteria. MS/MSD RPDs were within the 0 % to 20 % criteria.
- Many of the analytes in the method blank were above the MDL and below the reporting limit. The validation reports that the digested method blank along with the undigested leachate method blank were contaminated with iron. All sample results for iron have the potential for a false positive bias of approximately 900 µg/L. Associated results were qualified where appropriate (footnote 12, page 5-28). None of the detected blank constituents were above method reporting limits.
- The samples were analyzed with a dilution factor of 2.5 because of the high level of sodium in the samples.

Other minor deficiencies were noted. As was the case for data package H3B110210, some erratic functioning of the data system was observed with regard to rounding.

Additionally, the lab narrative states that strontium, barium, and zinc have a percent difference greater than 10% in the serial dilution. The qualifier "E" was used in the lab data package to indicate an element for which the serial dilution percent difference was outside STL's acceptable range. However, the "E" qualifier was not listed and defined with other qualifiers in the multiple tables of the data package where it was used.

In the original data package, the silicon peak for several samples was saturated, as was shown in the raw data. The laboratory reported that the instrument linear range was not updated in a timely manner and the range of 5000 as reported in the original data package was not correct. A revised package was subsequently submitted for validation. The revised data package contained an updated linear range report and the silicon peak was not saturated (Appendix J of Supplement 4).

Data Package F4D070183

No major deficiencies were encountered that resulted in the qualification of sample data as unusable. Following are additional observations:

- All LCSs were within criteria.
- Percent recoveries for all MS/MSDs were within the criteria of 75 % to 125 % except for silver. The MS/MSD recovery for silver was outside the established QC limits, but the RPD was within limits, indicating a possible matrix interference. All RPDs were within the 0 % to 20 % criteria.
- Many of the analytes in the method blank were above the MDL and below the reporting limit. Associated results were qualified where appropriate (footnote 12, page 5-28). None of the detected blank constituents were above method reporting limits.
- The samples were analyzed with a dilution factor of 2.5 because of the high level of sodium in the samples.

As was the case for data package H3B110210, some erratic functioning of the data system was observed with regard to rounding. This was noted as a minor deficiency in the validation report, but did not result in qualification of the data.

Data Package F4D070189

No major deficiencies were encountered that resulted in the qualification of sample data as unusable. Following are additional observations:

- All LCSs were within criteria.
- Percent recoveries for all MS/MSDs were within the criteria of 75 % to 125 % and RPDs were within the 0 % to 20 % criteria.
- Many of the analytes in the method blank were above the MDL and below the reporting limit. Associated results were qualified where appropriate (footnote 12, page 5-28). None of the detected blank constituents were found in excess of method reporting limits.
- The samples were analyzed with a dilution factor of 2.5 because of the high level of sodium in the samples.

Other minor deficiencies were noted. As was the case for data package H3B110210, some erratic functioning of the data system was observed with regard to rounding.

The lab narrative states that barium has a percent difference greater than 10% in the serial dilution, and was qualified accordingly. The qualifier "E" was used in the lab data package to indicate an element for which the serial dilution percent difference was outside STL's acceptable range. However, the "E" qualifier was not listed and defined with other qualifiers in the multiple tables of the data package where it was used.

In the original data package, the silicon peak for sample HLW03-21-2 was saturated, as was shown in the raw data. The laboratory reported that the instrument linear range was not updated in a timely manner and the range of 5000 as reported in the original data package is not correct. In addition, the original data package contained two blank pages. A revised package was subsequently submitted; however, the dates on the Summary Report, Metals Data Reporting Forms, and TCLP Extraction/Chain of Custody were inconsistent. Accordingly, a second revision was requested to correct this inconsistency (Appendix J of Supplement 4).

5.8.9 Calculations [Part 5: 29]

The oily waste extraction procedure was not used; therefore, calculations were not required. Sample TCLP data were compared directly to the proposed delisting level using the DRAS model (Section 4.4).

Table 5-1 Selected Spiking Levels of COPCs in IHLW Glasses

Symbol	COPC	Oxide	Maximum Expected Concentration in Glass (wt%)	Spiking Concentration in Glass (oxide wt%)			
Case 1: Nonleachable Constituents							
Ag	Silver	Ag_2O	0.19 %	0.20 %			
As	Arsenic	As_2O_3	0.34 %	0.34 %			
Ba	Barium	BaO	1.57 %	1.57 %			
Be	Beryllium	BeO	0.02 %	0.10 %			
Cr	Chromium	Cr_2O_3	0.40 %	0.50 %			
Cd	Cadmium [a]	CdO	1.57 %	0.10 %			
Cu	Copper	CuO	0.17 %	0.17 %			
Hg	Mercury [b]	HgO	0.23 %	0.23 %			
Ni	Nickel	NiO	0.84 %	1.00 %			
Pb	Lead	PbO	0.46 %	0.50 %			
Se	Selenium	SeO_2	0.18 %	0.20 %			
V	Vanadium	V_2O_5	0.11 %	0.50 %			
Zn	Zinc	ZnO	0.15 %	2.00 %			
CN	Cyanide (total) [b]	CN	0.01 %	0.04 %			
Case 2: Potentially Leachable Constituents				**Four Spike Levels: E, F, G, and H**			
Sb	Antimony	Sb_2O_3	0.29 %	0.10 %	0.29 %	0.60 %	1.20 %
Tl	Thallium	Tl_2O_3	0.33 % [d]	0.35 %	0.17 %	0.07 %	0.03 %
Case 3: Leachable Constituents				**Varied Spike Levels [c]**			
Cd	Cadmium	CdO	1.57 %	0.10 % to 1.6 %			

a Cadmium is a Case 3 constituent, but was present in Case 1 bounding and nominal glass at the concentration shown, and is listed for completeness of the table.

b COPC is volatile.

c Case 3 matrix glass compositions are discussed in greater detail in section 5.3.1.2.

d The value shown is from the memo "Instructions for HLW Regulatory Spike Testing" (CCN 060291), converted from Tl_2O to Tl_2O_3; however, later estimates performed by WTP based on feed component limits in Table TS-8.1 of the WTP contract and 35 % waste loading revised these values downwards to 0.18 wt% Tl_2O_3.

Values taken from source document as reported (see Supplement 4).

Table 5-2 Compositions of the IHLW Bounding Case Glass with Four Spike Combinations Tested in Triplicate

Oxide	HLW99-03E HLW99-03ER1[a] HLW99-03ER2 (wt%)	HLW99-03F HLW99-03FR1 HLW99-03FR2 (wt%)	HLW99-03G HLW99-03GR1 HLW99-03GR2 (wt%)	HLW99-03H HLW99-03HR1 HLW99-03HR2 (wt%)
Ag_2O	0.20 %	0.20 %	0.20 %	0.20 %
Al_2O_3	11.58 %	11.58 %	11.55 %	11.42 %
As_2O_3	0.34 %	0.34 %	0.34 %	0.34 %
B_2O_3	21.05 %	21.05 %	21.00 %	20.77 %
BaO	1.57 %	1.57 %	1.57 %	1.57 %
BeO	0.10 %	0.10 %	0.10 %	0.10 %
Bi_2O_3	2.11 %	2.11 %	2.10 %	2.08 %
CdO	0.10 %	0.10 %	0.10 %	0.10 %
Ce_2O_3	0.21 %	0.21 %	0.21 %	0.21 %
Cl-	0.21 %	0.21 %	0.21 %	0.21 %
CoO	0.21 %	0.21 %	0.21 %	0.21 %
Cr_2O_3	0.50 %	0.50 %	0.50 %	0.50 %
Cs_2O	0.21 %	0.21 %	0.21 %	0.21 %
CuO	0.17 %	0.17 %	0.17 %	0.17 %
F	0.21 %	0.21 %	0.21 %	0.21 %
Fe_2O_3	2.11 %	2.11 %	2.10 %	2.08 %
K_2O	1.05 %	1.05 %	1.05 %	1.04 %
La_2O_3	0.21 %	0.21 %	0.21 %	0.21 %
Li_2O	7.37 %	7.37 %	7.35 %	7.27 %
MgO	2.11 %	2.11 %	2.10 %	2.08 %
MnO_2	0.21 %	0.21 %	0.21 %	0.21 %
Na_2O	8.63 %	8.63 %	8.61 %	8.52 %
NiO	1.00 %	1.00 %	1.00 %	1.00 %
PbO	0.50 %	0.50 %	0.50 %	0.50 %
PdO	0.04 %	0.04 %	0.04 %	0.04 %
Rh_2O_3	0.08 %	0.08 %	0.08 %	0.08 %
Ru_2O_3	0.14 %	0.14 %	0.14 %	0.13 %
Sb_2O_3	0.10 %	0.29 %	0.60 %	1.20 %
SeO_2	0.20 %	0.20 %	0.20 %	0.20 %
SiO_2	29.95 %	29.94 %	29.88 %	30.01 %

Table 5-2 Compositions of the IHLW Bounding Case Glass with Four Spike Combinations Tested in Triplicate

Oxide	HLW99-03E HLW99-03ER1[a] HLW99-03ER2 (wt%)	HLW99-03F HLW99-03FR1 HLW99-03FR2 (wt%)	HLW99-03G HLW99-03GR1 HLW99-03GR2 (wt%)	HLW99-03H HLW99-03HR1 HLW99-03HR2 (wt%)
SrO	0.21 %	0.21 %	0.21 %	0.21 %
TeO_2	0.21 %	0.21 %	0.21 %	0.21 %
TiO_2	1.05 %	1.05 %	1.05 %	1.04 %
Tl_2O_3	0.35 %	0.17 %	0.07 %	0.03 %
V_2O_5	0.50 %	0.50 %	0.50 %	0.50 %
WO_3	0.21 %	0.21 %	0.21 %	0.21 %
ZnO	2.00 %	2.00 %	2.00 %	2.00 %

a R1 and R2 are identifiers used to distinguish the replicates.

Values taken from source document as reported (see Supplement 4).

Table 5-3 Compositions of the IHLW Typical Case Glass with Four Spike Combinations

Oxide	HLW98-77E (wt%)	HLW98-77F (wt%)	HLW98-77G (wt%)	HLW98-77H (wt%)
Ag_2O	0.20 %	0.20 %	0.20 %	0.20 %
Al_2O_3	4.94 %	4.94 %	4.92 %	4.89 %
As_2O_3	0.34 %	0.34 %	0.34 %	0.34 %
B_2O_3	11.31 %	11.31 %	11.29 %	11.22 %
BaO	1.57 %	1.57 %	1.57 %	1.57 %
BeO	0.10 %	0.10 %	0.10 %	0.10 %
CaO	0.27 %	0.27 %	0.27 %	0.26 %
CdO	0.10 %	0.10 %	0.10 %	0.10 %
Cr_2O_3	0.50 %	0.50 %	0.50 %	0.50 %
CuO	0.17 %	0.17 %	0.17 %	0.17 %
F	0.04 %	0.04 %	0.04 %	0.03 %
Fe_2O_3	11.61 %	11.61 %	11.58 %	11.51 %
K_2O	0.03 %	0.03 %	0.03 %	0.03 %
La_2O_3	0.39 %	0.39 %	0.39 %	0.38 %
Li_2O	3.35 %	3.35 %	3.34 %	3.32 %
MgO	0.10 %	0.10 %	0.10 %	0.10 %
MnO_2	0.16 %	0.16 %	0.16 %	0.16 %
Na_2O	11.08 %	11.08 %	11.05 %	10.98 %
Nd_2O_3	0.29 %	0.29 %	0.29 %	0.29 %
NiO	1.00 %	1.00 %	1.00 %	1.00 %
PbO	0.50 %	0.50 %	0.50 %	0.50 %
SO_3	0.07 %	0.07 %	0.07 %	0.07 %
Sb_2O_3	0.10 %	0.29 %	0.60 %	1.20 %
SeO_2	0.20 %	0.20 %	0.20 %	0.20 %
SiO_2	45.09 %	45.08 %	44.98 %	44.71 %
SrO	0.03 %	0.03 %	0.03 %	0.03 %
Tl_2O_3	0.35 %	0.17 %	0.07 %	0.03 %
V_2O_5	0.50 %	0.50 %	0.50 %	0.50 %
ZnO	2.00 %	2.00 %	2.00 %	2.00 %
ZrO_2	3.62 %	3.62 %	3.61 %	3.59 %

Values taken from source document as reported (see Supplement 4).

Table 5-4 Component Constraints for IHLW Initial Test Matrix

Component	Outer Layer		Inner Layer	
	Lower Limit (wt%)	Upper Limit (wt%)	Lower Limit (wt%)	Upper Limit (wt%)
Al_2O_3	4	8.5	5.5	7.5
B_2O_3	5	14	8	13
CdO	0.05	1.5	0.5	1.0
Fe_2O_3	8	14	10	12
Li_2O	2	6	2.5	5
MnO	0	5	1.5	3.5
Na_2O	4	15	9	15
NiO	0.1	1.0	0.3	0.8
Sb_2O_3	0.02	0.2	0.05	0.15
SeO_2	0.02	0.2	0.05	0.15
SiO_2	38	53	41	49
SrO	0	5	1.5	3.5
Tl_2O_3	0.02	0.2	0.05	0.15
ZrO_2	0	6	1.5	4.5
Spike	**0.15**	**1.5**	**0.3**	**1.0**
Ag_2O	0.02	0.2	0.04	0.13
As_2O_3	0.02	0.2	0.04	0.13
BaO	0.03	0.3	0.06	0.20
Cr_2O_3	0.02	0.2	0.04	0.13
CuO	0.01	0.1	0.02	0.07
PbO	0.04	0.4	0.08	0.27
V_2O_5	0.01	0.1	0.02	0.07
Constant	**4.2**		**4.2**	
Bi_2O_3	0.01		0.01	
CaO	0.5		0.5	
CeO_2	0.05		0.05	
Cl	0.2		0.2	
CoO	0.01		0.01	
Cs_2O	0.01		0.01	

Table 5-4 Component Constraints for IHLW Initial Test Matrix

Component	Outer Layer		Inner Layer	
	Lower Limit (wt%)	Upper Limit (wt%)	Lower Limit (wt%)	Upper Limit (wt%)
F	0.05		0.05	
K_2O	0.06		0.06	
La_2O_3	0.3		0.3	
MgO	0.12		0.12	
P_2O_5	0.5		0.5	
PdO	0.12		0.12	
Rh_2O_3	0.05		0.05	
RuO_2	0.08		0.08	
SO_3	0.1		0.1	
TeO_2	0.01		0.01	
TiO_2	0.03		0.03	
ZnO	2.0		2.0	

Values taken from source document as reported (see Supplement 4).

Table 5-5 Component Constraints for IHLW Augmentation Test Matrix

Component	Outer Layer		Inner Layer	
	Lower Limit (wt%)	Upper Limit (wt%)	Lower Limit (wt%)	Upper Limit (wt%)
Variables ("Base" Glass Components)	**94.5**	**97.56**	**96.18**	**97.29**
Al_2O_3	2	8.5	3	5
B_2O_3	5	14	7	12
Cr_2O_3	0.02	0.5	0.08	0.2
Fe_2O_3	2	14	5	10
Li_2O	2	6	2.5	5
MnO	0	7	1.5	4.5
Na_2O	4	15	7	12
NiO	0.1	1.0	0.3	0.5
SiO_2	36	53	41	49
SrO	0	10	1.5	4.5
ThO_2	0	6	3	4.5
UO_2	0	6	2	4
ZnO	0	4	1	3
ZrO_2	0	10	6	9
Selected RCRA Components	**0.24**	**3.7**	**0.51**	**1.62**
CdO	0.05	1.6	0.1	0.3
SeO_2	0.02	0.2	0.05	0.15
Sb_2O_3	0.02	0.3	0.05	0.15
Tl_2O_3	0.02	0.33	0.05	0.15
Spike	**0.13**	**1.3**	**0.26**	**0.87**
Ag_2O	0.02	0.2	0.04	0.13
As_2O_3	0.02	0.2	0.04	0.13
BaO	0.03	0.3	0.06	0.20
CuO	0.01	0.1	0.02	0.07
PbO	0.04	0.4	0.08	0.27
V_2O_5	0.01	0.1	0.02	0.07

Table 5-5 Component Constraints for IHLW Augmentation Test Matrix

Component	Outer Layer		Inner Layer	
	Lower Limit (wt%)	Upper Limit (wt%)	Lower Limit (wt%)	Upper Limit (wt%)
Constant	**2.2**		**2.2**	
Bi_2O_3	0.01		0.01	
CaO	0.5		0.5	
CeO_2	0.05		0.05	
Cl	0.2		0.2	
CoO	0.01		0.01	
Cs_2O	0.01		0.01	
F	0.05		0.05	
K_2O	0.06		0.06	
La_2O_3	0.3		0.3	
MgO	0.12		0.12	
P_2O_5	0.5		0.5	
PdO	0.12		0.12	
Rh_2O_3	0.05		0.05	
RuO_2	0.08		0.08	
SO_3	0.1		0.1	
TeO_2	0.01		0.01	
TiO_2	0.03		0.03	

Values taken from source document as reported (see Supplement 4).

Table 5-6 Target Composition of Test Matrix Glass

Glass ID	Point Type (layered design)	Base Components																	
		Al_2O_3	B_2O_3	Fe_2O_3	Li_2O	MnO	Na_2O	SiO_2	SrO	ThO_2	UO_2	ZrO_2	Cr_2O_3	NiO	ZnO	CdO	Tl_2O_3	Sb_2O_3	SeO_2
HLW02-01	1a.Center	6.172	9.928	10.899	3.996	2.385	10.958	43.616	2.444	0	0	2.974	0.108	0.518	1.999	0.771	0.11	0.11	0.11
HLW02-02	1a.Outer01	4	14	14	6	0	4	50.46	0	0	0	0	0.2	0.1	1.999	1.5	0.02	0.2	0.02
HLW02-03	1a.Outer02	4	14	8	2	0	15	38	4.38	0	0	6	0.2	1	1.999	1.5	0.2	0.02	0.2
HLW02-04	1a.Outer03	4	5	14	2	0.518	15	52.932	0	0	0	0	0.02	0.1	1.999	1.5	0.2	0.2	0.2
HLW02-05	1a.Outer04	4	5	8	6	0	13.788	52.653	0	0	0	6	0.02	0.1	1.999	0.05	0.02	0.02	0.02
HLW02-06	1a.Outer05	8.5	5	8	4.739	5	15	40.491	0	0	0	6	0.02	1	1.999	1.5	0.2	0.02	0.2
HLW02-07	1a.Outer06	8.5	5	8	6	0	11.705	53	0	0	0	1.525	0.2	0.1	1.999	0.05	0.2	0.2	0.02
HLW02-08	1a.Outer07	4	14	9.205	3.31	5	15	38.745	0	0	0	6	0.02	0.1	1.999	0.05	0.02	0.2	0.02
HLW02-09	1a.Outer08	8.5	11.589	14	2.271	0	15	38	5	0	0	0	0.02	1	1.999	0.05	0.02	0.2	0.02
HLW02-10	1a.Outer09	8.5	14	8	6	0	10.513	38	2.797	0	0	6	0.02	0.1	1.999	1.5	0.02	0.02	0.2
HLW02-11	1a.Outer10	4	14	8	6	0	10.857	45.144	0	0	0	6	0.02	1	1.999	0.05	0.2	0.2	0.2
HLW02-12	1a.Outer11	4	5	11.386	6	5	12.761	41.414	0	0	0	6	0.2	1	1.999	1.5	0.02	0.02	0.2
HLW02-13	1a.Outer12	4	5	14	6	5	10.427	43.121	5	0	0	1.182	0.2	0.1	1.999	0.05	0.2	0.02	0.2
HLW02-14	1a.Outer13	4	5	8	6	2.49	4.14	53	5	0	0	6	0.02	0.1	1.999	1.5	0.2	0.2	0.02
HLW02-15	1a.Outer14	8.5	14	14	2	4.689	12.541	38	0	0	0	0	0.2	0.1	1.999	0.05	0.2	0.02	0.2
HLW02-16	1a.Outer15	8.5	5	8	6	5	9.654	39.126	5	0	0	6	0.2	0.1	1.999	1.5	0.02	0.2	0.2
HLW02-17	1a.Outer16	8.5	5	13.843	6	0	7.69	52.958	0	0	0	0	0.02	0.1	1.999	1.5	0.02	0.02	0.02
HLW02-18	1a.Outer17	4	5	11.13	2.014	0	15	49.867	0	0	0	6	0.2	1	1.999	0.05	0.02	0.2	0.02
HLW02-19	1a.Outer18	4	14	10.781	2	5	8.849	38	5	0	0	6	0.02	0.1	1.999	1.5	0.02	0.2	0.2
HLW02-20	1a.Outer19	4	14	14	2	0	6.453	51.734	3.253	0	0	0	0.02	0.1	1.999	0.05	0.02	0.02	0.02
HLW02-21	1a.Outer20	8.5	14	8	2	0	15	46.44	0	0	0	1.5	0.02	0.1	1.999	0.05	0.02	0.02	0.02
HLW02-22	1a.Outer21	8.5	14	9.5	6	0	4	53	0.08	0	0	0	0.02	0.1	1.999	0.05	0.02	0.2	0.2
HLW02-23	1a.Outer22	8.5	14	8	6	5	5.59	39.32	5	0	0	1.5	0.02	1	1.999	1.5	0.2	0.02	0.02
HLW02-24	1a.Outer23	8.5	5	8	2	5	12.198	47.062	5	0	0	1.5	0.153	0.1	1.999	0.05	0.02	0.02	0.2
HLW02-25	1a.Outer24	8.5	14	9.5	2	0.355	6.883	47.392	5	0	0	0	0.02	0.1	1.999	1.5	0.2	0.2	0.02
HLW02-26	1a.Outer25	4	5	12.5	2	4.96	15	38	5	0	0	6	0.2	0.1	1.999	1.5	0.2	0.02	0.02
HLW02-27	1a.Outer26	4	14	12.5	6	3.365	4.274	39.941	5	0	0	6	0.02	0.1	1.999	0.05	0.2	0.02	0.2
HLW02-28	1a.Inner01	7.5	8	10.45	2.5	1.5	15	41	3.5	0	0	4.5	0.04	0.3	1.999	1	0.15	0.05	0.05
HLW02-29	1a.Inner02	7.5	13	10	3.75	1.5	9	41	3.5	0	0	4.5	0.133	0.3	1.999	0.5	0.05	0.05	0.15
HLW02-30	1a.Inner03	5.5	9.722	10	5	3.5	11.229	41	3.5	0	0	4.5	0.04	0.3	1.999	1	0.05	0.15	0.05
HLW02-31	1a.Inner04	5.5	13	10	2.5	1.5	14.981	41	1.5	0	0	4.369	0.04	0.3	1.999	0.5	0.15	0.05	0.15

Table 5-6 Target Composition of Test Matrix Glass

Glass ID	Point Type (layered design)	Base Components																	
		Al_2O_3	B_2O_3	Fe_2O_3	Li_2O	MnO	Na_2O	SiO_2	SrO	ThO_2	UO_2	ZrO_2	Cr_2O_3	NiO	ZnO	CdO	Tl_2O_3	Sb_2O_3	SeO_2
HLW02-32	1a.Inner05	7.5	8	10	5	1.5	10.733	46.118	3.5	0	0	1.5	0.04	0.3	1.999	1	0.05	0.15	0.15
HLW02-33	1a.Inner06	6.341	8	12	2.5	3.5	15	41	3.5	0	0	2.009	0.04	0.8	1.999	0.5	0.05	0.15	0.15
HLW02-34	1a.Inner07	5.5	13	12	3.957	1.5	10.893	41	3.5	0	0	1.5	0.133	0.8	1.999	1	0.05	0.05	0.05
HLW02-35	1a.Inner08	6.489	13	12	5	3.5	9.161	41	1.5	0	0	1.5	0.133	0.8	1.999	0.5	0.15	0.15	0.05
HLW02-36	1a.Inner09	5.5	8.669	12	2.5	1.5	15	45.082	1.5	0	0	1.5	0.133	0.3	1.999	1	0.05	0.05	0.15
HLW02-37	1a.Inner10	6.762	13	10	2.5	3.5	11.188	41	1.5	0	0	4.5	0.04	0.8	1.999	0.5	0.05	0.15	0.05
HLW02-38	1a.Inner11	6.894	13	12	4.256	1.5	9	41	3.5	0	0	1.5	0.133	0.8	1.999	1	0.05	0.15	0.15
HLW02-39	1a.Inner12	7.5	8.992	10	2.5	1.5	11.059	49	1.5	0	0	1.5	0.04	0.8	1.999	1	0.05	0.05	0.05
HLW02-40	1a.Inner13	7.5	9.834	10	2.632	1.5	9.684	49	1.5	0	0	1.5	0.133	0.3	1.999	1	0.15	0.15	0.05
HLW02-41	1a.Inner14	6.5	13	10	2.5	1.5	9	48.95	1.5	0	0	1.5	0.04	0.3	1.999	0.5	0.15	0.05	0.05
HLW02-42	1a.Inner15	5.5	13	10	5	1.5	9	44.45	3.5	0	0	2.5	0.04	0.3	1.999	0.5	0.15	0.05	0.05
HLW02-43	1a.Inner16	6.5	13	10	2.5	3.5	12.45	41	3.5	0	0	1.5	0.04	0.3	1.999	1	0.05	0.15	0.05
HLW02-44	1a.Inner17	5.5	9.071	10	2.5	3.5	15	43.68	1.5	0	0	2.5	0.133	0.3	1.999	1	0.05	0.15	0.05
HLW02-45	1a.Inner18	5.5	8	11	2.5	3.5	9.619	48.831	3.5	0	0	1.5	0.04	0.3	1.999	1	0.05	0.05	0.15
HLW02-46	1a.Inner19	5.5	9.149	10	3.701	3.5	9	49	1.5	0	0	2.5	0.04	0.8	1.999	0.5	0.15	0.05	0.15
HLW02-47	1a.Inner20	5.5	9.807	10	2.5	3.5	9.444	49	1.5	0	0	2.5	0.133	0.3	1.999	0.5	0.15	0.05	0.05
HLW02-48	1a.Inner21	6	8	12	3.34	1.5	15	41	1.711	0	0	4.5	0.133	0.8	1.999	0.5	0.15	0.15	0.15
HLW02-49	1a.Inner22	7.5	8.74	12	5	3.5	9	44.211	1.5	0	0	3	0.04	0.3	1.999	0.5	0.15	0.05	0.05
HLW02-50	1a.Inner23	6	13	12	2.5	1.5	9.82	43.53	1.5	0	0	4.5	0.04	0.3	1.999	0.5	0.15	0.15	0.05
HLW02-51	1a.Inner24	7.5	8	10.5	4.589	1.5	9	45.162	3.5	0	0	4.5	0.04	0.3	1.999	0.5	0.15	0.15	0.15
HLW02-52	RepHLW02-01	6.172	9.928	10.899	3.996	2.385	10.958	43.616	2.444	0	0	2.974	0.108	0.518	1.999	0.771	0.11	0.11	0.11
HLW02-53	RepHLW02-17	8.5	5	13.843	6	0	7.69	52.958	0	0	0	0	0.02	0.1	1.999	1.5	0.02	0.02	0.02
HLW02-54	RepHLW02-4	4	5	14	2	0.518	15	52.932	0	0	0	0	0.02	0.1	1.999	1.5	0.2	0.2	0.2
HLW02-55	RepHLW02-42	5.5	13	10	5	1.5	9	44.45	3.5	0	0	2.5	0.04	0.3	1.999	0.5	0.15	0.05	0.05
HLW02-56	RepHLW02-44	5.5	9.071	10	2.5	3.5	15	43.68	1.5	0	0	2.5	0.133	0.3	1.999	1	0.05	0.15	0.05
HLW02-57	RepHLW02-8	4	14	9.205	3.31	5	15	38.745	0	0	0	6	0.02	0.1	1.999	0.05	0.02	0.2	0.02
HLW03-01	1b.Outer01	8.335	13.728	13.728	5.883	6.078	3.922	35.301	0	2.764	0	2.983	0.02	0.098	3.059	0.05	0.33	0.02	0.2
HLW03-02	1b.Outer02	1.951	13.659	13.659	2.472	6.83	11.175	35.124	0	0	0	9.086	0.488	0.976	0	1.6	0.33	0.3	0.02
HLW03-03	1b.Outer03	1.953	4.883	13.674	2.677	6.837	10.753	35.161	9.767	0	0	6.403	0.488	0.977	1.946	1.6	0.33	0.02	0.2
HLW03-04	1b.Outer04	1.961	4.903	13.728	5.883	3.172	4.458	42.575	9.806	0	5.883	2.942	0.49	0.098	0	0.05	0.33	0.02	0.2
HLW03-05	1b.Outer05	8.176	4.809	1.924	1.924	6.733	14.428	47.84	0	3.812	0	0	0.481	0.096	3.847	1.6	0.33	0.3	0.2

Table 5-6 Target Composition of Test Matrix Glass

Glass ID	Point Type (layered design)	Base Components																	
		Al_2O_3	B_2O_3	Fe_2O_3	Li_2O	MnO	Na_2O	SiO_2	SrO	ThO_2	UO_2	ZrO_2	Cr_2O_3	NiO	ZnO	CdO	Tl_2O_3	Sb_2O_3	SeO_2
HLW03-06	1b.Outer06	8.344	4.908	1.963	5.89	6.872	3.927	52.03	5.091	1.416	0	4.095	0.491	0.982	0	1.6	0.02	0.02	0.02
HLW03-07	1b.Outer07	4.979	4.979	13.94	4.767	6.97	11.735	39.967	0	0	5.974	0	0.498	0.1	3.473	0.05	0.02	0.02	0.2
HLW03-08	1b.Outer08	8.033	4.834	1.934	5.152	6.768	14.503	34.807	0	4.413	0	9.669	0.483	0.097	3.867	1.6	0.02	0.3	0.02
HLW03-09	1b.Outer09	7.666	13.692	3.485	1.979	0	14.845	52.453	0	2.551	0	0	0.02	0.099	0	0.05	0.33	0.3	0.2
HLW03-10	1b.Outer10	8.377	4.928	9.991	5.913	6.899	12.863	35.481	0	2.628	1.047	7.257	0.02	0.986	0	0.05	0.02	0.02	0.02
HLW03-11	1b.Outer11	1.991	4.979	9.572	1.991	0	14.936	52.772	0	5.045	5.974	0	0.02	0.1	0	0.05	0.02	0.02	0.2
HLW03-12	1b.Outer12	1.989	4.973	1.989	5.026	6.963	3.979	44.433	9.947	3.742	5.968	3.695	0.497	0.099	3.979	0.05	0.02	0.3	0.02
HLW03-13	1b.Outer13	8.463	4.979	8.664	5.227	6.97	3.983	35.845	9.957	3.85	5.974	0.849	0.498	0.996	1.125	0.05	0.02	0.02	0.2
HLW03-14	1b.Outer14	1.989	4.972	9.045	2.503	6.961	10.423	35.798	9.944	4.114	0	6.51	0.02	0.994	3.978	0.05	0.33	0.02	0.02
HLW03-15	1b.Outer15	1.951	13.659	13.659	1.951	1.348	5.247	51.71	0	2.44	0	0	0.02	0.098	3.336	1.6	0.33	0.3	0.02
HLW03-16	1b.Outer16	1.962	4.904	7.935	2.873	6.866	3.924	44.407	9.809	2.578	5.885	1.005	0.02	0.981	2.782	0.05	0.02	0.3	0.2
HLW03-17	1b.Outer17	8.377	13.798	1.971	1.971	6.899	4.474	46.224	0	2.244	4.53	1.644	0.02	0.294	3.942	0.05	0.02	0.02	0.02
HLW03-18	1b.Outer18	1.989	4.972	13.921	5.921	0	10.531	52.472	0	5.966	0	0	0.497	0.98	0	0.05	0.33	0.02	0.02
HLW03-19	1b.Outer19	1.963	4.908	9.634	5.89	0.197	10.142	52.03	0	5.846	0	0	0.491	0.982	3.927	1.6	0.02	0.02	0.02
HLW03-20	1b.Outer20	1.924	4.809	13.466	5.771	0	10.1	50.697	0.145	5.771	0.406	0	0.019	0.962	0	1.6	0.33	0.3	0.2
HLW03-21	1b.Inner01	4.964	6.949	4.964	2.482	4.467	10.841	48.644	1.489	2.978	1.985	5.956	0.079	0.298	0.993	0.3	0.05	0.05	0.05
HLW03-22	1b.Inner02	4.927	6.898	9.776	2.464	1.478	11.826	40.405	4.435	2.956	3.942	5.913	0.079	0.296	0.985	0.3	0.05	0.05	0.15
HLW03-23	1b.Inner03	4.969	11.925	7.751	2.484	1.491	11.925	40.744	1.491	2.981	3.975	5.963	0.199	0.298	0.994	0.1	0.05	0.05	0.15
HLW03-24	1b.Inner04	2.978	6.949	4.964	4.964	4.467	8.16	48.644	1.489	2.978	1.985	5.956	0.079	0.496	2.978	0.3	0.05	0.05	0.05
HLW03-25	1b.Inner05	2.96	11.838	4.933	2.466	1.48	11.838	42.143	4.439	2.96	1.973	5.919	0.079	0.493	2.96	0.1	0.15	0.05	0.15
HLW03-26	1b.Inner06	4.933	6.906	4.933	4.933	1.48	10.457	40.447	4.439	4.439	3.946	5.919	0.197	0.493	2.96	0.1	0.05	0.15	0.15
HLW03-27	1b.Inner07	4.933	6.906	9.372	4.045	1.48	11.838	40.447	1.48	4.439	1.973	5.919	0.197	0.493	2.96	0.1	0.05	0.15	0.15
HLW03-28	1b.Inner08	3.633	11.925	9.938	4.969	1.491	10.499	40.744	1.491	2.981	1.988	5.963	0.08	0.497	0.994	0.1	0.05	0.15	0.05
HLW03-29	1b.Inner09	2.978	6.949	4.964	4.964	3.526	11.913	40.702	1.489	4.467	3.971	7.692	0.199	0.298	2.978	0.3	0.05	0.05	0.05
HLW03-30	1b.Inner10	2.975	11.901	4.959	4.959	4.463	6.942	43.252	1.488	4.463	1.983	8.238	0.079	0.298	0.992	0.1	0.15	0.15	0.15
HLW03-31	1b.Inner11	4.959	6.942	4.959	4.959	4.463	8.543	45.109	1.488	2.975	1.983	8.925	0.198	0.496	0.992	0.1	0.15	0.15	0.15
HLW03-32	1b.Inner12	4.933	6.906	4.933	4.933	2.932	9.123	40.447	1.48	4.439	3.946	8.879	0.079	0.493	2.96	0.1	0.15	0.15	0.05
HLW03-33	1b.Inner13	4.969	11.925	9.938	3.905	1.491	6.956	40.744	1.491	2.981	3.195	5.963	0.199	0.452	2.981	0.1	0.05	0.15	0.05
HLW03-34	1b.Inner14	2.96	6.906	9.865	2.466	1.48	9.553	48.339	1.48	3.863	1.973	5.919	0.197	0.493	0.987	0.1	0.15	0.05	0.15
HLW03-35	1b.Inner15	4.969	10.409	4.969	2.484	4.472	6.956	48.694	1.491	3.18	1.988	5.963	0.08	0.497	1.04	0.1	0.15	0.05	0.05
HLW03-36	1b.Inner16	4.927	6.898	9.52	2.696	1.478	7.971	48.289	1.478	3.563	1.971	5.913	0.197	0.493	0.985	0.3	0.05	0.15	0.05

Table 5-6 Target Composition of Test Matrix Glass

Glass ID	Point Type (layered design)	Base Components																	
		Al_2O_3	B_2O_3	Fe_2O_3	Li_2O	MnO	Na_2O	SiO_2	SrO	ThO_2	UO_2	ZrO_2	Cr_2O_3	NiO	ZnO	CdO	Tl_2O_3	Sb_2O_3	SeO_2
HLW03-37	1b.Inner17	2.96	11.838	7.24	4.871	1.48	6.906	40.447	1.48	4.439	3.946	7.343	0.079	0.493	2.96	0.1	0.15	0.05	0.15
HLW03-38	1b.Inner18	4.927	6.898	9.855	2.464	1.478	9.642	43.263	1.478	3.885	3.942	7.069	0.197	0.296	0.985	0.3	0.05	0.05	0.15
HLW03-39	1b.Inner19	2.95	6.884	8.513	4.856	1.475	6.884	48.188	1.475	4.425	1.967	7.087	0.197	0.295	0.983	0.3	0.15	0.15	0.15
HLW03-40	1b.Inner20	4.953	6.935	9.412	4.892	1.486	6.935	43.06	3.287	4.458	3.963	5.944	0.079	0.495	0.991	0.3	0.05	0.15	0.15
HLW03-41	1b.Center	3.895	8.747	6.951	3.716	2.703	9.109	43.134	2.71	3.664	2.867	6.779	0.14	0.396	1.923	0.2	0.1	0.1	0.1
HLW03-42	RepHLW02-46	5.5	9.149	10	3.701	3.5	9	49	1.5	0	0	2.5	0.04	0.8	1.999	0.5	0.15	0.05	0.15
HLW03-43	RepHLW03-06	8.344	4.908	1.963	5.89	6.872	3.927	52.03	5.091	1.416	0	4.095	0.491	0.982	0	1.6	0.02	0.02	0.02
HLW03-44	RepHLW03-11	1.991	4.979	9.572	1.991	0	14.936	52.772	0	5.045	5.974	0	0.02	0.1	0	0.05	0.02	0.02	0.2
HLW03-45	RepHLW03-26	4.933	6.906	4.933	4.933	1.48	10.457	40.447	4.439	4.439	3.946	5.919	0.197	0.493	2.96	0.1	0.05	0.15	0.15

Glass ID	Point Type (layered design)	Constant Constituents																	Spike Constituents					
		Bi_2O_3	CaO	CeO_2	Cl	CoO	Cs_2O	F	K_2O	La_2O_3	MgO	P_2O_5	PdO	Rh_2O_3	RuO_2	SO_3	TeO_2	TiO_2	Ag_2O	As_2O_3	BaO	CuO	PbO	V_2O_5
HLW02-01	1a.Center	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.10773	0.10773	0.162	0.05427	0.21627	0.05427
HLW02-02	1a.Outer01	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-03	1a.Outer02	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-04	1a.Outer03	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-05	1a.Outer04	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-06	1a.Outer05	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-07	1a.Outer06	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-08	1a.Outer07	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-09	1a.Outer08	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-10	1a.Outer09	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-11	1a.Outer10	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-12	1a.Outer11	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-13	1a.Outer12	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-14	1a.Outer13	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-15	1a.Outer14	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-16	1a.Outer15	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-17	1a.Outer16	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-18	1a.Outer17	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-19	1a.Outer18	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-20	1a.Outer19	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005

Table 5-6 Target Composition of Test Matrix Glass

Glass ID	Point Type (layered design)	Constant Constituents																	Spike Constituents					
		Bi_2O_3	CaO	CeO_2	Cl	CoO	Cs_2O	F	K_2O	La_2O_3	MgO	P_2O_5	PdO	Rh_2O_3	RuO_2	SO_3	TeO_2	TiO_2	Ag_2O	As_2O_3	BaO	CuO	PbO	V_2O_5
HLW02-21	1a.Outer20	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-22	1a.Outer21	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-23	1a.Outer22	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-24	1a.Outer23	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.15295	0.15295	0.23	0.07705	0.30705	0.07705
HLW02-25	1a.Outer24	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-26	1a.Outer25	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.1995	0.1995	0.3	0.1005	0.4005	0.1005
HLW02-27	1a.Outer26	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-28	1a.Inner01	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-29	1a.Inner02	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-30	1a.Inner03	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-31	1a.Inner04	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-32	1a.Inner05	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-33	1a.Inner06	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-34	1a.Inner07	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-35	1a.Inner08	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-36	1a.Inner09	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-37	1a.Inner10	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-38	1a.Inner11	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-39	1a.Inner12	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-40	1a.Inner13	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-41	1a.Inner14	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-42	1a.Inner15	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-43	1a.Inner16	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-44	1a.Inner17	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-45	1a.Inner18	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-46	1a.Inner19	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-47	1a.Inner20	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-48	1a.Inner21	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-49	1a.Inner22	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-50	1a.Inner23	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-51	1a.Inner24	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201

Table 5-6 Target Composition of Test Matrix Glass

Glass ID	Point Type (layered design)	Constant Constituents																	Spike Constituents					
		Bi_2O_3	CaO	CeO_2	Cl	CoO	Cs_2O	F	K_2O	La_2O_3	MgO	P_2O_5	PdO	Rh_2O_3	RuO_2	SO_3	TeO_2	TiO_2	Ag_2O	As_2O_3	BaO	CuO	PbO	V_2O_5
HLW02-52	RepHLW02-01	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.10773	0.10773	0.162	0.05427	0.21627	0.05427
HLW02-53	RepHLW02-17	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-54	RepHLW02-4	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW02-55	RepHLW02-42	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.0399	0.0399	0.06	0.0201	0.0801	0.0201
HLW02-56	RepHLW02-44	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.133	0.133	0.2	0.067	0.267	0.067
HLW02-57	RepHLW02-8	0.01008	0.4998	0.0504	0.2016	0.01008	0.01008	0.0504	0.0588	0.2982	0.1218	0.4998	0.1218	0.0504	0.0798	0.1008	0.01008	0.02982	0.01995	0.01995	0.03	0.01005	0.04005	0.01005
HLW03-01	1b.Outer01	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.200	0.200	0.300	0.100	0.400	0.100
HLW03-02	1b.Outer02	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-03	1b.Outer03	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-04	1b.Outer04	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.200	0.200	0.300	0.100	0.400	0.100
HLW03-05	1b.Outer05	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.200	0.200	0.300	0.100	0.400	0.100
HLW03-06	1b.Outer06	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-07	1b.Outer07	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-08	1b.Outer08	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.200	0.200	0.300	0.100	0.400	0.100
HLW03-09	1b.Outer09	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-10	1b.Outer10	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.200	0.200	0.300	0.100	0.400	0.100
HLW03-11	1b.Outer11	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-12	1b.Outer12	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-13	1b.Outer13	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-14	1b.Outer14	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-15	1b.Outer15	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-16	1b.Outer16	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.200	0.200	0.300	0.100	0.400	0.100
HLW03-17	1b.Outer17	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.200	0.200	0.300	0.100	0.400	0.100
HLW03-18	1b.Outer18	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-19	1b.Outer19	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-20	1b.Outer20	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.200	0.200	0.300	0.100	0.400	0.100
HLW03-21	1b.Inner01	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-22	1b.Inner02	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-23	1b.Inner03	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-24	1b.Inner04	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-25	1b.Inner05	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067

Table 5-6 Target Composition of Test Matrix Glass

Glass ID	Point Type (layered design)	Constant Constituents																	Spike Constituents					
		Bi_2O_3	CaO	CeO_2	Cl	CoO	Cs_2O	F	K_2O	La_2O_3	MgO	P_2O_5	PdO	Rh_2O_3	RuO_2	SO_3	TeO_2	TiO_2	Ag_2O	As_2O_3	BaO	CuO	PbO	V_2O_5
HLW03-26	1b.Inner06	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-27	1b.Inner07	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-28	1b.Inner08	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-29	1b.Inner09	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-30	1b.Inner10	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-31	1b.Inner11	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-32	1b.Inner12	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-33	1b.Inner13	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-34	1b.Inner14	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-35	1b.Inner15	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-36	1b.Inner16	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-37	1b.Inner17	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-38	1b.Inner18	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-39	1b.Inner19	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067
HLW03-40	1b.Inner20	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-41	1b.Center	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.087	0.087	0.130	0.043	0.174	0.043
HLW03-42	RepHLW02-46	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.040	0.040	0.060	0.020	0.080	0.020
HLW03-43	RepHLW03-06	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-44	RepHLW03-11	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.020	0.020	0.030	0.010	0.040	0.010
HLW03-45	RepHLW03-26	0.01	0.5	0.05	0.2	0.01	0.01	0.05	0.06	0.3	0.12	0.5	0.12	0.05	0.08	0.1	0.01	0.03	0.134	0.134	0.201	0.067	0.268	0.067

Values taken from source document as reported (see Supplement 4).

Table 5-7 Comparison of Sampling Design in the LDR /Delisting DQO with Actual Experimental Design

Design or Actual Experiment	COPC Type	Experimental Design	Number of Experiments [a]	Statistical Analysis	Numbers Are Per Experiment			
					Number of Glasses (k)	Number of Spiking Levels (m)	Number of Samples per Glass, per Spiking Level Combination (n)	Total Number of Samples: N=k×m×n
Design	Nonleachable Metals	One glass with one spiking level	1-3	Case 1	1	1	6	6
Actual	Nonleachable Metals	Two glasses (nominal and bounding), one spike level	1 nominal 1 bounding	Case 1	1 nominal 1 bounding	1	Nominal (4) Bounding (12)	16
Design	Potentially Leachable Metals	One glass with multiple spiking levels	1-3	Case 2	1	4-5	3	12-15
Actual	Potentially Leachable Metals	Two glasses (nominal and bounding), four spike levels	1 nominal 1 bounding	Case 2	1 nominal 1 bounding	4	Nominal (1) Bounding (3)	16 [b]
Design	Leachable Metals	Multiple glasses with multiple spiking levels	1	Case 3 [c]	15-60	1	1	15-60
Actual	Leachable Metals	Multiple glasses with multiple spiking levels	2	Case 3 [c]	57 Initial 45 Augmentation	1	1	57 Initial 45 Augmentation 102 Total

a Note that the number of experiments (column 3) is not necessarily the same as the number of glasses tested per experiment (column 5). In instances where glasses are analyzed separately (nonleachable metals/Case 1, and leachable metals/Case 2), the number of experiments is the same as the number of glasses tested per experiment. But in Case 3, an experiment is run using multiple glasses. Here, the number of experiments run and the number of glasses per experiment are not the same.

b For Case 2, 1 nominal glass × 4 spike levels × 1 replicate = 4. One bounding glass × 4 spike levels × 3 replicates = 12. 4 + 12 = 16 total samples.

c Although 15 to 60 glasses with one spike level are specified, interpretation is that glass composition will be varied by any combination of base glass formulae and spike levels. As a result, 15 to 60 unique glass compositions will be required to support the Case 3 statistical approach.

Table 5-8 Sample Identification and Corresponding Glass

VSL Sample ID	Glass ID	Glass or Matrix Point Type (and Numeric Designator)	Sample Delivery Group	STL Sample ID
HLW98-77E	HLW98-77	Nominal Spike Glass	H3D070127	H3D070127-002
HLW98-77F	HLW98-77	Nominal Spike Glass	H3D070127	H3D070127-003
HLW98-77G	HLW98-77	Nominal Spike Glass	H3D070127	H3D070127-004
HLW98-77H	HLW98-77	Nominal Spike Glass	H3D070127	H3D070127-005
HLW99-03E	HLW99-03	Bounding Spike Glass, Replicate E1	H3D070127	H3D070127-006
HLW99-03F	HLW99-03	Bounding Spike Glass, Replicate F1	H3D070127	H3D070127-007
HLW99-03G	HLW99-03	Bounding Spike Glass, Replicate G1	H3D070127	H3D070127-008
HLW99-03H	HLW99-03	Bounding Spike Glass, Replicate H1	H3D070127	H3D070127-009
HLW99-03ER1	HLW99-03	Bounding Spike Glass, Replicate E2	H3D070127	H3D070127-010
HLW99-03FR1	HLW99-03	Bounding Spike Glass, Replicate F2	H3D070127	H3D070127-011
HLW99-03GR1	HLW99-03	Bounding Spike Glass, Replicate G2	H3D070127	H3D070127-012
HLW99-03HR1	HLW99-03	Bounding Spike Glass, Replicate H2	H3D070127	H3D070127-013
HLW99-03ER2	HLW99-03	Bounding Spike Glass, Replicate E3	H3D070127	H3D070127-014
HLW99-03FR2	HLW99-03	Bounding Spike Glass, Replicate F3	H3D070127	H3D070127-015
HLW99-03GR2	HLW99-03	Bounding Spike Glass, Replicate G3	H3D070127	H3D070127-016
HLW99-03HR2	HLW99-03	Bounding Spike Glass, Replicate H3	H3D070127	H3D070127-03HR2
HLW99-03M12	M12-G-19A	Spike Glass Control	H3D070127	H3D070127-001
HLW02-01	HLW02-01	Initial Matrix, Center	H3B110210	H3B110210-010
HLW02-02	HLW02-02	Initial Matrix, Outer Layer 01	H3B270125	H3B270125-016
HLW02-03	HLW02-03	Initial Matrix, Outer Layer 02	H3B110210	H3B110210-006
HLW02-04	HLW02-04	Initial Matrix, Outer Layer 03	H3B110213	H3B110213-009
HLW02-05	HLW02-05	Initial Matrix, Outer Layer 04	H3B110213	H3B110213-002
HLW02-06	HLW02-06	Initial Matrix, Outer Layer 05	H3B110213	H3B110213-010
HLW02-07	HLW02-07	Initial Matrix, Outer Layer 06	H3B110213	H3B110213-013
HLW02-08	HLW02-08	Initial Matrix, Outer Layer 07	H3B110213	H3B110213-004
HLW02-09	HLW02-09	Initial Matrix, Outer Layer 08	H3B110213	H3B110213-019
HLW02-10	HLW02-10	Initial Matrix, Outer Layer 09	H3B110210	H3B110210-012
HLW02-11	HLW02-11	Initial Matrix, Outer Layer 10	H3B270125	H3B270125-020
HLW02-12	HLW02-12	Initial Matrix, Outer Layer 11	H3B110210	H3B110210-014
HLW02-13	HLW02-13	Initial Matrix, Outer Layer 12	H3B110213	H3B110213-015
HLW02-14	HLW02-14	Initial Matrix, Outer Layer 13	H3B110213	H3B110213-014
HLW02-15	HLW02-15	Initial Matrix, Outer Layer 14	H3B110210	H3B110210-005
HLW02-16	HLW02-16	Initial Matrix, Outer Layer 15	H3B110213	H3B110213-007
HLW02-17	HLW02-17	Initial Matrix, Outer Layer 16	H3B270125	H3B270125-011
HLW02-18	HLW02-18	Initial Matrix, Outer Layer 17	H3B110210	H3B110210-017

Table 5-8 Sample Identification and Corresponding Glass

VSL Sample ID	Glass ID	Glass or Matrix Point Type (and Numeric Designator)	Sample Delivery Group	STL Sample ID
HLW02-19	HLW02-19	Initial Matrix, Outer Layer 18	H3B110213	H3B110213-001
HLW02-20R1	HLW02-20	Initial Matrix, Outer Layer 19	H3B270125	H3B270125-005
HLW02-21R1	HLW02-21	Initial Matrix, Outer Layer 20	H3B270125	H3B270125-001
HLW02-22	HLW02-22	Initial Matrix, Outer Layer 21	H3B270125	H3B270125-018
HLW02-23R1	HLW02-23	Initial Matrix, Outer Layer 22	H3B270125	H3B270125-017
HLW02-24	HLW02-24	Initial Matrix, Outer Layer 23	H3B270125	H3B270125-002
HLW02-25R1	HLW02-25	Initial Matrix, Outer Layer 24	H3B270125	H3B270125-006
HLW02-26	HLW02-26	Initial Matrix, Outer Layer 25	H3B110210	H3B100210-001
HLW02-27	HLW02-27	Initial Matrix, Outer Layer 26	H3B270125	H3B270125-015
HLW02-28	HLW02-28	Initial Matrix, Inner Layer 01	H3B110213	H3B110213-011
HLW02-29R1	HLW02-29	Initial Matrix, Inner Layer 02	H3B270125	H3B270125-007
HLW02-30	HLW02-30	Initial Matrix, Inner Layer 03	H3B110210	H3B110210-011
HLW02-31	HLW02-31	Initial Matrix, Inner Layer 04	H3B110210	H3B110210-019
HLW02-32R1	HLW02-32	Initial Matrix, Inner Layer 05	H3B270125	H3B270125-009
HLW02-33	HLW02-33	Initial Matrix, Inner Layer 06	H3B110210	H3B110210-013
HLW02-34R1	HLW02-34	Initial Matrix, Inner Layer 07	H3C100111	H3C100111-005
HLW02-35	HLW02-35	Initial Matrix, Inner Layer 08	H3B270125	H3B270125-004
HLW02-36	HLW02-36	Initial Matrix, Inner Layer 09	H3B110213	H3B110213-016
HLW02-37	HLW02-37	Initial Matrix, Inner Layer 10	H3B110210	H3B110210-016
HLW02-38	HLW02-38	Initial Matrix, Inner Layer 11	H3B110210	H3B110210-018
HLW02-39	HLW02-39	Initial Matrix, Inner Layer 12	H3B110213	H3B110213-012
HLW02-40	HLW02-40	Initial Matrix, Inner Layer 13	H3B270125	H3B270125-019
HLW02-41	HLW02-41	Initial Matrix, Inner Layer 14	H3B110210	H3B110210-008
HLW02-42	HLW02-42	Initial Matrix, Inner Layer 15	H3B110213	H3B110213-005
HLW02-43	HLW02-43	Initial Matrix, Inner Layer 16	H3B270125	H3B270125-003
HLW02-44	HLW02-44	Initial Matrix, Inner Layer 17	H3B110210	H3B110210-007
HLW02-45	HLW02-45	Initial Matrix, Inner Layer 18	H3B110210	H3B110210-003
HLW02-46	HLW02-46	Initial Matrix, Inner Layer 19	H3B110210	H3B110210-004
HLW02-47	HLW02-47	Initial Matrix, Inner Layer 20	H3B270125	H3B270125-013
HLW02-48	HLW02-48	Initial Matrix, Inner Layer 21	H3B110210	H3B110210-015
HLW02-49	HLW02-49	Initial Matrix, Inner Layer 22	H3B110213	H3B110213-006
HLW02-50	HLW02-50	Initial Matrix, Inner Layer 23	H3B270125	H3B270125-010
HLW02-51R1	HLW02-51	Initial Matrix, Inner Layer 24	H3B270125	H3B270125-008
HLW02-52	HLW02-52	Replicate of HLW02-01	H3B110213	H3B110213-017
HLW02-53	HLW02-53	Replicate of HLW02-17	H3B110213	H3B110231-003

Table 5-8 Sample Identification and Corresponding Glass

VSL Sample ID	Glass ID	Glass or Matrix Point Type (and Numeric Designator)	Sample Delivery Group	STL Sample ID
HLW02-54	HLW02-54	Replicate of HLW02-4	H3B110213	H3B110213-020
HLW02-55	HLW02-55	Replicate of HLW02-42	H3B110210	H3B100210-002
HLW02-56	HLW02-56	Replicate of HLW02-44	H3B110210	H3B110210-020
HLW02-57	HLW02-57	Replicate of HLW02-8	H3B270125	H3B270125-014
HLW02-M12	M12-G-19A	Initial Matrix Control Glass	H3B110210	H3B110210-009
HLW02-M12A	M12-G-19A	Initial Matrix Control Glass	H3B110213	H3B110213-008
HLW02-M12GA91	M12-G-19A	Initial Matrix Control Glass	H3B270125	H3B270125-012
HLW02-M12B	M12-G-19A	Initial Matrix Control Glass	H3C100111	H3C100111-020
HLW03-19A	M12-G-19A	Initial Matrix Control Glass	H3D100122	H3D100122-001
HLW03-19M	M12-G-19A	Initial Matrix Control Glass	H3D100122	H3D100122-002
HLW03-01-2	HLW03-01	Augmentation Matrix, Outer Layer 01	F4D070183	F4D070183-013
HLW03-02	HLW03-02	Augmentation Matrix, Outer Layer 02	H3D100122	H3D100122-005
HLW03-03	HLW03-03	Augmentation Matrix, Outer Layer 03	H3D100122	H3D100122-003
HLW03-04-2	HLW03-04	Augmentation Matrix, Outer Layer 04	F4D070189	F4D070189-003
HLW03-05-2	HLW03-05	Augmentation Matrix, Outer Layer 05	F4D070189	F4D070189-012
HLW03-06-2	HLW03-06	Augmentation Matrix, Outer Layer 06	F4D070183	F4D070183-014
HLW03-07-2	HLW03-07	Augmentation Matrix, Outer Layer 07	F4D070174	F4D070174-002
HLW03-08-2	HLW03-08	Augmentation Matrix, Outer Layer 08	F4D070183	F4D070183-012
HLW03-09-2	HLW03-09	Augmentation Matrix, Outer Layer 09	F4D070183	F4D070183-016
HLW03-10R1-2	HLW03-10	Augmentation Matrix, Outer Layer 10	F4D070183	F4D070183-011
HLW03-11-2	HLW03-11	Augmentation Matrix, Outer Layer 11	F4D070189	F4D070189-001
HLW03-12-2	HLW03-12	Augmentation Matrix, Outer Layer 12	F4D070174	F4D070174-001
HLW03-13-2	HLW03-13	Augmentation Matrix, Outer Layer 13	F4D070189	F4D070189-002
HLW03-14-2	HLW03-14	Augmentation Matrix, Outer Layer 14	F4D070183	F4D070183-015
HLW03-15-2	HLW03-15	Augmentation Matrix, Outer Layer 15	F4D070189	F4D070189-013
HLW03-16-2	HLW03-16	Augmentation Matrix, Outer Layer 16	F4D070183	F4D070183-002
HLW03-17-2	HLW03-17	Augmentation Matrix, Outer Layer 17	F4D070183	F4D070183-004
HLW03-18-2	HLW03-18	Augmentation Matrix, Outer Layer 18	F4D070183	F4D070183-017
HLW03-19-2	HLW03-19	Augmentation Matrix, Outer Layer 19	F4D070189	F4D070189-019
HLW03-20-2	HLW03-20	Augmentation Matrix, Outer Layer 20	F4D070189	F4D070189-011
HLW03-21-2	HLW03-21	Augmentation Matrix, Inner Layer 01	F4D070189	F4D070189-010
HLW03-22-2	HLW03-22	Augmentation Matrix, Inner Layer 02	F4D070183	F4D070183-006
HLW03-23-2	HLW03-23	Augmentation Matrix, Inner Layer 03	F4D070189	F4D070189-006
HLW03-24-2	HLW03-24	Augmentation Matrix, Inner Layer 04	F4D070183	F4D070183-009
HLW03-25-2	HLW03-25	Augmentation Matrix, Inner Layer 05	F4D070174	F4D070174-013

Table 5-8 Sample Identification and Corresponding Glass

VSL Sample ID	Glass ID	Glass or Matrix Point Type (and Numeric Designator)	Sample Delivery Group	STL Sample ID
HLW03-26-2	HLW03-26	Augmentation Matrix, Inner Layer 06	F4D070174	F4D070174-004
HLW03-27-2	HLW03-27	Augmentation Matrix, Inner Layer 07	F4D070174	F4D070174-010
HLW03-28-2	HLW03-28	Augmentation Matrix, Inner Layer 08	F4D070174	F4D070174-012
HLW03-29-2	HLW03-29	Augmentation Matrix, Inner Layer 09	F4D070174	F4D070174-003
HLW03-30-2	HLW03-30	Augmentation Matrix, Inner Layer 10	F4D070183	F4D070183-007
HLW03-31-2	HLW03-31	Augmentation Matrix, Inner Layer 11	F4D070183	F4D070183-010
HLW03-32-2	HLW03-32	Augmentation Matrix, Inner Layer 12	F4D070183	F4D070183-005
HLW03-33-2	HLW03-33	Augmentation Matrix, Inner Layer 13	F4D070174	F4D070174-019
HLW03-34-2	HLW03-34	Augmentation Matrix, Inner Layer 14	F4D070183	F4D070183-008
HLW03-35-2	HLW03-35	Augmentation Matrix, Inner Layer 15	F4D070189	F4D070189-009
HLW03-36-2	HLW03-36	Augmentation Matrix, Inner Layer 16	F4D070174	F4D070174-011
HLW03-37-2	HLW03-37	Augmentation Matrix, Inner Layer 17	F4D070183	F4D070183-003
HLW03-38-2	HLW03-38	Augmentation Matrix, Inner Layer 18	F4D070174	F4D070174-005
HLW03-39-2	HLW03-39	Augmentation Matrix, Inner Layer 19	F4D070189	F4D070189-008
HLW03-40-2	HLW03-40	Augmentation Matrix, Inner Layer 20	F4D070189	F4D070189-004
HLW03-41-2	HLW03-41	Augmentation Matrix, Center	F4D070189	F4D070189-007
HLW03-42	HLW03-42	Replicate of HLW02-46	H3D100122	H3D100122-004
HLW03-43-2	HLW03-43	Replicate of HLW03-06	F4D070189	F4D070189-014
HLW03-44-2	HLW03-44	Replicate of HLW03-11	F4D070183	F4D070183-001
HLW03-45-2	HLW03-45	Replicate of HLW03-26	F4D070189	F4D070189-005
HLW03-107M	M12-G-19A	Augmentation Matrix Control Glass	F4D070174	F4D070174-015
HLW03-G45	M12-G-19A	Augmentation Matrix Control Glass	F4D070174	F4D070174-014
HLW03-G42	M12-G-19A	Augmentation Matrix Control Glass	F4D070183	F4D070183-018
HLW03-M42	M12-G-19A	Augmentation Matrix Control Glass	F4D070183	F4D070183-019
HLW03-106	M12-G-19A	Augmentation Matrix Control Glass	F4D070189	F4D070189-015
HLW03-M41	M12-G-19A	Augmentation Matrix Control Glass	F4D070189	F4D070189-016

Table 5-9 Crosswalk of Section 5.8 to "Framework for Delisting Petitions"

WASTE ANALYSIS INFORMATION	Petition Location / Section Number
21) Analyses done by in-house staff? - No. a. Name and address of the organization(s) or company(s) responsible for sample analyses. b. Resume of qualifications individual(s) who conducted data reduction, validation, and laboratory quality control	5.8.1 (5.8.1.1 through 5.8.1.2) VSL: Supplement 4, Appendix O STL: Supplement 4, Appendix I Validator: Supplement 4, Appendix K
22) Signed laboratory data reporting forms from all analyses, including results from quality control analyses.	5.8.2 Supplement 4, Appendix J
23) Provide the following information. a. Sample identification numbers b. Type of sample c. Date of sample receipt by the laboratory. d. The sample preparation methods. e. The date of sample preparation. f. Name of analyst. g. The date of extraction and analysis. h. The analysis method. i. The specific constituent. j. The test results. k. The basis for the analysis. l. The quantitation limits.	5.8.3 Appendix C
24) Provide the names and model numbers of all equipment used during analysis.	5.8.4
25) Provide all other information necessary to fully interpret the test procedures or results.	5.8.5 (5.8.5.1 through 5.8.5.7) Table 5-20 Table 5-21 Supplement 5
26) For each quality control analysis that involved a matrix or a surrogate spike and spike duplicate analysis, provide the following information. a. The name of the spike analyte added. b. The concentration of the spike analyte in the unspiked sample. c. The amount of the spike analyte added. d. The measured amount of the spike in both spiked samples. e. The calculated percent recovery of the spike and method of calculation. f. The acceptance criterion for recovery of each matrix spike. g. The relative percent difference (RPD) between the duplicate results. h. The acceptance criterion for the RPD.	5.8.6 (5.8.6.1 through 5.8.6.4) Table 5-16 Table 5-17 Table 5-18
27) Identify whether the waste analytical data was corrected - No	5.8.7
28) Explain any inconsistencies or deviations found in the reported analytical results.	5.8.8 Supplement 4, Appendices L2, L3, and L4.
29) Include all calculation sheets - not applicable	5.8.9

Table 5-10 Analytical Results for Volatile Nonleachable (Case 1) COCs in Spiked IHLW Glasses

Glass	Sample ID	Total Cyanide (mg/kg Total)	Mercury (mg/kg Total)	Mercury (mg/L, TCLP)
HLW98-77 (nominal glass composition)	HLW98-77E	ND	ND	0.000057 B
	HLW98-77F	ND	ND	ND
	HLW98-77G	ND	ND	0.000030 B
	HLW98-77H	ND	ND	0.000039 B
HLW99-03 (bounding glass composition)	HLW99-03E	ND	ND	ND
	HLW99-03ER1	ND	ND	ND
	HLW99-03ER2	ND	ND	0.000035 B
	HLW99-03F	ND	ND	ND
	HLW99-03FR1	ND	ND	ND
	HLW99-03FR2	ND	ND	ND
	HLW99-03G	ND	ND	ND
	HLW99-03GR1	ND	ND	ND
	HLW99-03GR2	ND	ND	0.000030 B
	HLW99-03H	ND	ND	0.000043 B
	HLW99-03HR1	ND	ND	0.000036 B
	HLW99-03HR2	ND	ND	ND
Proposed Delisting Level		230 [a]	4.00 [b]	0.200
MDL		0.27	0.005	0.000030
RL/EQL		0.50	0.030	0.002000

ND = Not Detected. Below the Method Detection Limit (MDL)

Values taken from source document as reported (see Supplement 4).

B = Estimated, Between the MDL and the Reporting Limit/Estimated Quantitation Limit (RL/EQL)

a Cyanide limit = 20× proposed delisting level (20 L/kg × 11.5 mg/L TCLP = 230 mg/kg), based on a 20:1 dilution required by the TCLP (SW-846 Method 1311, EPA 1999)

b Mercury limit = 20× proposed delisting level (20 L/kg × 0.200 mg/L TCLP =4.00 mg/kg), based on a 20:1 dilution required by the TCLP (SW-846 Method 1311, EPA 1999)

Table 5-11 Analytical Results for Nonvolatile Nonleachable (Case 1) COCs in Spiked IHLW Glasses

Glass	Sb_2O_3 Spike (wt%)	Tl_2O_3 Spike (wt%)	Sample ID	Ag (Silver) (mg/L, TCLP)	As (Arsenic) (mg/L, TCLP)	Ba (Barium) (mg/L, TCLP)	Be (Beryllium) (mg/L, TCLP)
HLW98-77 (nominal glass composition)	0.10	0.35	HLW98-77E	0.0727	0.0296 B	0.439	0.0098 B
	0.29	0.17	HLW98-77F	0.0645	0.0395	0.402	0.0097 B
	0.60	0.07	HLW98-77G	0.0620	0.0322	0.408	0.0096 B
	1.20	0.03	HLW98-77H	0.0801	0.0347	0.430	0.0091 B
HLW99-03 (bounding glass composition)	0.10	0.35	HLW99-03E	1.11	0.0763	8.99	0.184
			HLW99-03ER1	1.13	0.0837	9.61	0.209
			HLW99-03ER2	0.863	0.0719	7.17	0.166
	0.29	0.17	HLW99-03F	0.972	0.0704	8.48	0.164
			HLW99-03FR1	1.07	0.0662	8.84	0.170
			HLW99-03FR2	0.969	0.0834	8.26	0.179
	0.60	0.07	HLW99-03G	1.15	0.0738	9.80	0.190
			HLW99-03GR1	0.980	0.0688	8.40	0.177
			HLW99-03GR2	0.687	0.0524	6.01	0.132
	1.20	0.03	HLW99-03H	0.910	0.0620	7.64	0.161
			HLW99-03HR1	0.734	0.0686	6.12	0.134
			HLW99-03HR2	0.821	0.0675	6.69	0.161
Proposed Delisting Level (mg/L)				3.07	0.616	100	1.33
MDL (mg/L)				0.0119	0.0145	0.0031	0.0027
RL/EQL (mg/L)				0.03	0.03	0.15	0.015

B = Estimated. Result is less than the Reporting Limit/Estimated Quantitation Limit (RL/EQL), but greater than the MDL.

Values taken from source document as reported (see Supplement 4).

Table 5-11 Analytical Results for Nonvolatile Nonleachable (Case 1) COCs in Spiked IHLW Glasses

Glass	Sb_2O_3 Spike (wt%)	Tl_2O_3 Spike (wt%)	Sample ID	Cd (Cadmium) [a] (mg/L, TCLP)	Cr (Chromium) (mg/L, TCLP)	Cu (Copper) (mg/L, TCLP)	Ni (Nickel) (mg/L, TCLP)
HLW98-77 (nominal glass composition)	0.10	0.35	HLW98-77E	0.0240	0.0196 B	0.0451 B	0.126
	0.29	0.17	HLW98-77F	0.0273	0.0382	0.0511 B	0.144
	0.60	0.07	HLW98-77G	0.0259	0.0348	0.0490 B	0.149
	1.20	0.03	HLW98-77H	0.0306	0.0292 B	0.0478 B	0.141
HLW99-03 (bounding glass composition)	0.10	0.35	HLW99-03E	0.649	1.19	0.874	4.95
			HLW99-03ER1	0.680	1.26	0.917	5.05
			HLW99-03ER2	0.538	0.931	0.703	3.59
	0.29	0.17	HLW99-03F	0.571	1.04	0.763	4.51
			HLW99-03FR1	0.687	1.16	0.740	4.71
			HLW99-03FR2	0.611	0.954	0.789	4.31
	0.60	0.07	HLW99-03G	0.824	1.14	0.923	4.78
			HLW99-03GR1	0.629	1.19	0.816	3.86
			HLW99-03GR2	0.485	0.708	0.627	2.85
	1.20	0.03	HLW99-03H	0.526	0.863	0.722	2.99
			HLW99-03HR1	0.427	0.641	0.583	2.65
			HLW99-03HR2	0.462	0.759	0.656	2.59
Proposed Delisting Level (mg/L)				0.480	4.95	29,200	22.6
MDL (mg/L)				0.0023	0.0072	0.0119	0.011
RL/EQL (mg/L)				0.015	0.03	0.075	0.12

B = Estimated. Result is less than the Reporting Limit/Estimated Quantitation Limit (RL/EQL), but greater than the MDL.

Values taken from source document as reported (see Supplement 4).

a Cadmium is not truly a Case 1 COPC and is addressed further via a Case 3 approach in section 5.8.5.7. The IHLW bounding glass was intentionally formulated to release constituents (under TCLP conditions) at levels which would exceed the leachate concentrations of nominal production glasses. Accordingly, the IHLW bounding glass provides an indication of which constituents are not likely to ever leach from WTP above acceptable limits (e.g. silver, arsenic, barium, chromium, copper, nickel, lead, selenium, vanadium and zinc).

Table 5-11 Analytical Results for Nonvolatile Nonleachable (Case 1) COCs in Spiked IHLW Glasses

Glass	Sb_2O_3 Spike (wt%)	Tl_2O_3 Spike (wt%)	Sample ID	Pb (Lead) (mg/L, TCLP)	Se (Selenium) (mg/L, TCLP)	V (Vandium) (mg/L, TCLP)	Zn (Zinc) (mg/L, TCLP)
HLW98-77 (nominal glass composition)	0.10	0.35	HLW98-77E	0.136	0.0613	0.0412 B	0.565 J
	0.29	0.17	HLW98-77F	0.124	0.0859	0.0723 B	0.562 J
	0.60	0.07	HLW98-77G	0.123	0.0611	0.0560 B	0.523 J
	1.20	0.03	HLW98-77H	0.131	0.0724	0.0468 B	0.566 J
HLW99-03 (bounding glass composition)	0.10	0.35	HLW99-03E	1.79	0.413	0.133 B	11.5 J
			HLW99-03ER1	1.88	0.428	0.117 B	12.0 J
			HLW99-03ER2	1.64	0.259	0.105 B	8.90 J
	0.29	0.17	HLW99-03F	1.71	0.307	0.113 B	10.6 J
			HLW99-03FR1	1.77	0.319	0.107 B	11.3 J
			HLW99-03FR2	1.81	0.238	0.128 B	10.2 J
	0.60	0.07	HLW99-03G	1.83	0.420	0.130 B	12.2 J
			HLW99-03GR1	1.67	0.438	0.0938 B	10.3 J
			HLW99-03GR2	1.40	0.237	0.0636 B	7.37 J
	1.20	0.03	HLW99-03H	1.60	0.407	0.101 B	9.13 J
			HLW99-03HR1	1.34	0.245	0.125 B	7.34 J
			HLW99-03HR2	1.49	0.302	0.0967 B	7.89 J
Proposed Delisting Level (mg/L)				5.00	1.00	16.9	225
MDL (mg/L)				0.009	0.0122	0.0169	0.0077
RL/EQL (mg/L)				0.03	0.015	0.15	0.06

B = Estimated. Result is less than the Reporting Limit/Estimated Quantitation Limit (RL/EQL), but greater than the MDL.

J = Result is estimated because of method blank contamination.

Values taken from source document as reported (see Supplement 4).

Table 5-12 Comparison of Delisting Levels to IHLW Spiked Bounding Glass TCLP Results for Nonvolatile Case 1 COPCs

Chemical Symbol	COC	MDL (mg/L)	EQL (mg/L)	Maximum (mg/L TCLP)	Maximum Mean (mg/L TCLP)	90 % UCI (mg/L TCLP)	Proposed Delisting Level (mg/L TCLP)
Ag	Silver	0.0118	0.030	1.15	1.03	1.15	3.07
As	Arsenic	0.0145	0.030	0.0837	0.0773	0.0837	0.616
Ba	Barium	0.0031	0.150	9.80	8.59	9.57	100
Be	Beryllium	0.0027	0.015	0.209	0.186	0.203	1.33
Cd	Cadmium [a]	0.0023	0.015	0.824	0.646	0.727	0.480
Cr	Chromium	0.0072	0.030	1.26	1.13	1.27	4.95
Cu	Copper	0.0119	0.075	0.923	0.831	0.913	29,200
Ni	Nickel	0.0110	0.120	5.05	4.53	5.05	22.6
Pb	Lead	0.0090	0.030	1.88	1.77	1.89	5.00
Se	Selenium	0.0122	0.015	0.438	0.367	0.436	1.00
V	Vanadium	0.0169	0.150	0.133	0.118	0.135	16.9
Zn	Zinc	0.0077	0.060	12.2	10.8	12.1	225

a Cadmium is not truly a Case 1 COPC and is addressed further via a Case 3 approach in section 5.8.5.7. The IHLW bounding glass was intentionally formulated to release constituents (under TCLP conditions) at levels which would exceed the leachate concentrations of nominal production glasses. Accordingly, the IHLW bounding glass provides an indication of which constituents are not likely to ever leach from WTP above acceptable limits (e.g. silver, arsenic, barium, chromium, copper, nickel, lead, selenium, vanadium and zinc).

Values taken from source document as reported (see Supplement 4).

Table 5-13 Analytical Results for Case 2 COCs in Spiked IHLW Glasses

Glass	Sb_2O_3 Spike (wt%)	Tl_2O_3 Spike (wt%)	Sample ID	Sb (Antimony) (mg/L, TCLP)	Tl (Thallium) (mg/L, TCLP)
HLW99-03 (bounding glass composition)	0.10	0.35	HLW99-03E	0.0908 B	0.919
			HLW99-03ER1	0.0571 B	0.847
			HLW99-03ER2	0.0608 B	0.465
	0.29	0.17	HLW99-03F	0.181	0.230
			HLW99-03FR1	0.180	0.181
			HLW99-03FR2	0.219	0.219
	0.60	0.07	HLW99-03G	0.408	0.138
			HLW99-03GR1	0.305	0.106
			HLW99-03GR2	0.290	0.072
	1.20	0.03	HLW99-03H	0.578	0.0425
			HLW99-03HR1	0.682	0.0363
			HLW99-03HR2	0.547	0.0243 B
HLW98-77 (nominal glass composition)	0.10	0.35	HLW98-77E	ND	0.153
	0.29	0.17	HLW98-77F	0.056 B	0.080
	0.60	0.07	HLW98-77G	0.067 B	0.040
	1.20	0.03	HLW98-77H	0.103 B	ND
Proposed Delisting Level (mg/L)				0.659	0.282
MDL (mg/L)				0.0388	0.0227
RL/EQL (mg/L)				0.18	0.03

ND = Not detected

Values taken from source document as reported (see Supplement 4).

B = Estimated. Result is less than the Reporting Limit or Estimated Quantitation Limit (RL or EQL), but greater than the MDL.

Table 5-14 COC Levels (oxide wt%) Whose 90 % Upper Confidence Intervals Equal the Corresponding Delisting Levels

COC	Chemical Symbol	Proposed Delisting Level (mg/L)	Spike Conc. Range (oxide wt %)	Spike Conc. Range (mg/kg)	Special Considerations	90 % UCI COPC Level [a] (oxide wt%)		90 % UCI COPC Level [a] (mg/kg)	
						With a Zero-Intercept	No Zero-Intercept	With a Zero-Intercept	No Zero-Intercept
Bounding Glass									
Antimony	Sb	0.659	0.10 to 1.20	835 to 10,024	NA	1.23	1.20	8753	8539
Thallium	Tl	0.282	0.03 to 0.35	268 to 3132	With Tl_2O_3 0.35 wt% spike	0.136	0.129	1217	1154
					Without Tl_2O_3 0.35 wt% spike [c]	0.205	0.205	1835	1835
Nominal Glass [b]									
Thallium	Tl	0.282	0.03 to 0.35	268 to 3132	Typical glass uncertainty estimate	0.596	0.598	5334	5352
					Bounding glass uncertainty estimate	0.517	0.530	4627	4743

a Not including loss due to partial volatility.

b A Case 2 statistical analysis was not performed for Sb releases from the spiked nominal glasses as discussed in Section 5.8.5.6.

c Analysis of the thallium spiking data without the Tl_2O_3 0.35 wt% spiking level included is considered to be more appropriate for determining where the regression equation and its 90 % UCI will intersect the proposed delisting level, because it better fits the data nearest the proposed delisting levels.

NA = Not applicable.

Values taken from source document as reported (see Supplement 4).

Table 5-15 Coefficients and Statistics for the TCLP Glass Durability Model

Model Term	20-Term Model		10-Term Model	
	Coefficient Estimate For Original Oxides	Coefficient Estimate For Revised Oxides	Coefficient Estimate For Original Oxides	Coefficient Estimate For Revised Oxides
Al_2O_3	-0.6709	-0.6710	0.3257	0.3206
B_2O_3	7.9976	7.9976	8.0665	8.0629
CdO	14.4585	14.4567	NA	NA
Cr_2O_3	8.8202	8.8392	NA	NA
Fe_2O_3	0.7230	0.7222	1.5677	1.5634
Li_2O	11.5996	11.6018	11.3541	11.3524
MnO	9.2566	9.2563	10.7633	10.7668
Na_2O	9.9091	9.9084	9.3328	9.3299
NiO	14.3555	14.3648	NA	NA
Sb_2O_3	-9.9347	-9.8727	NA	NA
SeO_2	-51.0459	-51.0526	NA	NA
SiO_2	-0.2656	-0.2668	0.1617	0.1629
SrO	6.3943	6.3950	NA	NA
ThO_2	1.5301	1.5280	NA	NA
Tl_2O_3	-19.6629	NA	NA	NA
Tl_2O	NA	-21.4439	NA	NA
UO_2	4.5784	4.5427	NA	NA
ZnO	15.0596	15.0837	15.4324	15.4380
ZrO_2	1.1343	1.1334	2.0438	2.0457
Spike	0.4487	0.5351	NA	NA
ln(CdO)	0.9389	0.9389	0.9859	0.9858
Goodness-of-Fit Statistics				
R^2	0.981	0.981	0.977	0.977
R^2_A	0.977	0.977	0.975	0.975
R^2_P	0.970	0.970	0.971	0.971
RMSE	0.1750	0.1750	0.1818	0.1818
LOF p-value	0.339	0.339	0.288	0.288

Table 5-15 Coefficients and Statistics for the TCLP Glass Durability Model

NA = Not Applicable. Term was dropped during model reduction.

R^2 = This statistic is referred to as *R-squared*, and is the proportion of variation in values of a response variable over a model development dataset that is accounted for by a fitted model.

R^2_A = This statistic is referred to as *adjusted R-squared*, and is the proportion of variation in values of a response variable over a model development dataset that is accounted for by a fitted model after adjusting for the number of fitted coefficients in the model.

R^2_P = This statistic is referred to as *predicted R-squared*, and is the proportion of variation in values of a response variable over a model development dataset that is accounted for by a fitted model, where each data point is in-turn left out of the fitting process and thus not used to obtain the predicted value of the response variable for that data point. Generally $R^2_P \leq R^2_A \leq R^2 \leq 1$, although R^2_P can take negative values in cases where there are one or more highly influential data points in the model development dataset.

RMSE = Root-Mean-Squared-Error

LOF p-value = This statistic represents the chance of being incorrect in declaring the model has a statistically significant lack-of-fit. The LOF statistic checks whether the differences between measured and predicted property values from a fitted model are larger than expected based on the experimental and measurement uncertainty in the data. The p-value represents the probability of incorrectly deciding a coefficient is significantly different than zero.

Values taken from source document as reported (see Supplement 4).

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	F3E080262001	EDD	F3E080262
Client ID	HLW03-31		
QC Batch ID	3129240		
Collection Date	25-Apr-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Antimony	MS	1240	180	7	2.5	15.4	1250	98	0.81
Antimony	MSD	1230	180	7	2.5	15.4	1250	97	
Arsenic	MS	4890	30	3	2.5	9.4	5000	98	0.55
Arsenic	MSD	4860	30	3	2.5	9.4	5000	97	
Barium	MS	4700	150	17	2.5	32.8	5000	93	0.47
Barium	MSD	4680	150	17	2.5	32.8	5000	93	
Cadmium	MS	144	15	5	2.5	29	125	92	0.40
Cadmium	MSD	143	15	0.5	2.5	29	125	91	
Chromium	MS	489	30	5	2.5	10.5	500	96	0.03
Chromium	MSD	488	30	0.825	2.5	10.5	500	96	
Copper	MS	548	75	19.25	2.5	ND	625	88	0.91
Copper	MSD	543	75	4	2.5	ND	625	87	
Lead	MS	1230	30	4	2.5	34.2	1250	96	0.02
Lead	MSD	1230	30	4	2.5	34.2	1250	96	
Nickel	MS	1290	120	30	2.5	109	1250	95	0.26
Nickel	MSD	1290	120	4	2.5	109	1250	95	
Selenium	MS	5030	15	3	2.5	31.6	5000	100	0.44
Selenium	MSD	5010	15	3	2.5	31.6	5000	100	
Silver	MS	168	30	15	2.5	ND	125	134	0.83
Silver	MSD	167	30	1.2	2.5	ND	125	133	

Lab ID	F3E090273001	EDD	F3E090273
Client ID	HLW03-08		
QC Batch ID	3132505		
Collection Date	07-May-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Antimony	MS	593	144	5.6	2	82.9	500	102	0.08
Antimony	MSD	593	144	5.6	2	82.9	500	102	
Arsenic	MS	2150	24	2.4	2	33.4	2000	106	0.55
Arsenic	MSD	2140	24	2.4	2	33.4	2000	105	
Barium	MS	2470	120	13.6	2	473	2000	100	0.23
Barium	MSD	2470	120	13.6	2	473	2000	100	
Cadmium	MS	2310	12	4	2	2240	50	140	1.00
Cadmium	MSD	2280	12	4	2	2240	50	92	
Chromium	MS	404	24	4	2	200	200	102	0.97
Chromium	MSD	400	24	4	2	200	200	100	
Copper	MS	377	60	15.4	2	137	250	96	0.32
Copper	MSD	376	60	15.4	2	137	250	96	
Lead	MS	854	24	3.2	2	351	500	101	0.22
Lead	MSD	852	24	3.2	2	351	500	100	
Nickel	MS	598	96	24	2	99	500	100	0.59
Nickel	MSD	595	96	24	2	99	500	99	
Selenium	MS	2200	12	2.4	2	20.5	2000	109	0.23
Selenium	MSD	2200	12	2.4	2	20.5	2000	109	
Silver	MS	330	24	12	2	255	50	149	0.76
Silver	MSD	327	24	12	2	255	50	144	

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	F3E080262001	EDD	F3E080262
Client ID	HLW03-31		
QC Batch ID	3129240		
Collection Date	25-Apr-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Thallium	MS	4910	30	7.25	2.5	17.5	5000	98	0.26
Thallium	MSD	4930	30	7.25	2.5	17.5	5000	98	
Vanadium	MS	1200	150	5.75	2.5	ND	1250	96	0.12
Vanadium	MSD	1200	150	3.5	2.5	ND	1250	96	
Zinc	MS	1590	60	6	2.5	321	1250	101	0.15
Zinc	MSD	1580	60	6	2.5	321	1250	101	

Lab ID	F3E090273001	EDD	F3E090273
Client ID	HLW03-08		
QC Batch ID	3132505		
Collection Date	07-May-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Thallium	MS	1990	24	5.8	2	ND	2000	100	0.65
Thallium	MSD	1980	24	5.8	2	ND	2000	99	
Vanadium	MS	523	120	4.6	2	23.2	500	100	0.01
Vanadium	MSD	523	120	4.6	2	23.2	500	100	
Zinc	MS	5790	48	4.8	2	5200	500	118	0.93
Zinc	MSD	5740	48	4.8	2	5200	500	107	

a Dil = Dilution factor.

b % Rec = Percent recovery. Acceptance criteria for the spikes, 75 % to 125 %.

c RPD = Relative percent difference. Acceptance criteria for the RPD, 0 % to 20 %

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	F3E120129001	EDD	F3E120129
Client ID	HLW03-06		
QC Batch ID	3134383		
Collection Date	09-May-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Antimony	MS	497	180	5.15	2.5	ND	500	100	1.10
Antimony	MSD	503	180	7	2.5	ND	500	100	
Arsenic	MS	2030	30	3.73	2.5	ND	2000	101	2.00
Arsenic	MSD	2070	30	3	2.5	ND	2000	103	
Barium	MS	1850	150	17	2.5	32.6	2000	91	2.10
Barium	MSD	1890	150	17	2.5	32.6	2000	93	
Cadmium	MS	349	15	0.71	2.5	311	50	75	2.90
Cadmium	MSD	359	15	5	2.5	311	50	95	
Chromium	MS	196	30	1.5	2.5	7.1	200	95	2.00
Chromium	MSD	200	30	5	2.5	7.1	200	97	
Copper	MS	206	75	3	2.5	ND	250	82	2.60
Copper	MSD	211	75	19.3	2.5	ND	250	84	
Lead	MS	496	30	4.5	2.5	14.7	500	96	1.60
Lead	MSD	504	30	4	2.5	14.7	500	98	
Nickel	MS	606	120	3.05	2.5	134	500	94	1.80
Nickel	MSD	617	120	30	2.5	134	500	97	
Selenium	MS	2060	15	3.25	2.5	ND	2000	103	3.40
Selenium	MSD	2130	15	3	2.5	ND	2000	107	
Silver	MS	68.1	30	1.04	2.5	ND	50	136	1.60
Silver	MSD	69.2	30	15	2.5	ND	50	138	

Lab ID	H3B110210001	EDD	H3B110210
Client ID	HLW02-26		
QC Batch ID	3049372		
Collection Date	29-Jan-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Antimony	MS	4900	180	38.8	1	ND	5000	98	0.32
Antimony	MSD	4920	180	38.8	1	ND	5000	98	
Arsenic	MS	5140	30	14.5	1	ND	5000	103	0.20
Arsenic	MSD	5130	30	14.5	1	ND	5000	103	
Barium	MS	49600	150	3.1	1	147	50000	99	0.22
Barium	MSD	49700	150	3.1	1	147	50000	99	
Beryllium	MS	1070	15	2.7	1	ND	1000	107	1.10
Beryllium	MSD	1060	15	2.7	1	ND	1000	106	
Cadmium	MS	1630	15	2.3	1	583	1000	104	0.64
Cadmium	MSD	1620	15	2.3	1	583	1000	103	
Chromium	MS	5150	30	7.2	1	16.1	5000	103	0.05
Chromium	MSD	5140	30	7.2	1	16.1	5000	103	
Copper	MS	5050	75	11.9	1	35.8	5000	100	0.23
Copper	MSD	5060	75	11.9	1	35.8	5000	100	
Lead	MS	5320	30	9	1	117	5000	104	0.19
Lead	MSD	5310	30	9	1	117	5000	104	
Nickel	MS	5320	120	11	1	28	5000	106	0.05
Nickel	MSD	5320	120	11	1	28	5000	106	
Selenium	MS	996	15	12.2	1	ND	1000	100	0.87
Selenium	MSD	1000	15	12.2	1	ND	1000	100	

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	F3E120129001	EDD	F3E120129
Client ID	HLW03-06		
QC Batch ID	3134383		
Collection Date	09-May-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Thallium	MS	1960	30	9.1	2.5	ND	2000	98	1.20
Thallium	MSD	1990	30	7.25	2.5	ND	2000	99	
Vanadium	MS	476	150	1.47	2.5	ND	500	95	1.70
Vanadium	MSD	484	150	5.75	2.5	ND	500	97	
Zinc	MS	520	60	8.5	2.5	ND	500	104	1.10
Zinc	MSD	526	60	6	2.5	ND	500	105	

Lab ID	H3B110210001	EDD	H3B110210
Client ID	HLW02-26		
QC Batch ID	3049372		
Collection Date	29-Jan-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Silver	MS	1090	30	11.8	1	86.9	1000	101	0.32
Silver	MSD	1090	30	11.8	1	86.9	1000	100	
Thallium	MS	5170	30	22.7	1	ND	5000	103	.037
Thallium	MSD	5190	30	22.7	1	ND	5000	104	
Vanadium	MS	5220	150	16.9	1	ND	5000	104	0.11
Vanadium	MSD	5220	150	16.9	1	ND	5000	104	
Zinc	MS	6100	60	7.7	1	750	5000	107	0.31
Zinc	MSD	6120	60	7.7	1	750	5000	107	

a Dil = Dilution factor.

b % Rec = Percent recovery. Acceptance criteria for the spikes, 75 % to 125 %.

c RPD = Relative percent difference. Acceptance criteria for the RPD, 0 % to 20 %.

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	H3B110213001	EDD	H3B110213
Client ID	HLW02-19		
QC Batch ID	3052096		
Collection Date	05-Feb-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Antimony	MS	5070	180	38.8	1	ND	5000	101	0.85
Antimony	MSD	5120	180	38.8	1	ND	5000	102	
Arsenic	MS	5080	30	14.5	1	ND	5000	102	0.44
Arsenic	MSD	5110	30	14.5	1	ND	5000	102	
Barium	MS	50400	150	3.1	1	51	50000	101	1.10
Barium	MSD	50900	150	3.1	1	51	50000	102	
Beryllium	MS	1040	15	2.7	1	ND	1000	104	0.62
Beryllium	MSD	1040	15	2.7	1	ND	1000	104	
Cadmium	MS	1570	15	2.3	1	562	1000	101	0.19
Cadmium	MSD	1570	15	2.3	1	562	1000	101	
Chromium	MS	5030	30	7.2	1	ND	5000	101	0.27
Chromium	MSD	5020	30	7.2	1	ND	5000	100	
Copper	MS	5190	75	11.9	1	ND	5000	104	0.96
Copper	MSD	5240	75	11.9	1	ND	5000	105	
Lead	MS	5110	30	9	1	22.9	5000	102	0.40
Lead	MSD	5090	30	9	1	22.9	5000	101	
Nickel	MS	5190	120	11	1	33.9	5000	103	0.60
Nickel	MSD	5160	120	11	1	33.9	5000	102	
Selenium	MS	1040	15	12.2	1	26.4	1000	101	1.10
Selenium	MSD	1050	15	12.2	1	26.4	1000	103	

Lab ID	H3B270125018	EDD	H3B270125
Client ID	HLW02-22		
QC Batch ID	3069123		
Collection Date	19-Feb-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Antimony	MS	4900	180	38.8	1	ND	5000	98	0.17
Antimony	MSD	4890	180	38.8	1	ND	5000	98	
Arsenic	MS	5160	30	14.5	1	ND	5000	103	1.40
Arsenic	MSD	5090	30	14.5	1	ND	5000	102	
Barium	MS	50800	150	3.1	1	12.6	50000	102	0.82
Barium	MSD	50400	150	3.1	1	12.6	50000	101	
Beryllium	MS	1050	15	2.7	1	ND	1000	105	0.05
Beryllium	MSD	1050	15	2.7	1	ND	1000	105	
Cadmium	MS	1050	15	2.3	1	8	1000	104	0.92
Cadmium	MSD	1040	15	2.3	1	8	1000	103	
Chromium	MS	5160	30	7.2	1	ND	5000	103	1.20
Chromium	MSD	5090	30	7.2	1	ND	5000	102	
Copper	MS	5080	75	11.9	1	ND	5000	102	0.44
Copper	MSD	5050	75	11.9	1	ND	5000	101	
Lead	MS	5150	30	9	1	13.5	5000	103	0.22
Lead	MSD	5140	30	9	1	13.5	5000	103	
Nickel	MS	5370	120	11	1	12	5000	107	1.10
Nickel	MSD	5310	120	11	1	12	5000	106	
Selenium	MS	1030	15	12.2	1	14.5	1000	101	1.70
Selenium	MSD	1010	15	12.2	1	14.5	1000	100	

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	H3B110213001	EDD	H3B110213
Client ID	HLW02-19		
QC Batch ID	3052096		
Collection Date	05-Feb-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Silver	MS	970	30	11.8	1	ND	1000	97	1.40
Silver	MSD	957	30	11.8	1	ND	1000	96	
Thallium	MS	5110	30	22.7	1	ND	5000	102	0.25
Thallium	MSD	5100	30	22.7	1	ND	5000	102	
Vanadium	MS	5170	150	16.9	1	ND	5000	103	0.30
Vanadium	MSD	5190	150	16.9	1	ND	5000	104	
Zinc	MS	6180	60	7.7	1	765	5000	108	0.42
Zinc	MSD	6210	60	7.7	1	765	5000	109	

Lab ID	H3B270125018	EDD	H3B270125
Client ID	HLW02-22		
QC Batch ID	3069123		
Collection Date	19-Feb-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Silver	MS	1010	30	11.8	1	ND	1000	101	0.37
Silver	MSD	1000	30	11.8	1	ND	1000	100	
Thallium	MS	5210	30	22.7	1	ND	5000	104	0.43
Thallium	MSD	5180	30	22.7	1	ND	5000	104	
Vanadium	MS	5200	150	16.9	1	ND	5000	104	0.84
Vanadium	MSD	5150	150	16.9	1	ND	5000	103	
Zinc	MS	5590	60	7.7	1	306	5000	106	0.50
Zinc	MSD	5560	60	7.7	1	306	5000	105	

a Dil = Dilution factor.

b % Rec = Percent recovery. Acceptance criteria for the spikes, 75 % to 125 %.

c RPD = Relative percent difference. Acceptance criteria for the RPD, 0 % to 20 %.

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	H3C100111015	**EDD**	H3C100111
Client ID	HLW98-77R2		
QC Batch ID	3071372		
Collection Date	12-Feb-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Antimony	MS	4830	180	38.8	1	ND	5000	97	2.10
Antimony	MSD	4930	180	38.8	1	ND	5000	99	
Arsenic	MS	5160	30	14.5	1	ND	5000	103	1.90
Arsenic	MSD	5260	30	14.5	1	ND	5000	105	
Barium	MS	50500	150	3.1	1	4	50000	101	2.60
Barium	MSD	51800	150	3.1	1	4	50000	104	
Beryllium	MS	1060	15	2.7	1	ND	1000	106	2.80
Beryllium	MSD	1090	15	2.7	1	ND	1000	109	
Cadmium	MS	1070	15	2.3	1	24	1000	104	2.00
Cadmium	MSD	1090	15	2.3	1	24	1000	107	
Chromium	MS	5160	30	7.2	1	ND	5000	103	2.40
Chromium	MSD	5280	30	7.2	1	ND	5000	106	
Copper	MS	5010	75	11.9	1	ND	5000	100	2.40
Copper	MSD	5140	75	11.9	1	ND	5000	103	
Lead	MS	5210	30	9	1	13.2	5000	104	3.10
Lead	MSD	5380	30	9	1	13.2	5000	107	
Nickel	MS	5610	120	11	1	161	5000	109	2.70
Nickel	MSD	5760	120	11	1	161	5000	112	
Selenium	MS	1020	15	12.2	1	ND	1000	102	2.00
Selenium	MSD	1040	15	12.2	1	ND	1000	104	

Lab ID	H3D070127001	**EDD**	H3D070127
Client ID	HLW99-03M12		
QC Batch ID	3098167		
Collection Date	03-Apr-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Mercury	MS	0.167	0.033	0.005	1	ND	0.167	100	
Mercury	MSD	0.159	0.033	0.005	1	ND	0.167	95	4.80

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	H3C100111015					**EDD**	H3C100111		
Client ID	HLW98-77R2								
QC Batch ID	3071372								
Collection Date	12-Feb-03								
Analyte	**QC Type**	**Conc. Of Spiked Sample (mg/kg)**	**EQL (mg/kg)**	**MDL (mg/kg)**	**Dil [a]**	**Unspiked Sample Conc. (mg/kg)**	**Spike Level (mg/kg)**	**% Rec (%) [b]**	**RPD (%) [c]**
Silver	MS	1020	30	11.8	1	16.5	1000	100	2.60
Silver	MSD	1050	30	11.8	1	16.5	1000	103	
Thallium	MS	5250	30	22.7	1	ND	5000	105	2.60
Thallium	MSD	5390	30	22.7	1	ND	5000	108	
Vanadium	MS	5220	150	16.9	1	ND	5000	104	2.40
Vanadium	MSD	5350	150	16.9	1	ND	5000	107	
Zinc	MS	5900	60	7.7	1	646	5000	105	2.10
Zinc	MSD	6030	60	7.7	1	646	5000	108	

a Dil = Dilution factor.

b % Rec = Percent recovery. Acceptance criteria for the spikes, 75 % to 125 %.

c RPD = Relative percent difference. Acceptance criteria for the RPD, 0 % to 20 %.

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID	H3D070127001	**EDD**	H3D070127
Client ID	HLW99-03M12		
QC Batch ID	3099207		
Collection Date	03-Apr-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Antimony	MS	5070	180	38.8	1	ND	5000	101	2.20
Antimony	MSD	4960	180	38.8	1	ND	5000	99	
Arsenic	MS	5280	30	14.5	1	ND	5000	106	1.30
Arsenic	MSD	5210	30	14.5	1	ND	5000	104	
Barium	MS	50100	150	3.1	1	11.4	50000	100	0.39
Barium	MSD	49900	150	3.1	1	11.4	50000	100	
Beryllium	MS	1120	15	2.7	1	ND	1000	112	1.20
Beryllium	MSD	1100	15	2.7	1	ND	1000	110	
Cadmium	MS	1150	15	2.3	1	21.9	1000	112	1.30
Cadmium	MSD	1130	15	2.3	1	21.9	1000	111	
Chromium	MS	5420	30	7.2	1	8	5000	108	0.54
Chromium	MSD	5390	30	7.2	1	8	5000	108	
Copper	MS	5060	75	11.9	1	15.9	5000	101	2.00
Copper	MSD	4960	75	11.9	1	15.9	5000	99	
Lead	MS	5650	30	9	1	28.6	5000	112	1.80
Lead	MSD	5550	30	9	1	28.6	5000	110	
Nickel	MS	5650	120	11	1	82	5000	111	1.60
Nickel	MSD	5560	120	11	1	82	5000	110	
Selenium	MS	1050	15	12.2	1	12.4	1000	103	3.20
Selenium	MSD	1010	15	12.2	1	12.4	1000	100	

Lab ID	H3D070127001	**EDD**	H3D070127
Client ID	HLW99-03M12		
QC Batch ID	3100118		
Collection Date	03-Apr-03		

Analyte	QC Type	Conc. Of Spiked Sample (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil [a]	Unspiked Sample Conc. (mg/kg)	Spike Level (mg/kg)	% Rec (%) [b]	RPD (%) [c]
Mercury	MS	0.00475	0.002	0.00003	1	ND	0.005	95	4.70
Mercury	MSD	0.00498	0.002	0.00003	1	ND	0.005	100	

Table 5-16 Summary of Matrix Spikes and Matrix Spike Duplicates by Batch/Electronic Data Deliverable

Lab ID		H3D070127001				**EDD**	H3D070127		
Client ID		HLW99-03M12							
QC Batch ID		3099207							
Collection Date		03-Apr-03							
Analyte	**QC Type**	**Conc. Of Spiked Sample (mg/kg)**	**EQL (mg/kg)**	**MDL (mg/kg)**	**Dil [a]**	**Unspiked Sample Conc. (mg/kg)**	**Spike Level (mg/kg)**	**% Rec (%) [b]**	**RPD (%) [c]**
Silver	MS	1170	30	11.8	1	32	1000	114	2.00
Silver	MSD	1150	30	11.8	1	32	1000	112	
Thallium	MS	5360	30	22.7	1	ND	5000	107	1.60
Thallium	MSD	5270	30	22.7	1	ND	5000	105	
Vanadium	MS	5390	150	16.9	1	ND	5000	108	2.10
Vanadium	MSD	5280	150	16.9	1	ND	5000	106	
Zinc	MS	6260	60	7.7	1	615	5000	113	1.40
Zinc	MSD	6180	60	7.7	1	615	5000	111	

a Dil = Dilution factor.

b % Rec = Percent recovery. Acceptance criteria for the spikes, 75 % to 125 %.

c RPD = Relative percent difference. Acceptance criteria for the RPD, 0 % to 20 %.

Table 5-17 Summary of Laboratory Control Samples by Batch/Electronic Data Deliverable

QCBatchID 3129240					EDD F3E080262		QCBatchID 3132505					EDD F3E090273	
QCSampleID F3E090000240C							QCSampleID F3E120000505C						
Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec	Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Antimony	2450	180	7	2.5	2500	98	Antimony	1030	144	5.6	2	1000	103
Arsenic	2450	30	3	2.5	2500	98	Arsenic	1050	24	2.4	2	1000	105
Barium	2340	150	17	2.5	2500	94	Barium	1010	120	13.6	2	1000	101
Cadmium	2360	15	5	2.5	2500	94	Cadmium	996	12	4	2	1000	100
Chromium	2370	30	5	2.5	2500	95	Chromium	999	24	4	2	1000	100
Copper	2540	75	19.25	2.5	2500	102	Copper	1090	60	15.4	2	1000	109
Lead	2420	30	4	2.5	2500	97	Lead	1030	24	3.2	2	1000	103
Nickel	2390	120	30	2.5	2500	96	Nickel	1010	96	24	2	1000	101
Selenium	2560	15	3	2.5	2500	102	Selenium	1100	12	2.4	2	1000	110
Silver	639	30	15	2.5	625	102	Silver	270	24	12	2	250	108
Thallium	2450	30	7.25	2.5	2500	98	Thallium	1010	24	5.8	2	1000	101
Vanadium	2410	150	5.75	2.5	2500	96	Vanadium	1020	120	4.6	2	1000	102
Zinc	2530	60	6	2.5	2500	101	Zinc	1060	48	4.8	2	1000	106

QCBatchID 3134383					EDD F3E120129		QCBatchID 3049372					EDD H3B110210	
QCSampleID F3E140000383C							QCSampleID H3B180000372C						
Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec	Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Antimony	1000	180	5.15	2.5	1000	100	Antimony	5000	180	38.8	1	5000	100
Arsenic	1040	30	3.725	2.5	1000	104	Arsenic	5190	30	14.5	1	5000	104
Barium	928	150	17	2.5	1000	93	Barium	50200	150	3.1	1	50000	100
Cadmium	985	15	0.713	2.5	1000	98	Beryllium	1070	15	2.7	1	1000	107
Chromium	961	30	1.503	2.5	1000	96	Cadmium	1060	15	2.3	1	1000	106
Copper	991	75	3	2.5	1000	99	Chromium	5170	30	7.2	1	5000	103
Lead	992	30	4.5	2.5	1000	99	Copper	5090	75	11.9	1	5000	102
Nickel	980	120	3.05	2.5	1000	98	Lead	5250	30	9	1	5000	105
Selenium	1050	15	3.25	2.5	1000	105	Nickel	5340	120	11	1	5000	107
Silver	265	30	1.04	2.5	250	106	Selenium	1020	15	12.2	1	1000	102
Thallium	1000	30	9.1	2.5	1000	100	Silver	1020	30	11.8	1	1000	102
Vanadium	979	150	1.468	2.5	1000	98	Thallium	5160	30	22.7	1	5000	103
Zinc	1050	60	8.5	2.5	1000	105	Vanadium	5250	150	16.9	1	5000	105
							Zinc	5510	60	7.7	1	5000	110

Table 5-17 Summary of Laboratory Control Samples by Batch/Electronic Data Deliverable

QCBatchID 3052096 **EDD** H3B110213
QCSampleID H3B210000096C

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Antimony	4920	180	38.8	1	5000	98
Arsenic	5040	30	14.5	1	5000	101
Barium	49100	150	3.1	1	50000	98
Beryllium	1040	15	2.7	1	1000	104
Cadmium	1030	15	2.3	1	1000	103
Chromium	5010	30	7.2	1	5000	100
Copper	4970	75	11.9	1	5000	99
Lead	5100	30	9	1	5000	102
Nickel	5160	120	11	1	5000	103
Selenium	1000	15	12.2	1	1000	100
Silver	1000	30	11.8	1	1000	100
Thallium	5070	30	22.7	1	5000	101
Vanadium	5100	150	16.9	1	5000	102
Zinc	5350	60	7.7	1	5000	107

QCBatchID 3069123 **EDD** H3B270125
QCSampleID H3C100000123C

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Antimony	4860	180	38.8	1	5000	97
Arsenic	5120	30	14.5	1	5000	102
Barium	49900	150	3.1	1	50000	100
Beryllium	1060	15	2.7	1	1000	106
Cadmium	1050	15	2.3	1	1000	105
Chromium	5160	30	7.2	1	5000	103
Copper	5030	75	11.9	1	5000	101
Lead	5170	30	9	1	5000	103
Nickel	5340	120	11	1	5000	107
Selenium	1000	15	12.2	1	1000	100
Silver	1030	30	11.8	1	1000	103
Thallium	5160	30	22.7	1	5000	103
Vanadium	5190	150	16.9	1	5000	104
Zinc	5400	60	7.7	1	5000	108

QCBatchID 3071372 **EDD** H3C100111
QCSampleID H3C120000372C

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Antimony	4920	180	38.8	1	5000	98
Arsenic	5130	30	14.5	1	5000	103
Barium	50600	150	3.1	1	50000	101
Beryllium	1050	15	2.7	1	1000	105
Cadmium	1050	15	2.3	1	1000	105
Chromium	5100	30	7.2	1	5000	102
Copper	5100	75	11.9	1	5000	102
Lead	5180	30	9	1	5000	104
Nickel	5310	120	11	1	5000	106
Selenium	1000	15	12.2	1	1000	100
Silver	992	30	11.8	1	1000	99
Thallium	5150	30	22.7	1	5000	103
Vanadium	5190	150	16.9	1	5000	104
Zinc	5410	60	7.7	1	5000	108

QCBatchID 3098167 **EDD** H3D070127
QCSampleID H3D080000167C

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Mercury	0.828	0.03	0.01	1	0.833	99

Table 5-17 Summary of Laboratory Control Samples by Batch/Electronic Data Deliverable

QCBatchID 3099207 **EDD** H3D070127
QCSampleID H3D090000207C

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Antimony	5190	180	38.8	1	5000	104
Arsenic	5330	30	14.5	1	5000	107
Barium	51800	150	3.1	1	50000	104
Beryllium	1120	15	2.7	1	1000	112
Cadmium	1100	15	2.3	1	1000	110
Chromium	5370	30	7.2	1	5000	107
Copper	5220	75	11.9	1	5000	104
Lead	5500	30	9	1	5000	110
Nickel	5520	120	11	1	5000	110
Selenium	1060	15	12.2	1	1000	106
Silver	1070	30	11.8	1	1000	107
Thallium	5410	30	22.7	1	5000	108
Vanadium	5390	150	16.9	1	5000	108
Zinc	5750	60	7.7	1	5000	115

QCBatchID 3100118 **EDD** H3D070127
QCSampleID H3D100000118C

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Mercury	0.00489	0	0	1	0.005	98

QCBatchID 3105330 **EDD** H3D100122
QCSampleID H3D150000330C

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Spike Level (µg/L)	% Rec
Antimony	4890	180	38.8	1	5000	98
Arsenic	5080	30	14.5	1	5000	102
Barium	49800	150	3.1	1	50000	100
Beryllium	1060	15	2.7	1	1000	106
Cadmium	1040	15	2.3	1	1000	104
Chromium	5120	30	7.2	1	5000	102
Copper	5000	75	11.9	1	5000	100
Lead	5170	30	9	1	5000	103
Nickel	5320	120	11	1	5000	106
Selenium	988	15	12.2	1	1000	99
Silver	1020	30	11.8	1	1000	102
Thallium	5140	30	22.7	1	5000	103
Vanadium	5200	150	16.9	1	5000	104
Zinc	5400	60	7.7	1	5000	108

Table 5-17 Summary of Laboratory Control Samples by Batch/Electronic Data Deliverable

QCBatchID 3098423					EDD H3D070127		QCBatchID 3099539					EDD H3D070127	
QCSampleID H3D080000423C							QCSampleID H3D090000539C						
Analyte	Conc (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil	Spike Level (mg/kg)	% Rec	Analyte	Conc (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil	Spike Level (mg/kg)	% Rec
Cyanide, Total	10.1	0.5	0.27	1	9.9	102	Cyanide, Total	10.2	0.5	0.27	1	9.92	103

Table 5-18 Summary of Method Blank Results by Batch/Electronic Data Deliverable

QCBatchID 3129240 EDD F3E080262					QCBatchID 3132505 EDD F3E090273				
QCSampleID F3E080000499B					QCSampleID F3E090000585B				
Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil
Antimony	ND	180	7	2.5	Antimony	6.9	144	5.6	2
Arsenic	ND	30	3	2.5	Arsenic	ND	24	2.4	2
Barium	22	500	17	2.5	Barium	24.2	400	13.6	2
Cadmium	ND	15	0.5	2.5	Cadmium	ND	12	4	2
Chromium	ND	30	0.825	2.5	Chromium	ND	24	4	2
Copper	ND	75	4	2.5	Copper	ND	60	15.4	2
Lead	15.5	30	4	2.5	Lead	11.9	24	3.2	2
Nickel	ND	120	4	2.5	Nickel	ND	96	24	2
Selenium	10.7	15	3	2.5	Selenium	7.1	12	2.4	2
Silver	ND	30	1.2	2.5	Silver	ND	24	12	2
Thallium	ND	30	7.25	2.5	Thallium	ND	24	5.8	2
Vanadium	ND	150	3.5	2.5	Vanadium	ND	120	4.6	2
Zinc	38.4	60	6	2.5	Zinc	10	48	4.8	2

QCBatchID 3134383 EDD F3E120129					QCBatchID 3049372 EDD H3B110210				
QCSampleID F3E130000416B					QCSampleID H3B170000168B				
Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil
Antimony	ND	180	7	2.5	Antimony	ND	180	38.8	1
Arsenic	12.4	30	3	2.5	Arsenic	ND	30	14.5	1
Barium	ND	500	17	2.5	Barium	22.4	150	3.1	1
Cadmium	ND	15	5	2.5	Beryllium	ND	15	2.7	1
Chromium	ND	30	5	2.5	Cadmium	ND	15	2.3	1
Copper	ND	75	19.25	2.5	Chromium	ND	30	7.2	1
Lead	6.9	30	4	2.5	Copper	ND	75	11.9	1
Nickel	ND	120	30	2.5	Lead	ND	30	9	1
Selenium	ND	15	3	2.5	Nickel	ND	120	11	1
Silver	ND	30	15	2.5	Selenium	ND	15	12.2	1
Thallium	ND	30	7.25	2.5	Silver	ND	30	11.8	1
Vanadium	ND	150	5.75	2.5	Thallium	ND	30	22.7	1
Zinc	ND	60	6	2.5	Vanadium	ND	150	16.9	1
					Zinc	28.3	60	7.7	1

Table 5-18 Summary of Method Blank Results by Batch/Electronic Data Deliverable

QCBatchID 3052096 EDD H3B110213					QCBatchID 3069123 EDD H3B270125				
QCSampleID H3B190000154B					QCSampleID H3C100000123B				
Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil
Antimony	ND	180	38.8	1	Antimony	ND	180	38.8	1
Arsenic	ND	30	14.5	1	Arsenic	ND	30	14.5	1
Barium	3.7	150	3.1	1	Barium	ND	150	3.1	1
Beryllium	ND	15	2.7	1	Beryllium	ND	15	2.7	1
Cadmium	ND	15	2.3	1	Cadmium	ND	15	2.3	1
Chromium	ND	30	7.2	1	Chromium	ND	30	7.2	1
Copper	ND	75	11.9	1	Copper	ND	75	11.9	1
Lead	ND	30	9	1	Lead	ND	30	9	1
Nickel	ND	120	11	1	Nickel	ND	120	11	1
Selenium	ND	15	12.2	1	Selenium	ND	15	12.2	1
Silver	ND	30	11.8	1	Silver	ND	30	11.8	1
Thallium	ND	30	22.7	1	Thallium	ND	30	22.7	1
Vanadium	ND	150	16.9	1	Vanadium	ND	150	16.9	1
Zinc	10.4	60	7.7	1	Zinc	28.8	60	7.7	1

QCBatchID 3071372 EDD H3C100111					QCBatchID 3099207 EDD H3D070127				
QCSampleID H3C110000119B					QCSampleID H3D080000114B				
Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil	Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil
Antimony	ND	180	38.8	1	Antimony	ND	180	38.8	1
Arsenic	ND	30	14.5	1	Arsenic	ND	30	14.5	1
Barium	5.2	150	3.1	1	Barium	ND	150	3.1	1
Beryllium	ND	15	2.7	1	Beryllium	ND	15	2.7	1
Cadmium	5.4	15	2.3	1	Cadmium	ND	15	2.3	1
Chromium	ND	30	7.2	1	Chromium	ND	30	7.2	1
Copper	ND	75	11.9	1	Copper	ND	75	11.9	1
Lead	ND	30	9	1	Lead	ND	30	9	1
Nickel	ND	120	11	1	Mercury	ND	0	3E-05	1
Selenium	ND	15	12.2	1	Nickel	ND	120	11	1
Silver	ND	30	11.8	1	Selenium	ND	15	12.2	1
Thallium	ND	30	22.7	1	Silver	ND	30	11.8	1
Vanadium	ND	150	16.9	1	Thallium	ND	30	22.7	1
Zinc	21.1	60	7.7	1	Vanadium	ND	150	16.9	1
					Zinc	72.3	60	7.7	1

Table 5-18 Summary of Method Blank Results by Batch/Electronic Data Deliverable

QCBatchID 3100118 **EDD** H3D070127
QCSampleID H3D080000114B

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil
Antimony	ND	180	38.8	1
Arsenic	ND	30	14.5	1
Barium	ND	150	3.1	1
Beryllium	ND	15	2.7	1
Cadmium	ND	15	2.3	1
Chromium	ND	30	7.2	1
Copper	ND	75	11.9	1
Lead	ND	30	9	1
Mercury	ND	0	3E-05	1
Nickel	ND	120	11	1
Selenium	ND	15	12.2	1
Silver	ND	30	11.8	1
Thallium	ND	30	22.7	1
Vanadium	ND	150	16.9	1
Zinc	72.3	60	7.7	1

QCBatchID 3098167 **EDD** H3D070127
QCSampleID H3D080000167B

Analyte	Conc (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil
Mercury	ND	0.03	0.005	1

QCBatchID 3105330 **EDD** H3D100122
QCSampleID H3D140000152B

Analyte	Conc (µg/L)	EQL (µg/L)	MDL (µg/L)	Dil
Antimony	ND	180	38.8	1
Arsenic	ND	30	14.5	1
Barium	17.8	150	3.1	1
Beryllium	ND	15	2.7	1
Cadmium	ND	15	2.3	1
Chromium	ND	30	7.2	1
Copper	ND	75	11.9	1
Lead	17.7	30	9	1
Nickel	ND	120	11	1
Selenium	ND	15	12.2	1
Silver	ND	30	11.8	1
Thallium	ND	30	22.7	1
Vanadium	ND	150	16.9	1
Zinc	38.1	60	7.7	1

Table 5-18 Summary of Method Blank Results by Batch/Electronic Data Deliverable

QCBatchID 3098423 EDD H3D070127					QCBatchID 3099539 EDD H3D070127				
QCSampleID H3D080000423B					QCSampleID H3D090000539B				
Analyte	Conc (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil	Analyte	Conc (mg/kg)	EQL (mg/kg)	MDL (mg/kg)	Dil
Cyanide, Total	ND	0.5	0.27	1	Cyanide, Total	ND	0.5	0.27	1

Table 5-19 TCLP Results from VSL Control Glasses

Lab	Sample ID	Results (by element, mg/L TCLP)											
		Al	Ba	B	Cd	Fe	Pb	Li	Mg	Ni	Si	Sr	Zn
STLKNX	HLW02-M12	328 B	27.2 B J	883 J	17.3	1340	16.9 B	461 J	207	65.1 B	2080	41.7 B J	430 J
STLKNX	HLW02-M12A	290 B	5.8 B J	771	17.4	1430	19.4 B	412 J	189	64.1 B	1850	38.2 B	384 J
STLKNX	HLW02-M12B	373 B	4.8 B J	891	18.3 J	1540	15.1 B	479 J	211 J	70.4 B	1780	42.8 B J	411 J
STLKNX	HLW02-M12GA91	232 B	7.7 B	776	16.6	1470	23.6 B	460	198	61.1 B	1180 B	39.8 B	394 J
STLKNX	HLW03-19A	409 B J	41.6 B J	1540 J	16.4	1510	38.9 J	415 J	158	69.2 B	1860	35.7 B J	382 J
STLKNX	HLW03-19M	268 B J	11.9 B J	725 J	15.6	2060	26.8 B J	382 J	178	57.7 B	1510	35.5 B J	669 J
STLKNX	HLW99-03M12	265 B	11.4 B	1150	21.9	2140	28.6 B	573	252	82 B	1240 B	48.2 B J	615 J
	Ave. (mg/L TCLP)	309	16	962	18	1641	24	455	199	67	1643	40	469
	RSD (percent)	21%	87%	30%	12%	20%	34%	14%	15%	12%	21%	11%	26%
STLSTL	HLW03-106	188 B	22.2 BE	674	12.7	842	28.8 B	401	145	48.2 B	2070	34.4 B	360
STLSTL	HLW03-107M	224 B	12.4 B	658	12.9	808	24.5 J	404	151 N	51.4 B	1620 N	35.1 BNE	304 N
STLSTL	HLW03-G42	223 B	13.1 B	625	12.2 B	731	20.1 B	382	141	48.1 B	1690	32.3 B	287
STLSTL	HLW03-G45	254 B	10.7 B	616	12.6	840	24.3 J	374	144 N	50.9 B	1830 N	33.9 BNE	294 N
STLSTL	HLW03-M41	248 B	17.2 BE	723	13.6	987	26.4 B	420	158	55.5 B	2580	37.2 B	387
STLSTL	HLW03-M42	275 B	13.2 B	658	13.1	869	22.8 B	402	150	52 B	1810	34.4 B	290
	Ave. (mg/L TCLP)	235	15	659	13	846	24	397	148	51	1933	35	320
	RSD (percent)	13%	28%	6%	4%	10%	12%	4%	4%	5%	18%	5%	13%
STLSTL to STLKNX ratio:		0.761	0.938	0.685	0.728	0.516	1.012	0.874	0.745	0.760	1.177	0.858	0.683

STLKNX = STL Knoxville
STLSTL = STL St. Louis
Ave. = Average
RSD = relative standard deviations (standard deviation ÷ average)

B = Estimated result, result is less than reporting limits.
J = The associated method blank contains the element at a reportable level.
N = Matrix spike spiked analyte recovery is outside of control limits.
E = Matrix interference.

Table 5-20 Vitreous State Laboratory Procedures that Pertain to Spike, Initial Matrix, and Augmentation Matrix Glass Testing

Title	Document Code	Rev. #	Date
Crucible Melts	TPI-CM*	1	07/10/2002
Calibration of Balances	TPI-COB	2	12/07/2000
Metallic Labware Cleaning Using Hydrofluoric or Nitric Acid	TPI-MLCHFN*	0	10/02/2001
Preparation of Glass for Analysis	TPI-PGA*	0	06/13/2001
Receiving, Shipping and Handling of Radioactive and Non Radioactive Materials	TPI-SH*	6	05/02/2001
Thermocouple Calibration	TPI-TC*	5 7	12/08/00 05/10/02
Notebook Record Guide	QA-NRG*	4	07/30/2001
Procedure for Project Management and Reporting	QA-PM	2	03/23/2000
Procurement and Material Control	QA-PMC	9	08/01/2002
Quality Assurance Programs Planning and Documentation	QA-PPD	3	06/30/2000
Project Quality Assurance Programs Reviews	QA-PREV	2	03/26/2001
Quality Assurance Records Control	QA-RECS	2	05/09/2002
Readiness Review	QA-RR	1	06/13/2000
Surveillance	QA-S	2	06/13/2000
Procedure for Spreadsheet Documentation	QA-SD	2	08/16/2000
Scientific Investigation	QA-SI	2	08/03/2001
Indoctrination, Training and Qualification	QA-T	2	06/02/2000
VSL HLW Waste Acceptance Items and Activities for RPP-WTP Support Work Conducted by VSL	VSL-HLW-I&A List	2	06/06/2002
Hazardous Waste Management Program Plan	VSL-HWMP	1	11/07/1997
Quality Assurance Manual	VSL-QA	13	08/05/2002
Quality Assurance Project Plan for RPP-WTP Support Activities Conducted by VSL	VSL-RPP-WTP (QAPP)	4	08/02/2001

* Procedures marked are directly related to glass fabrication and sampling, and included in Supplement 5. Other procedures cited here are programmatic, or indirectly related to glass fabrication and sampling, and are available upon request.

Table 5-21 Severn Trent Laboratories Quality Assurance Manual and Standard Operating Procedures Provided in Supplement 5

Title	Document Code	Rev. #	Implementation Date
Internal Chain of Custody	KNOX-SC-0004	2	11/7/01
Receipt and Log In of Commercial Samples	KNOX-SC-0003	4	11/7/01
Toxicity Characteristic Leaching Procedure and Synthetic Leaching Procedure	KNOX-OP-0012	0	9/20/01
ICP-AES, Spectrometric method for Trace Element Analyses, SW-846 Method 6010B and EPA Method 200.7	KNOX-MT-0007	0	11/27/01
Preparation and Analysis of Mercury in Solid Samples by Cold Vapor Atomic Absorption, SW-846 Method 7470A and EPA Method 245.1	KNOX-MT-0009	1	8/14/02
Preparation and Analysis of Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW-846 Method 7471A and EPA Method 245.5	KNOX-MT-0010	1	8/14/02
Cyanide Analysis	KNOX-WC-0001	3	1/19/01
Sample Receipt and Chain of Custody	STL-QA-0006	5	3/17/03
Toxicity Characteristic Leaching Procedure and Synthetic Leaching Procedure and the California Wet Leach Procedure for Metals	STL-IP-0016	0	5/5/03
ICP-AES, Spectrometric method for Trace Element Analyses, SW-846 Method 6010B and EPA Method 200.7	STL-MT-0003	1	3/15/03
Labware Preparation for Inorganic and Trace Metal Analysis	STL-IP-0004	3	5/5/03
Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA, ICP Spectroscopy or ICP/MS (Methods 3010A and 200.8)	STL-IP-0013	5	4/30/03

Table 5-22 Spike Glass Validated Data Summary, Sample Delivery Group H3B110213

Element Concentration in µg/L, unless otherwise noted.	Antimony		Arsenic		Barium		Beryllium		Cadmium		Chromium		Copper		Lead		Nickel	
Glass ID	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated
HLW99-03E	90.8 B	90.8	76.3	76.3	8990	8990	184	184	649	649	1190	1190	874	874	1790	1790	4950	4950
HLW99-03ER1	57.1 B	57.1	83.7	83.7	9610	9610	209	209	680	680	1260	1260	917	917	1880	1880	5050	5050
HLW99-03ER2	60.8 B	60.8 B	71.9	71.9	7170	7170	166	166	538	538	931	931	703	703	1640	1640	3590	3590
HLW99-03F	181	181	70.4	70.4	8480	8480	164	164	571	571	1040	1040	763	763	1710	1710	4510	4510
HLW99-03FR1	180	180	66.2	66.2	8840	8840	170	170	687	687	1160	1160	740	740	1770	1770	4710	4710
HLW99-03FR2	219	219	83.4	83.4	8260	8260	179	179	611	611	954	954	789	789	1810	1810	ND	4310
HLW99-03G	408	408	73.8	73.8	9800	9800	190	190	824	824	1140	1140	923	923	1830	1830	4780	4780
HLW99-03GR1	305	305	68.8	68.8	8400	8400	177	177	629	629	1190	1190	816	816	1670	1670	3860	3860
HLW99-03GR2	290	290	52.4	52.4	6010	6010	132	132	485	485	708	708	627	627	1400	1400	2850	2850
HLW99-03H	578	578	62	62	7640	7640	161	161	526	526	863	863	722	722	1600	1600	2990	2990
HLW99-03HR1	682	682	68.6	68.6	6120	6120	134	134	427	427	641	641	583	583	1340	1340	2650	2650
HLW99-03HR2	547	547	67.5	67.5	6690	6690	161	161	462	462	759	759	656	656	1490	1490	2590	2590
Proposed Delisting Level (TCLP)	659		616		100,000		1,330		480		4,950		2.92E+07		5,000		22,600	

Element Concentration in µg/L, unless otherwise noted.	Selenium		Silver		Thallium		Vanadium		Zinc		TCLP Mercury		Total Mercury		Total Cyanide (mg/L)	
Glass ID	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated
HLW99-03E	413	413	1110	1110	919	919	133 B	133	11500 J	11500	ND	0.030 UJ	ND	5.0 UJ	ND	0.27 UJ
HLW99-03ER1	428	428	1130	1130	847	847	117 B	117	12000 J	12000	ND	0.030 UJ	ND	5.0 UJ	ND	0.27 UJ
HLW99-03ER2	259	259	863	863	465	465	105 B	105	8900 J	8900	0.035 B	0.035	ND	5.0 UJ	ND N*	0.27 UJ
HLW99-03F	307	307	972	972	230	230	113 B	113	10600 J	10600	ND	0.030 UJ	ND	5.0 UJ	ND	0.27 UJ
HLW99-03FR1	319	319	1070	1070	181	181	107 B	107	11300 J	11300	ND	0.030 UJ	ND	5.0 UJ	ND	0.27 UJ
HLW99-03FR2	ND	238	4310	969	238	219	969	128	219	10200	128 B	0.030 UJ	10200 J	5.0 UJ	ND N*	0.27 UJ
HLW99-03G	420	420	1150	1150	138	138	130 B	130	12200 J	12200	ND	0.030 UJ	ND	5.0 UJ	ND	0.27 UJ
HLW99-03GR1	438	438	980	980	106	106	93.8 B	93.8	10300 J	10300	ND	0.030 UJ	ND	5.0 UJ	ND N*	0.27 UJ
HLW99-03GR2	237	237	687	687	72.2	72.2	63.6 B	63.6	7370 J	7370	ND	0.03	0.03 B	5.0 UJ	ND N*	0.27 UJ
HLW99-03H	407	407	910	910	42.5	42.5	101 B	101	9130 J	9130	0.043 B	0.043	ND	5.0 UJ	ND	0.27 UJ
HLW99-03HR1	245	245	734	734	36.3	36.3	125 B	125	7340 J	7340	ND	0.036	0.036 B	5.0 UJ	ND N*	0.27 UJ
HLW99-03HR2	302	302	821	821	24.3 B	24.3	96.7 B	96.7	7890 J	7890	ND	0.030 UJ	ND	5.0 UJ	ND N*	0.27 UJ
Proposed Delisting Level (TCLP)	1,000		3,070		282		16,900		225,000		200		4000		230 mg/L	

Laboratory Qualifier Definitions (see Supplement 4, Appendix J):
- ND = Not detected at or above the MDL.
- B = Estimated result. Result is less than the reporting limit
- N = Spiked analyte recovery is outside control limits.

Validation Qualifier Definitions (see Supplement 4, Appendix L):
- U = The constituent was analyzed for but was not detected. The data should be considered usable for decision-making purposes.
- J = Indicates that the constituent was analyzed for and detected. The associated value is estimated due to a QC deficiency identified during data validation. The data should be considered usable for decision-making purposes.
- UJ = The constituent was analyzed for and was not detected. Due to a QC deficiency identified during data validation, the value reported may not accurately reflect the minimum detectable limit. The data should be considered usable for decision-making purposes.

Validation Notes: If the absolute value of the preparation blank is greater than the MDL and reporting limit, all associated undetected results are qualified as estimated (UJ) and all associated detected results less than 10 times the absolute value of the preparation blank as estimated (J). If the preparation blank results are greater than the MDL, all sample results less than the 5 times the highest blank concentration are qualified as undetected (UJ).

Table 5-23 Matrix Glass Validated Data Summary

Element Concentration in µg/L		Antimony		Arsenic		Barium		Beryllium		Cadmium		Chromium		Copper	
SDG#:	Glass ID	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated
H3B110210	HLW02-01	ND	38.8 UJ	ND	14.5 UJ	68.4 BJ	68.4 UJ	ND	2.7 UJ	257	257	ND	7.2 UJ	20 B	20
H3B270125	HLW02-02	ND	38.8 UJ	ND	14.5 UJ	60.7 B	60.7	ND	2.7 UJ	288	288	7.5 B	7.2 UJ	18.6 B	18.6
H3B110210	HLW02-03	ND	38.8 UJ	35.7	35.7	328 J	328	ND	2.7 UJ	1240	1240	45.3	45.3	74.7 B	74.7
H3B110213	HLW02-04	ND	38.8 U	ND	14.5 U	7.8 BJ	8.1 UJ	ND	2.7 U	264	264	ND	7.2 U	ND	11.9 U
H3B110213	HLW02-05	ND	38.8 U	ND	14.5 U	9.9 BJ	9.8 UJ	ND	2.7 U	11.3 B	11.4	ND	7.2 U	ND	11.9 U
H3B110213	HLW02-06	ND	38.8 U	ND	14.5 U	14.6 BJ	14.8 J	ND	2.7 U	565	557	ND	7.2 U	ND	11.9 U
H3B110213	HLW02-07	ND	38.8 U	ND	16.4	49.5 BJ	50.3	ND	2.7 U	7.8 B	7.9	12 B	11.8	23.8 B	27.4
H3B110213	HLW02-08	ND	38.8 U	ND	14.5 U	27.9 BJ	28.2 J	ND	2.7 U	38.1	38.2	ND	7.2 U	14.9 B	16.9
H3B110213	HLW02-09	ND	38.8 U	ND	14.5 U	59.8 BJ	61	ND	2.7 U	25.9	26	ND	7.2 U	ND	12.4
H3B110210	HLW02-10	ND	38.8 UJ	ND	14.5 UJ	69.5 BJ	69.5 J	ND	2.7 UJ	755	755	ND	7.2 UJ	12.3 B	12.3
H3B270125	HLW02-11	ND	38.8 UJ	ND	14.5 UJ	17.4 B	17.4	ND	2.7 UJ	20.5	20.5	ND	7.2 UJ	ND	11.9 UJ
H3B110210	HLW02-12	ND	38.8 UJ	20.2 B	20.2	133 BJ	133 J	ND	2.7 UJ	558	558	17.3 B	17.3	33 B	33
H3B110213	HLW02-13	ND	38.8 U	ND	17.6	139 BJ	142	ND	2.7 U	20.4	20.5	12.6 B	13.4	35.8 B	41.2
H3B110213	HLW02-14	ND	38.8 U	ND	14.5 U	21.2 BJ	21.6 J	ND	2.7 U	229	230	ND	7.2 U	ND	11.9 U
H3B110210	HLW02-15	ND	38.8 UJ	22.2 B	22.2	115 BJ	115 J	ND	2.7 UJ	19.6	19.6	13.4 B	13.4	31.1 B	31.1
H3B110213	HLW02-16	ND	38.8 U	ND	14.5 U	136 BJ	134	ND	2.7 U	528	522	11.2 B	15.2	34.3 B	39
H3B270125	HLW02-17	ND	38.8 UJ	ND	14.5 UJ	8 B	8	ND	2.7 UJ	260	260	ND	7.2 UJ	ND	11.9 UJ
H3B110210	HLW02-18	ND	38.8 UJ	21.1 B	21.1	66.6 BJ	66.6 UJ	ND	2.7 UJ	11.9 B	11.9 B	42.4	42.4	21.4 B	21.4
H3B110213	HLW02-19	ND	38.8 U	ND	14.5 U	9.8 BJ	51	ND	2.7 U	12.1 B	562	ND	7.2 U	ND	11.9 U
H3B270125	HLW02-20R1	ND	38.8 UJ	ND	14.5 UJ	25.2 B	25.2	ND	2.7 UJ	12.5 B	12.5	ND	7.2 UJ	ND	11.9 UJ
H3B270125	HLW02-21R1	ND	38.8 UJ	ND	14.5 UJ	13.6 B	13.6	ND	2.7 UJ	14 B	14	ND	7.2 UJ	ND	11.9 UJ
H3B270125	HLW02-22	ND	38.8 UJ	ND	14.5 UJ	12.6 B	12.6	ND	2.7 UJ	8 B	8	ND	7.2 UJ	ND	11.9 UJ
H3B270125	HLW02-23R1	ND	38.8 UJ	ND	14.5 UJ	63.9 B	63.9	ND	2.7 UJ	779	779	ND	7.2 UJ	ND	11.9 UJ
H3B270125	HLW02-24	ND	38.8 UJ	15 B	15	83.8 B	83.8	ND	2.7 UJ	13.1 B	13.1	ND	7.2 UJ	18.6 B	18.6
H3B270125	HLW02-25R1	ND	38.8 UJ	ND	14.5 UJ	29.2 B	29.2	ND	2.7 UJ	316	316	ND	7.2 UJ	ND	11.9 UJ
H3B110210	HLW02-26	ND	38.8 UJ	ND	14.5 UJ	147 BJ	147 UJ	ND	2.7 UJ	583	583	16.1 B	16.1	35.8 B	35.8
H3B270125	HLW02-27	ND	38.8 UJ	ND	14.5 UJ	49.2 B	49.2	ND	2.7 UJ	18.4	18.4	ND	7.2 UJ	ND	11.9 UJ
H3B110213	HLW02-28	ND	38.8 U	ND	14.5 U	46.5 BJ	46.4	ND	2.7 U	353	354	ND	7.2 U	17.6 B	19.7
H3B270125	HLW02-29R1	ND	38.8 UJ	ND	14.5 UJ	89.1 B	89.1	ND	2.7 UJ	165	165	ND	7.2 UJ	22 B	22
H3B110210	HLW02-30	ND	38.8 UJ	ND	14.5 UJ	81 BJ	81.0 UJ	ND	2.7 UJ	487	487	8.6 B	8.6	ND	11.9 UJ
H3B110210	HLW02-31	ND	38.8 UJ	ND	14.5 UJ	35.1 BJ	35.1 UJ	ND	2.7 UJ	197	197	ND	7.2 UJ	ND	11.9 UJ
H3B270125	HLW02-32R1	ND	38.8 UJ	ND	14.5 UJ	30.8 B	30.8	ND	2.7 UJ	233	233	ND	7.2 UJ	ND	11.9 UJ
H3B110210	HLW02-33	40.7 B	40.7	ND	14.5 UJ	82.5 BJ	82.5 J	ND	2.7 UJ	209	209	ND	7.2 UJ	ND	11.9 UJ
H3C100111	HLW02-34R1	ND	38.8 UJ	ND	14.5 UJ	118 BJ	118	ND	2.7 UJ	443 J	443	ND	7.2 UJ	23.5 B	23.5
H3B270125	HLW02-35	ND	38.8 UJ	ND	14.5 UJ	104 B	104	ND	2.7 UJ	230	230	ND	7.2 UJ	28.5 B	28.5
H3B110213	HLW02-36	ND	38.8 U	ND	15.6	57.1 BJ	58.1	ND	2.7 U	247	248	11 B	9.8	17.6 B	22.5
H3B110210	HLW02-37	ND	38.8 UJ	ND	14.5 UJ	51.5 BJ	51.5 UJ	ND	2.7 UJ	157	157	ND	7.2 UJ	ND	11.9 UJ
H3B110210	HLW02-38	ND	38.8 UJ	22.1 B	22.1	88.1 BJ	88.1 UJ	ND	2.7 UJ	342	342	10.8 B	10.8	20.9 B	20.9
H3B110213	HLW02-39	ND	38.8 U	ND	14.5 U	18.4 BJ	18.8 J	ND	2.7 U	181	182	ND	7.2 U	ND	11.9 U
H3B270125	HLW02-40	ND	38.8 UJ	ND	14.5 UJ	47.5 B	47.5	ND	2.7 UJ	195	195	ND	7.2 UJ	12.5 B	12.5
H3B110210	HLW02-41	ND	38.8 UJ	ND	14.5 UJ	43.9 BJ	43.9 UJ	ND	2.7 UJ	117	117	ND	7.2 UJ	46.4 B	46.4
H3B110213	HLW02-42	ND	38.8 U	ND	14.5 U	44 BJ	44.9	ND	2.7	166	167	ND	7.2 U	ND	16.5

Table 5-23 Matrix Glass Validated Data Summary (continued)

Element Concentration in µg/L		Antimony		Arsenic		Barium		Beryllium		Cadmium		Chromium		Copper	
SDG#:	Glass ID	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated
H3B270125	HLW02-43	ND	38.8 UJ	ND	14.5 UJ	67.3 B	67.3	ND	2.7 UJ	569	569	ND	7.2 UJ	14.1 B	14.1
H3B110210	HLW02-44	ND	38.8 UJ	19.1 B	19.1	106 BJ	106 UJ	ND	2.7 UJ	386	386	12.9 B	12.9	38.1 B	38.1
H3B110210	HLW02-45	ND	38.8 UJ	ND	14.5 UJ	43.1 BJ	43.1 UJ	ND	2.7 UJ	181	181	ND	7.2 UJ	ND	11.9 UJ
H3B110210	HLW02-46	ND	38.8 UJ	ND	14.5 UJ	22.6 BJ	22.6 UJ	ND	2.7 UJ	111	111	ND	7.2 UJ	ND	11.9 UJ
H3B270125	HLW02-47	ND	38.8 UJ	ND	14.5 UJ	68.9 B	68.9	ND	2.7 UJ	108	108	ND	7.2 UJ	15.7 B	15.7
H3B110210	HLW02-48	ND	38.8 UJ	ND	14.5 UJ	103 BJ	103 J	ND	2.7 UJ	182	182	12.7 B	12.7	25.6 B	25.6
H3B110213	HLW02-49	ND	38.8 U	ND	14.5 U	25.7 BJ	25.8 J	ND	2.7 U	125	126	ND	7.2 U	ND	12
H3B270125	HLW02-50	ND	38.8 UJ	ND	14.5 UJ	31.7 B	31.7	ND	2.7 UJ	171	171	ND	7.2 UJ	ND	11.9 UJ
H3B270125	HLW02-51R1	ND	38.8 UJ	ND	14.5 UJ	30.9 B	30.9	ND	2.7 UJ	121	121	ND	7.2 UJ	ND	11.9 UJ
H3B110213	HLW02-52	ND	38.8 U	ND	14.8	53.4 BJ	54.8	ND	2.7 U	199	201	7.6 B	8.2	13.6 B	20.6
H3B110213	HLW02-53	ND	38.8 U	ND	14.5 U	7.6 BJ	7.6 UJ	ND	2.7 U	204	207	ND	7.2 U	ND	11.9 U
H3B110213	HLW02-54	ND	38.8 U	ND	14.5 U	7.3 BJ	703	ND	2.7 U	252	249	ND	7.2 U	ND	11.9 U
H3B110210	HLW02-55	ND	38.8 UJ	ND	14.5 UJ	39.4 BJ	39.4 UJ	ND	2.7 UJ	156	156	ND	7.2 UJ	ND	11.9 UJ
H3B110210	HLW02-56	ND	38.8 UJ	15.8 B	15.8	83.4 BJ	83.4 UJ	ND	2.7 UJ	378	378	11.7 B	11.7	25 B	25
H3B270125	HLW02-57	ND	38.8 UJ	ND	14.5 UJ	32.7 B	32.7	ND	2.7 UJ	40.7	40.7	ND	7.2 UJ	ND	11.9 UJ
F4D070183	HLW03-01-2	144	144	89.5	89.5	280 B	280	ND	0.28 U	1420	1420	228	228	87.2	87.2
H3D100122	HLW03-02	ND	38.8 U	ND	14.5 U	58.5 BJ	58.5 UJ	ND	2.7 U	695	695	18.7 B	18.7	ND	11.9 U
H3D100122	HLW03-03	ND	38.8 U	ND	14.5 U	114 BJ	114 J	ND	2.7 U	789	789	21.3 B	21.3	ND	11.9 U
F4D070189	HLW03-04-2	4.8 B	4.8 U	21.8 B	21.8	110 BE	110 J	0.3 B	0.3	9.8 B	9.8	26.5 B	26.5	20.1 B	20.1
F4D070189	HLW03-05-2	71.5	71.5	70.8	70.8	136 BE	136 J	ND	0.28 U	642	642	102	102	51.9 B	51.9
F4D070183	HLW03-06-2	9.9 B	9.9	5.5 B	5.5	38.8 B	38.8 J	0.63 B	0.63	251	251	20.3 B	20.3	ND	3.3 U
F4D070174	HLW03-07-2	16.8 B	16.8 UJ	18.4 B	18.4	51 B	51.0 UJ	ND	0.28 U	46.5	46.5	199	199	ND	3.3 U
F4D070183	HLW03-08-2	12.6 B	12.6	43.7	43.7	125 B	125 J	ND	0.28 U	17.5	17.5	5.2 B	5.2 J	48 B	48
F4D070183	HLW03-09-2	30.7	30.7	6.1 B	6.1	17.8 B	17.8 J	0.45 B	0.45	10 B	10	3.1 B	3.1 J	ND	3.3 U
F4D070183	HLW03-10R1-2	12.6 B	12.7	67	67.1	209 BJ	209	ND	0.28 U	32.2	32.2	7.1 B	7.1 J	62.4 B	62.4
F4D070189	HLW03-11-2	ND	4.8 U	ND	3.8 U	21.1 BE	21.1 UJ	ND	0.28 U	7.4 B	7.4	1.6 B	1.6	ND	3.3 U
F4D070174	HLW03-12-2	174	174	18.4 B	18.4	215 B	215 J	0.75 B	0.75	43.2	43.2	129	129	ND	3.3 U
F4D070189	HLW03-13-2	ND	4.8 U	6.8 B	6.8	93.3 BE	93.3 J	0.73 B	0.73	18.5	18.5	13.2 B	13.2	5.3 B	5.3
F4D070183	HLW03-14-2	8.8 B	8.8	14.5 B	14.5	182 B	182	0.4 B	0.4	42.3	42.3	21 B	21	ND	3.3 U
F4D070189	HLW03-15-2	32.5	32.5	3.9 B	3.9	27.2 BE	27.2 UJ	ND	0.28 U	290	290	1.6 B	1.6	ND	3.3 U
F4D070183	HLW03-16-2	34.1	34.1	31.1	31.1	131 B	131 J	ND	0.28 U	13.2	13.2	2.2 B	2.2 J	23.5 B	23.5
F4D070183	HLW03-17-2	14.1 B	14.1	44	44	131 B	131 J	0.9 B	0.9	27.3	27.3	4.8 B	4.8 J	42.5 B	42.5
F4D070183	HLW03-18-2	10.3 B	10.3	4 B	4	16.8 B	16.8 J	0.98 B	0.98	8.1 B	8.1	32.6	32.6	ND	3.3 U
F4D070189	HLW03-19-2	ND	4.8 U	6.1 B	6.1	17.8 BE	17.8 UJ	ND	0.28 U	358	358	53	53	ND	3.3 U
F4D070189	HLW03-20-2	40.1	40.1	31.8	31.8	90.5 BE	90.5 J	0.45 B	0.45	345	345	5.1 B	5.1	36.9 B	36.9
F4D070189	HLW03-21-2	20.2 B	20.2	28.5 B	28.5	79 BE	79.0 J	ND	0.28 U	176	176	35.9	35.9	13.5 B	13.5
F4D070183	HLW03-22-2	13.2 B	13.2	19.7 B	19.7	94.6 B	94.6 J	0.38 B	0.38	85.3	85.3	11.5 B	11.5 J	15.5 B	15.5
F4D070189	HLW03-23-2	ND	4.8 U	7.5 B	7.5	33 BE	33.0 UJ	ND	0.28 U	23.7	23.7	13.1 B	13.1	5.5 B	5.5
F4D070183	HLW03-24-2	17.2 B	17.2	14.6 B	14.6	46.2 B	46.2 J	ND	0.28 U	116	116	23.6 B	23.6	ND	3.3 U
F4D070174	HLW03-25-2	8.2 B	8.2 UJ	21.7 B	21.7	107 B	107 UJ	ND	0.28 U	33	33	9.4 B	9.4	15.2 B	15.2
F4D070174	HLW03-26-2	94	94.0 J	82.7	82.7	234 B	234 J	ND	0.28 U	75.6	75.6	70.7	70.7	42.7 B	42.7
F4D070174	HLW03-27-2	17 B	17.0 UJ	9.6 B	9.6	72.8 B	72.8 UJ	ND	0.28 U	24.8	24.8	13.3 B	13.3	8.4 B	8.4
F4D070174	HLW03-28-2	18.7 B	18.7 UJ	ND	3.8 U	35.5 B	35.5 UJ	ND	0.28 U	29.9	29.9	7.5 B	7.5	ND	3.3 U

Table 5-23 Matrix Glass Validated Data Summary (continued)

Element Concentration in µg/L		Antimony		Arsenic		Barium		Beryllium		Cadmium		Chromium		Copper	
SDG#:	Glass ID	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated
F4D070174	HLW03-29-2	49.1	49.1 J	39.7	39.7	129 B	129 J	ND	0.28 U	313	313	152	152	14.7 B	14.7
F4D070183	HLW03-30-2	38.9	38.9	13.1 B	13.1	51.8 B	51.8 J	ND	0.28 U	36.8	36.8	20.5 B	20.5	ND	3.3 U
F4D070183	HLW03-31-2	46.8	46.8	14.7 B	14.7	61.1 B	61.1 J	ND	0.28 U	41.3	41.3	45.6	45.6	ND	3.3 U
F4D070183	HLW03-32-2	17.2 B	17.2	12.9 B	12.9	66.9 B	66.9 J	0.4 B	0.4	26.2	26.2	7.1 B	7.1 J	14.6 B	14.6
F4D070174	HLW03-33-2	20.8 B	20.8 UJ	9.2 B	9.2	33 BE	33.0 UJ	ND	0.28 U	19.7	19.7	6.1 B	6.1	ND	3.3 U
F4D070183	HLW03-34-2	10.5 B	10.5	17 B	17	57 B	57.0 J	ND	0.28 U	17.3	17.3	17.6 B	17.6	7.3 B	7.3
F4D070189	HLW03-35-2	ND	4.8 U	ND	3.8 U	26.7 BE	26.7 UJ	ND	0.28 U	14.2	14.2	5 B	5.0	ND	3.3 U
F4D070174	HLW03-36-2	12.4 B	12.4 UJ	11.2 B	11.2	48.3 B	48.3 UJ	ND	0.28 U	43	43	6.7 B	6.7	ND	3.3 U
F4D070183	HLW03-37-2	8.1 B	8.1	10.5 B	10.5	58.4 B	58.4 J	ND	0.28 U	21.5	21.5	6.6 B	6.6 J	12.6 B	12.6
F4D070174	HLW03-38-2	5.3 B	5.3 UJ	19.8 B	19.8	91.2 B	91.2 UJ	ND	0.28 U	68.8	68.8	17.6 B	17.6	10.5 B	10.5
F4D070189	HLW03-39-2	7.5 B	7.5	10.2 B	10.2	50.4 BE	50.4 UJ	ND	0.28 U	35.7	35.7	8.3 B	8.3	7.2 B	7.2
F4D070189	HLW03-40-2	14.8 B	14.8	6.9 B	6.9	34.3 BE	34.3 UJ	ND	0.28 U	48.6	48.6	4.5 B	4.5	4.2 B	4.2
F4D070189	HLW03-41-2	10.6 B	10.6	8.6 B	8.6	47.6 BE	47.6 UJ	ND	0.28 U	36.6	36.6	8.4 B	8.4	7.9 B	7.9
H3D100122	HLW03-42	ND	38.8 U	15.6 B	15.6	162 J	162 J	ND	2.7 U	168	168	13.1 B	13.1	20.6 B	20.6
F4D070189	HLW03-43-2	10.5 B	10.5	10.8 B	10.8	61.9 BE	61.9 UJ	ND	0.28 U	536	536	77.1	77.1	3.8 B	3.8
F4D070183	HLW03-44-2	4.9 B	4.9	ND	3.8 U	21.4 B	21.4 J	ND	0.28 U	6.7 B	6.7	ND	1.5 U	ND	3.3 U
F4D070189	HLW03-45-2	19 B	19	17.5 BE	17.5	92.6 BE	92.6 J	ND	0.28 U	34.4	34.4	18.3 B	18.3	21 B	21
Proposed Delisting Level (TCLP, µg/L)		1,000		616		100,000		1,330		480		4,950		29,200,000	

Laboratory Qualifier Definitions (see Supplement 4, Appendix J):

ND = Not detected at or above the MDL.
B = Estimated result. Result is less than the reporting limit
J = Method blank contamination. The associated method blank contains the target analyte at a reportable level.
N = Spiked analyte recovery is outside control limits.
E = The percent difference for the analyte in the serial dilution sample was greater than 10%.

Validation Qualifier Definitions (see Supplement 4, Appendix L):

U = The constituent was analyzed for but was not detected. The data should be considered usable for decision-making purposes.
J = Indicates that the constituent was analyzed for and detected. The associated value is estimated due to a QC deficiency identified during data validation. The data should be considered usable for decision-making purposes.
UJ = The constituent was analyzed for and was not detected. Due to a QC deficiency identified during data validation, the value reported may not accurately reflect the minimum detectable limit. The data should be considered usable for decision-making purposes.

Validation Notes: If the absolute value of the preparation blank is greater than the MDL and reporting limit, all associated undetected results are qualified as estimated (UJ) and all associated detected results less than 10 times the absolute value of the preparation blank as estimated (J). If the preparation blank results are greater than the MDL, all sample results less than the 5 times the highest blank concentration are qualified as undetected (UJ).

Table 5-23 Matrix Glass Validated Data Summary (continued)

Element Concentration in µg/L		Lead		Nickel		Selenium		Silver		Thallium		Vanadium		Zinc	
SDG#:	Glass ID	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated
H3B110210	HLW02-01	65.6	65.6	135	135	28.1	28.1	39.2	39.2	ND	22.7 UJ	ND	16.9 UJ	653 J	653
H3B270125	HLW02-02	74.8	74.8	ND	11.0 UJ	ND	12.2 UJ	36.8	36.8	ND	22.7 UJ	ND	16.9 UJ	377 J	377
H3B110210	HLW02-03	233	233	630	630	92.3	92.3	140	140	62.6	62.6	18.3 B	18.3	1600 J	1600
H3B110213	HLW02-04	ND	9.9	13.7 B	17.1	31	31.2	ND	13.2	ND	27.4	ND	16.9 U	350 J	363
H3B110213	HLW02-05	10.8 B	10.8	18.2 B	16.6	ND	14.5	14 B	11.8 U	ND	22.7 U	ND	16.9 U	417 J	431
H3B110213	HLW02-06	14.3 B	15.5	287	282	59.3	63.4	24.2 B	17.3	ND	22.7 U	ND	16.9 U	729 J	750
H3B110213	HLW02-07	66.1	67.2	13.6 B	13.4	ND	12.2 U	42.9	38.2	ND	22.7 U	ND	16.9 U	323 J	338
H3B110213	HLW02-08	23.9 B	23.6	49.7 B	50.4	ND	15	22.5 B	19	ND	22.7 U	ND	16.9 U	1390 J	1440
H3B110213	HLW02-09	18.8 B	20.4	392	389	ND	13.1	ND	11.8 U	ND	22.7 U	ND	16.9 U	976 J	1020
H3B110210	HLW02-10	31.2	31.2	38 B	38	64.2	64.2	12.8 B	12.8	ND	22.7 UJ	ND	16.9 UJ	999 J	999
H3B270125	HLW02-11	21.3 B	21.3	318	318	44.3	44.3	ND	11.8 UJ	32.8	32.8	ND	16.9 UJ	787 J	787
H3B110210	HLW02-12	118	118	266	266	29.3	29.3	85.4	85.4	ND	22.7 UJ	ND	16.9 UJ	741 J	741
H3B110213	HLW02-13	118	121	28.5 B	28.6	30.2	34	83.9	93.4	ND	22.7 U	ND	16.9 U	706 J	756
H3B110213	HLW02-14	12.8 B	12.4	14.9 B	12.2	ND	12.2 U	13.5 B	11.8 U	ND	22.7 U	ND	16.9 U	307 J	323
H3B110210	HLW02-15	136	136	19.8 B	19.8	26.1	26.1	63.6	63.6	41.7	41.7	ND	16.9 UJ	706 J	706
H3B110213	HLW02-16	119	119	27.3 B	29.5	40.1	45.6	69.2	73.1	ND	22.7 U	ND	16.9 U	690 J	704
H3B270125	HLW02-17	12.6 B	12.6	13 B	13	ND	12.2 UJ	ND	11.8 UJ	ND	22.7 UJ	ND	16.9 UJ	343 J	343
H3B110210	HLW02-18	80.2	80.2	185	185	ND	12.2 UJ	40.1	40.1	ND	22.7 UJ	ND	16.9 UJ	440 J	440
H3B110213	HLW02-19	11.2 B	22.9	17.4 B	33.9	ND	26.4	16.7 B	11.8 U	ND	22.7 U	ND	16.9 U	420 J	765
H3B270125	HLW02-20R1	14.5 B	14.5	15.2 B	15.2	ND	12.2 UJ	17.2 B	17.2	ND	22.7 UJ	ND	16.9 UJ	426 J	426
H3B270125	HLW02-21R1	16.1 B	16.1	23.4 B	23.4	ND	12.2 UJ	14.7 B	14.7	ND	22.7 UJ	ND	16.9 UJ	581 J	581
H3B270125	HLW02-22	13.5 B	13.5	12 B	12	14.5 B	14.5	ND	11.8 UJ	ND	22.7 UJ	ND	16.9 UJ	306 J	306
H3B270125	HLW02-23R1	22.6 B	22.6	414	414	ND	12.2 UJ	16 B	16	28 B	28	ND	16.9 UJ	1000 J	1000
H3B270125	HLW02-24	72.3	72.3	19.2 B	19.2	42.8	42.8	39.8	39.8	ND	22.7 UJ	ND	16.9 UJ	520 J	520
H3B270125	HLW02-25R1	13.7 B	13.7	15.8 B	15.8	12.5 B	12.5	15.4 B	15.4	34.2 B	34.2	ND	16.9 UJ	429 J	429
H3B110210	HLW02-26	117	117	28 B	28	ND	12.2 UJ	86.9	86.9	ND	22.7 UJ	ND	16.9 UJ	750 J	750
H3B270125	HLW02-27	17 B	17	32.4 B	32.4	32.8	32.8	ND	11.8 UJ	49.2	49.2	ND	16.9 UJ	764 J	764
H3B110213	HLW02-28	25.6 B	26.7	86 B	84.2	16.6	19.3	22.5 B	27.1	ND	22.7 U	ND	16.9 U	695 J	722
H3B270125	HLW02-29R1	76.8	76.8	75.4 B	75.4	31.9	31.9	39.4	39.4	ND	22.7 UJ	ND	16.9 UJ	644 J	644
H3B110210	HLW02-30	28.2 B	28.2	113 B	113	16.7	16.7	24.6 B	24.6	ND	22.7 UJ	ND	16.9 UJ	954 J	954
H3B110210	HLW02-31	35.5	35.5	92.5 B	92.5	41.8	41.8	23.1 B	23.1	33.3	33.3	ND	16.9 UJ	793 J	793
H3B270125	HLW02-32R1	22.3 B	22.3	55.6 B	55.6	36.3	36.3	14.4 B	14.4	ND	22.7 UJ	ND	16.9 UJ	455 J	455
H3B110210	HLW02-33	28.5 B	28.5	263	263	49.1	49.1	21.5 B	21.5	ND	22.7 UJ	ND	16.9 UJ	824 J	311
H3C100111	HLW02-34R1	90	90	281	281	15.6	15.6	70	70	ND	22.7 UJ	ND	16.9 UJ	863 J	863
H3B270125	HLW02-35	93.9	93.9	263	263	15.4	15.4	68.3	68.3	24 B	24	ND	16.9 UJ	884 J	884
H3B110213	HLW02-36	62.4	63.2	58.9 B	59.7	32.8	34.8	41.6	39.4	ND	22.7 U	ND	16.9 U	489 J	515
H3B110210	HLW02-37	27.5 B	27.5	194	194	14 B	14	20.4 B	20.4	ND	22.7 UJ	ND	16.9 UJ	627 J	627
H3B110210	HLW02-38	85.5	85.5	158	158	35	35	42.3	42.3	ND	22.7 UJ	ND	16.9 UJ	664 J	664
H3B110213	HLW02-39	18.6 B	18.9	119 B	119	ND	12.2 U	16.3 B	14.8	ND	22.7 U	ND	16.9 U	362 J	378
H3B270125	HLW02-40	53.4	53.4	44.9 B	44.9	13.5 B	13.5	23.3 B	23.3	ND	22.7 UJ	ND	16.9 UJ	387 J	387
H3B110210	HLW02-41	23.6 B	23.6	54.8 B	54.8	12.4 B	12.4	ND	11.8 UJ	24.2 B	24.2	ND	16.9 UJ	467 J	467
H3B110213	HLW02-42	27.7 B	27.9	79.4 B	77.9	15.8	21.3	17.5 B	20.9	ND	28.3	ND	16.9 U	654 J	683
H3B270125	HLW02-43	36.8	36.8	130	130	19.5	19.5	28.9 B	28.9	ND	22.7 UJ	ND	16.9 UJ	1070 J	1070

Table 5-23 Matrix Glass Validated Data Summary (continued)

Element Concentration in µg/L		Lead		Nickel		Selenium		Silver		Thallium		Vanadium		Zinc	
SDG#:	Glass ID	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated
H3B110210	HLW02-44	95	95	89.2 B	89.2	16.6	16.6	51.4	51.4	ND	22.7 UJ	ND	16.9 UJ	766 J	766
H3B110210	HLW02-45	17 B	17	44.3 B	44.3	14.4 B	14.4	14.9 B	14.9	ND	22.7 UJ	ND	16.9 UJ	360 J	360
H3B110210	HLW02-46	19.4 B	19.4	132	132	21.8	21.8	14.1 B	14.1	ND	22.7 UJ	ND	16.9 UJ	439 J	439
H3B270125	HLW02-47	63.1	63.1	48.9 B	48.9	ND	12.2 UJ	33.7	33.7	ND	22.7 UJ	ND	16.9 UJ	448 J	448
H3B110210	HLW02-48	77.6	77.6	227	227	39.3	39.3	45.6	45.6	ND	22.7 UJ	ND	16.9 UJ	720 J	720
H3B110213	HLW02-49	24.3 B	24.8	57.9 B	57.7	ND	14.2	ND	16.2	ND	22.7 U	ND	16.9 U	494 J	513
H3B270125	HLW02-50	27 B	27	76.2 B	76.2	17.1	17.1	22.5 B	22.5	41.5	41.5	ND	16.9 UJ	663 J	663
H3B270125	HLW02-51R1	21.6 B	21.6	ND	11.0 UJ	29.5	29.5	14.7 B	14.7	ND	22.7 UJ	ND	16.9 UJ	476 J	476
H3B110213	HLW02-52	54.3	54.5	106 B	108	24.4	28.2	36.1	35.6	ND	22.7 U	ND	16.9 U	504 J	531
H3B110213	HLW02-53	11.4 B	11.4	11.6 B	12.2	ND	13.4	ND	12.1	ND	22.7 U	ND	16.9 U	279 J	297
H3B110213	HLW02-54	ND	9.0 U	16.5 B	13.9	26.8	33.5	ND	11.8 U	ND	24.5	ND	16.9 U	338 J	348
H3B110210	HLW02-55	25.1 B	25.1	74 B	74	16.7	16.7	15.4 B	15.4	ND	22.7 UJ	ND	16.9 UJ	608 J	608
H3B110210	HLW02-56	88.4	88.4	85.2 B	85.2	18.8	18.8	58	58	ND	22.7 UJ	ND	16.9 UJ	741 J	741
H3B270125	HLW02-57	23.8 B	23.8	55.6 B	55.6	ND	12.2 UJ	24.4 B	24.4	ND	22.7 UJ	ND	16.9 UJ	1640 J	1640
F4D070183	HLW03-01-2	327	327	77.8 B	77.8	16.5	16.5 J	203 N	203	ND	9.0 U	35.9 B	35.9	3010	3010
H3D100122	HLW03-02	25.3 BJ	25.3 UJ	254	254	ND	12.2 U	19 B	19	36	36	ND	16.9 U	62 J	62.0 UJ
H3D100122	HLW03-03	24.5 BJ	24.5 UJ	235	235	28.4	28.4	27.5 B	27.5	36.4	36.4	ND	16.9 U	918 J	918
F4D070189	HLW03-04-2	82.9	82.9	14 B	14	31.3	31.3	99.4	99.4	ND	9.0 U	9.3 B	9.3	21.2 B	21.2 UJ
F4D070189	HLW03-05-2	191	191	43.3 B	43.3	61.9	61.9	90.1	90.1	70.7	70.7	22.7 B	22.7	1760	1760
F4D070183	HLW03-06-2	48.9	48.9 J	130	130	7.2 B	7.2 J	4.6 BN	4.6	ND	9.0 U	1.8 B	1.8	63.1	63.1 J
F4D070174	HLW03-07-2	104 J	104 J	60.8 B	60.8	95.9	95.9	27.3	27.3	ND	9.0 UJ	6.4 B	6.4	2750 N	2750
F4D070183	HLW03-08-2	161	161	25.8 B	25.8	16.4	16.4 J	99.5 N	99.5	24.2 B	24.2	15.3 B	15.3	938	938
F4D070183	HLW03-09-2	17.9 B	17.9 J	17.6 B	17.6	28.1	28.1 J	3.1 BN	3.1	30.2	30.2	2.4 B	2.4	9.6 B	9.6 J
F4D070183	HLW03-10R1-2	266 J	266	326	326	16.4 J	16.4 J	178	178	ND	9.0 U	23.7 B	23.7	9.6 BJ	9.6 J
F4D070189	HLW03-11-2	16.2 B	16.2 UJ	11.2 B	11.2	21.6	21.6	2.5 B	2.5	ND	9.0 U	ND	1.5 U	25.9 B	25.9 UJ
F4D070174	HLW03-12-2	49.1 J	49.1 UJ	94.8 B	94.8	6.1 B	6.1 UJ	30	30	ND	9.0 UJ	2.6 B	2.6	3120 N	3120
F4D070189	HLW03-13-2	23 B	23.0 UJ	145	145	19.2	19.2	8.7 B	8.7	ND	9.0 U	ND	1.5 U	411	411
F4D070183	HLW03-14-2	47.6	47.6 J	529	529	16	16.0 J	31.1 N	31.1	61.8	61.8	3.1 B	3.1	2790	2790
F4D070189	HLW03-15-2	26.2 B	26.2 UJ	11.8 B	11.8	6.7 B	6.7	5.5 B	5.5	37.2	37.2	ND	1.5 U	685	685
F4D070183	HLW03-16-2	107	107 J	196	196	18.6	18.6 J	56.9 N	56.9	ND	9.0 U	10.5 B	10.5	618	618
F4D070183	HLW03-17-2	184	184	153	153	4.6 B	4.6 J	69.1 N	69.1	ND	9.0 U	18.7 B	18.7	1740	1740
F4D070183	HLW03-18-2	278	278	114 B	114	9.5 B	9.5 J	4.4 BN	4.4	ND	9.0 U	2.5 B	2.5	42 B	42.0 J
F4D070189	HLW03-19-2	19.7 B	19.7 UJ	187	187	8.5 B	8.5	7.4 B	7.4	ND	9.0 U	ND	1.5 U	1000	1000
F4D070189	HLW03-20-2	104	104	182	182	33.7	33.7	38.5	38.5	15.7 B	15.7	10.4 B	10.4	17.6 B	17.6 UJ
F4D070189	HLW03-21-2	58.1	58.1 J	163	163	23.8	23.8	38.3	38.3	ND	9.0 U	7.2 B	7.2	663	663
F4D070183	HLW03-22-2	78.8	78.8 J	78.5 B	78.5	42.7	42.7 J	40.5 N	40.5	ND	9.0 U	7.8 B	7.8	267	267
F4D070189	HLW03-23-2	32.1	32.1 UJ	59.6 B	59.6	22.2	22.2	9.4 B	9.4	ND	9.0 U	ND	1.5 U	280	280
F4D070183	HLW03-24-2	40.9	40.9 J	179	179	17.6	17.6 J	26.6 N	26.6	ND	9.0 U	3.4 B	3.4	1060	1060
F4D070174	HLW03-25-2	98.7 J	98.7 J	138	138	37.9	37.9 J	44.6	44.6	ND	9.0 UJ	9 B	9	923 N	923
F4D070174	HLW03-26-2	228 J	228	358	358	106	106	119	119	ND	9.0 UJ	30.7 B	30.7	2080 N	2080
F4D070174	HLW03-27-2	89.4 J	89.4 J	101 B	101	29	29.0 J	32.8	32.8	ND	9.0 UJ	5.5 B	5.5	675 N	675
F4D070174	HLW03-28-2	43.6 J	30.0 UJ	128	128	16.2	16.2 UJ	8.2 B	8.2	ND	9.0 UJ	1.5 B	1.5 U	232 N	232

Table 5-23 Matrix Glass Validated Data Summary (continued)

Element Concentration in µg/L		Lead		Nickel		Selenium		Silver		Thallium		Vanadium		Zinc	
SDG#:	Glass ID	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated	As Reported	Validated
F4D070174	HLW03-29-2	106 J	106 J	295	295	33	33.0 J	74.5	74.5	ND	9.0 UJ	13 B	13	2990 N	2990
F4D070183	HLW03-30-2	43.6	43.6 J	106 B	106	26.1	26.1 J	24.7 B	24.7	17 B	17	3.3 B	3.3	346	346
F4D070183	HLW03-31-2	50.5	50.5 J	193	193	46.8	46.8 J	28.5 N	28.5	30.8	30.8	4.6 B	4.6	389	389
F4D070183	HLW03-32-2	82.3	82.3 J	108 B	108	16.1	16.1 J	36.5 N	36.5	ND	9.0 U	5.8 B	5.8	704	7.4
F4D070174	HLW03-33-2	26.4 B	26.4 UJ	65.2 B	65.2	13.7 B	13.7 UJ	7.3 BN	7.3	ND	9.0 UJ	1.7 B	1.7	545 E	545
F4D070183	HLW03-34-2	57.3	57.3	85.6 B	85.6	20.3	20.3 J	42 N	42	ND	9.0 U	6.4 B	6.4	156	156
F4D070189	HLW03-35-2	21.4 B	21.4 UJ	59.2 B	59.2	9.9 B	9.9	6.8 B	6.8	ND	9.0 U	ND	1.5 U	184	184 J
F4D070174	HLW03-36-2	79.1 J	79.1 J	48.6 B	48.6	12.8 B	12.8 UJ	19.8 B	19.8	ND	9.0 UJ	4.1 B	4.1	154 N	154 J
F4D070183	HLW03-37-2	70.5	70.5 J	98 B	98	20.2	20.2 J	29.8 N	29.8	10.2 B	10.2	6.8 B	6.8	602 B	602
F4D070174	HLW03-38-2	74.5 J	74.5 J	52.3 B	52.3	22.8	22.8 UJ	34.7	34.7	ND	9.0 UJ	7.8 B	7.8	217 N	217 J
F4D070189	HLW03-39-2	45.6	45.6 J	28.4 B	28.4	13.3 B	13.3	20.3 B	20.3	ND	9.0 U	3.1 B	3.1	148	148 J
F4D070189	HLW03-40-2	21 B	21.0 UJ	67.9 B	67.9	17.9	17.9	6.3 B	6.3	ND	9.0 U	ND	1.5 U	196	196
F4D070189	HLW03-41-2	40.2	40.2 J	61.5 B	61.5	12.3 B	12.3	16.7 B	16.7	ND	9.0 U	3.3 B	3.3	418	418
H3D100122	HLW03-42	50.5 J	50.5 UJ	182	182	20.7	20.7	25.3 B	25.3	ND	22.7 U	18.8 B	18.8	524 J	524
F4D070189	HLW03-43-2	26.8 B	26.8 UJ	296	296	9 B	9	13.8 B	13.8	ND	9.0 U	2.1 B	2.1	35.9 B	35.9 UJ
F4D070183	HLW03-44-2	18.6 B	18.6 J	11 B	11	24.3	24.3 J	1.7 B	1.7	ND	9.0 U	ND	1.5 U	12.1 B	12.1 J
F4D070189	HLW03-45-2	87.2	87.2	123	123	35.9	35.9	42.3	42.3	ND	9.0 U	7.8 B	7.8	1020	1020
Proposed Delisting Level (TCLP, µg/L)		22,600		5,000		3,070		659		282		16,900		225,000	

Laboratory Qualifier Definitions (see Supplement 4, Appendix J):

ND = Not detected at or above the MDL.
B = Estimated result. Result is less than the reporting limit
J = Method blank contamination. The associated method blank contains the target analyte at a reportable level.
N = Spiked analyte recovery is outside control limits.
E = The percent difference for the analyte in the serial dilution sample was greater than 10%.

Validation Qualifier Definitions (see Supplement 4, Appendix L):

U = The constituent was analyzed for but was not detected. The data should be considered usable for decision-making purposes.
J = Indicates that the constituent was analyzed for and detected. The associated value is estimated due to a QC deficiency identified during data validation. The data should be considered usable for decision-making purposes.
UJ = The constituent was analyzed for and was not detected. Due to a QC deficiency identified during data validation, the value reported may not accurately reflect the minimum detectable limit. The data should be considered usable for decision-making purposes.

Validation Notes: If the absolute value of the preparation blank is greater than the MDL and reporting limit, all associated undetected results are qualified as estimated (UJ) and all associated detected results less than 10 times the absolute value of the preparation blank as estimated (J). If the preparation blank results are greater than the MDL, all sample results less than the 5 times the highest blank concentration are qualified as undetected (UJ).

Figure 5-1 Crucible-Scale Glass Production

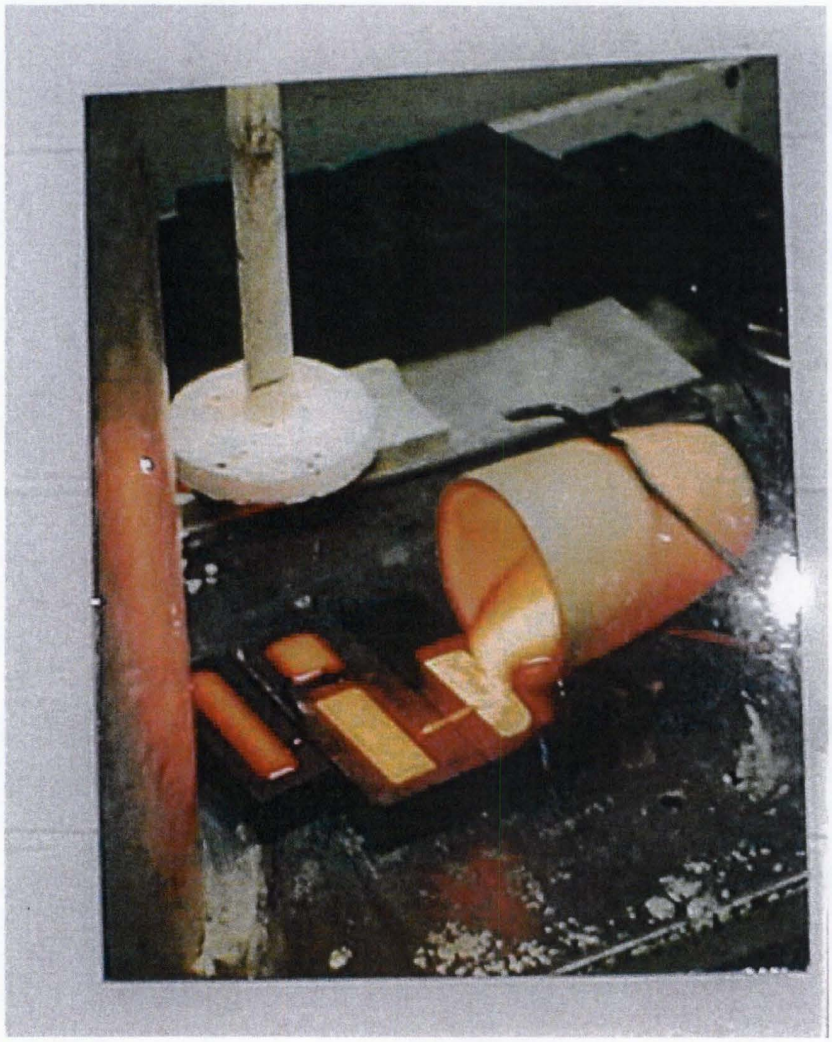
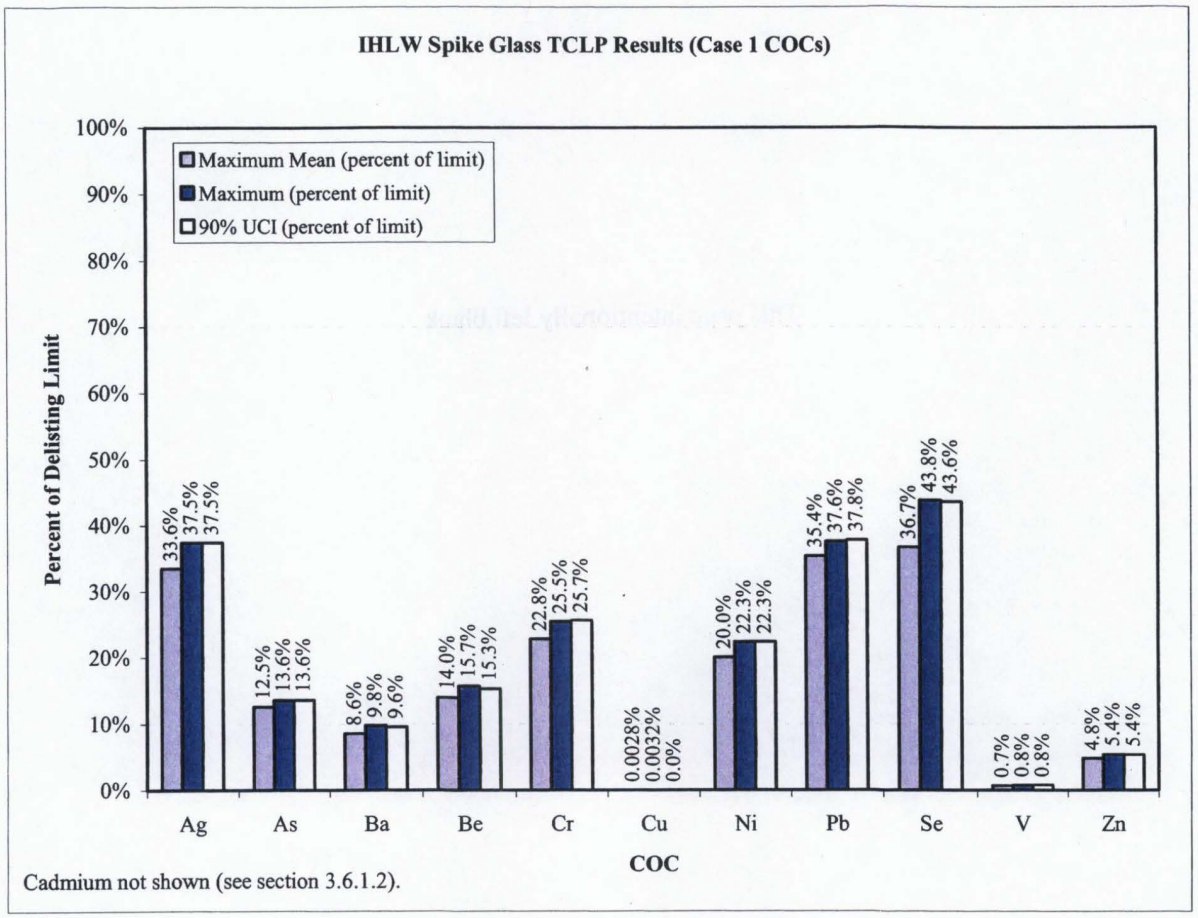


Figure 5-2 Photograph of Representative IHLW Spiked Test Glass

Figure 5-3 IHLW Bounding Glass TCLP Results for Case 1 COCs, as a Percent of the Limit



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7 References

Project Documents

24590-HLW-RPT-RT-03-001, *Preliminary Validation of HLW Glass Simulant and Scale* (Supplement 6 to this petition).

24590-WTP-DB-ENG-01-001, Rev 1I, *Basis of Design.*

24590-WTP-MRQ-PO-03-090, Rev 0, *G2 Model Version 3.0 V&V Test Case 11/3/03.*

24590-WTP-PL-RT-01-002, Rev 2, *Research and Technology Plan.*

24590-WTP-PL-RT-03-002, Rev 2, *IHLW Product Compliance Plan.*

24590-WTP-PL-RT-03-003, Rev 2, *Secondary Wastes Compliance Plan.*

24590-WTP-QAM-QA-01-001, Rev 7, *Quality Assurance Manual*

24590-WTP-RPT-ENV-01-012, Rev 2, *Data Quality Objectives Process in Support of LDR/Delisting at the WTP* (Supplement 2 to this petition).

24590-WTP-RPT-MGT-04-001, Rev 0, *Regulatory Data Quality Objectives Optimization Report.*

24590-WTP-RPT-PO-03-041, Rev 1, *2003 Process Operations Flowsheet Deliverables Concept Paper.*

24590-WTP-RPT-PO-03-050, Rev 0, *2003 Material Balance and Process Flowsheet Assessment.*

24590-WTP-RPT-PT-02-002, Rev 1, *Integrated Emissions Baseline Report Update.*

24590-WTP-RPT-PT-02-005, Rev 2, *Flowsheet Bases, Assumptions, and Requirements.*

24590-WTP-VV-PT-02-007, Rev 0, *Dynamic (G2) Model Version 2.0 Verification and Validation Report.*

CCN 040672, E-mail from D Swanberg to I Pegg, I Joseph, P Brockman, and B Bowen, Vitreous State Laboratory, 3 September 2002, "Guidance for HLW Baseline Glass Formulation Test Plan VSL-01T3600-3, Rev. 2."

CCN 060291, Memo to I Pegg, Vitreous State Laboratory, 7 January 2003, "Instructions for HLW Regulatory Spike Testing."

CCN 079274, Meeting Minutes, 7 January 2004, "Evaluate Product Qualification and Control Analyte List for Rapid Turnaround Technique Compliance Strategy"

Codes and Standards

10 CFR 63. *Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada*, Code of Federal Regulations, as amended.

10 CFR 830. *Nuclear Safety Management*, Code of Federal Regulations, as amended.

40 CFR 136. *Guidelines Establishing Test Procedures for the Analysis of Pollutants*, Code of Federal Regulations, as amended.

40 CFR 141. *National Drinking Water Regulations*, Code of Federal Regulations, as amended.

40 CFR 197. *Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada*, Code of Federal Regulations, as amended.

40 CFR 260. *Hazardous Waste Management System,* Code of Federal Regulations, as amended.

40 CFR 261. *Identification and Listing of Hazardous Waste*, Code of Federal Regulations, as amended.

40 CFR 268.42, *Treatment Standards Expressed as Specified Technologies*, Code of Federal Regulations, as amended.

40 CFR 268.44, *Variance from a Treatment Standard*, Code of Federal Regulations, as amended.

40 CFR 268.48. *Universal Treatment Standards*, Code of Federal Regulations, as amended.

66 FR 6975. 2001. "National Primary Drinking Water Regulations: Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring," *Federal Register*, Vol 66, No. 14, 22 January 2001.

American Society of Mechanical Engineers. ASME NQA-1-1989. *Quality Assurance Program Requirements for Nuclear Facilities*, New York, NY 10016-5990, 1989.

American Society of Mechanical Engineers. ASME NQA-2a-1990. *Quality Assurance Requirements of Computer Software for Nuclear Facility Applications*, New York, NY 10016-5990, 1990.

Public Law 107-200. *Approving the site at Yucca Mountain, Nevada, for the development of a repository for the disposal of high-level radioactive waste and spent nuclear fuel, pursuant to the Nuclear Waste Policy Act of 1982*. 116 Stat. 735. US Congress, Washington, DC. July 23, 2002.

Atomic Energy Act of 1954, 42 USC 2011 et seq. US Congress, Washington, DC.

Hazardous and Solid Waste Amendments of 1984, Public Law 98-616 et seq.

Nevada Revised Statutes for Disposal of Hazardous Waste, NRS 459, Nevada Revised Statutes, State of Nevada.

RCRA 1976. *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq. US Congress, Washington, DC.

Safe Drinking Water Act, 42 USC 300 et seq. US Congress, Washington, DC.

State of Washington Hazardous Waste Management Act of 1976, RCW 70.105.220, Revised Code of Washington.

WAC 173-303 (2003), *Dangerous Waste Regulations*, Washington Administrative Code, State of Washington.

Other Documents

Amerine DB. 1995. *DWPF Waste Form Qualification Report (U)*, WSRC-IM-91-116, Rev 1. Westinghouse Savannah River Company, Aiken, South Carolina.

Agnew SM. 1997. *Hanford Tank Chemical and Radionuclide Inventories: Hanford Defined Waste Model,* LA-UR-96-3860, Rev 4. Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson JD and Mudd OC. 1990. *A History of the 200 Area Tank Farms*, WHC-MR-0132. Westinghouse Hanford Company, Richland, Washington.

Certa PJ. 2003. *River Protection Project System Plan*, ORP-11242, Rev 2. CH2M Hill Hanford Group, Inc., Richland, Washington.

CHG. 2003. *Integrated Mission Acceleration Plan,* RPP-13678, Rev 0. CH2M Hill Hanford Group, Inc., Richland, Washington.

Cicero CA et al. 1993. *Phase Stability Determinations of DWPF Waste Glasses (U)*, WSRC-TR-93-227. Westinghouse Savannah River Company, Aiken, South Carolina.

Cooley SK, Piepel GF, Hao G, Kot WK, and Pegg IL. 2003. *Summary Report: Augmentation Test Matrix to Support TCLP Model Development for RPP-WTP HLW Glasses*. VSL-03S3780-1, Rev 1. Battelle Pacific Northwest Division, Richland, Washington, and Vitreous State Laboratory, The Catholic University of America, Washington, DC.

DOE. 1996. *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*, DOE/EIS-0189, http://www.globalsecurity.org/wmd/library/report/enviro/eis-0189/index.html, August 1996. US Department of Energy, Washington, DC.

DOE. 2000. DOE Contract DE-AC-27-01RV14136. US Department of Energy, Richland, Washington, as amended.

DOE. 2001. DOE O 414.1-1A. *Quality Assurance*, US Department of Energy, Washington, DC.

DOE. 2002a. *Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document*, DOE/RW-0351, Rev 4. US Department of Energy, Washington, DC.

DOE. 2002b. *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250. US Department of Energy, Office of Civilian Radioactive Waste Management, Washington, DC.

DOE. 2002c. *Yucca Mountain Site Suitability Evaluation,* DOE/RW-0549. US Department of Energy, Office of Civilian Radioactive Waste Management, Washington, DC.

DOE. 2003. *Quality Assurance Requirements and Description for the Civilian Radioactive Waste* Management Program, DOE/RW-0333P, Rev 13. US Department of Energy, Washington, DC.

DOE-RL. 1991. *Double-Shell Tank System Dangerous Waste Permit Application*, DOE/RL-90-39, as amended. US Department of Energy, Richland Operations Office, Richland, Washington.

Ecology. 2001. *Dangerous Waste Portion of the Resource Conservation and Recovery Permit for the Treatment, Storage, and Disposal of Dangerous Waste,* Permit WA7890008967, as amended. Washington State Department of Ecology, Olympia, Washington.

Ecology, EPA, and DOE. 1998. *Hanford Federal Facility Agreement and Consent Order*, 89-10, Revision 5. Washington State Department of Ecology, Olympia, Washington, US Environmental Protection Agency, Washington, DC, and US Department of Energy, Washington, DC ("Tri-Party Agreement").

EPA. 1992. *Vitrification Technologies for Treatment of Hazardous and Radioactive Waste*, 625/R-92/002. US Environmental Protection Agency, Office of Research and Development, Center for Environmental Research Information, Cincinnati, Ohio.

EPA. 1999. *Test Methods for Evaluating Solid Wastes—Physical/Chemical Methods*, SW-846, 3rd edition, as amended by Updates I (July 1992), II, IIA (August 1993), IIB, III, and IIIA. US Environmental Protection Agency, Washington, DC.

EPA. 2000. *RCRA Delisting Program Guidance Manual for the Petitioner,* EPA/R-93/007. US Environmental Protection Agency Region 6, Multimedia Planning and Permitting Division, Dallas, Texas.

EPA. 2002a. *Delisting Risk Assessment Software*, Revised Version 2.0, posted on the EPA web site http://www.epa.gov/earth1r6/6pd/rcra_c/pd-o/dras/dras.htm on 5/7/02. US Environmental Protection Agency Region 6, Multimedia Planning and Permitting Division, Dallas, Texas.

EPA. 2002b. *Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8)*, EPA/240/R-02/004, US Environmental Protection Agency, Office of Environmental Information, Washington DC.

EPA. 2003. *Hanford Federal Facility Waste Treatment Plant, High-Level Waste Delisting and LDR Compliance White Paper, Organic Constituent Destruction/Removal Performance in Vitrified Glass Wastes*. US Environmental Protection Agency, Region 10, Seattle, Washington.

EPA. 2005. *Public Health and Environmental Radiation Protection Standards for Yucca Mountain, NV,* Federal Register, Volume 70, Number 161, pages 49014-49065, 22 August 2005.

EPA/NRC. 1997. *Joint NRC/EPA Guidance on Testing Requirements for Mixed Radioactive and Hazardous Waste,* Federal Register, Volume 62, Number 224, pages 62079-62094, 20 November 1997.

Fu SS and Pegg IL. 1999. "The Effect of Composition on TCLP Leach Rates for Glasses with Similar Melt Viscosities," *Ceramic Transactions*, Eds. GT Chandler and X Feng, vol. 107, pp. 261

Gan H and Pegg IL. 2001. *Development of Property-Composition Models for RPP-WTP HLW Glasses*, Final Report, VSL-01R3600-1, Rev 0. Vitreous State Laboratory, The Catholic University of America, Washington, DC.

Gan H, Kot WK, and Pegg IL. 2002. *Constraints for Augmentation of Test Matrix to Support TCLP Model Development for RPP-WTP HLW Glasses*, Letter Report, VSL-02L7800-1, Rev 0, 24590-101-TSA-W000-0009-105-03. Vitreous State Laboratory, The Catholic University of America, Washington, DC.

Gephart RE, Lundgren RE. 1995. *Hanford Tank Clean up: A Guide to Understanding the Technical Issues*. PNNL-10773, Rev 0. Pacific Northwest National Laboratory, Richland, Washington.

Gensym. 2003. *G2 Dynamic Model Version 3.0 (G2 Bundle, Version 6.2)*. Gensym Corporation, 52 Second Avenue, Burlington, Massachusetts.

Ihaka R and Gentleman R. 1996. "R: A Language for Data Analysis and Graphics," *Journal of Computational and Graphical Statistics*, 5, 299-314.

Kim DS et al. 1995. "Effects of Crystallization on the Chemical Durability of Nuclear Waste Glasses," *Ceram. Trans.*, Vol. 61, pp 177-185. American Ceramic Society, Westerville, Ohio, USA.

Kim DS, and Vienna JD. 2002. *Model for TCLP Releases from Waste Glasses*, PNNL-14061, Rev 0. Battelle Pacific Northwest Division, Richland, Washington.

Kirkbride RA, Allen GK, Higley BA, Hohl TM, Lambert SL, and others. 2002. *Tank Farm Contractor Operations and Utilization Plan,* HNF-SD-WM-SP-012, Rev 4A. CH2M Hill Hanford Group, Inc., Richland, Washington.

Kot WK and Pegg IL. 2001. *Glass Formulation and Testing with RPP-WTP HLW Simulants*, Final Report, VSL-01R2540-2, Rev 0. Vitreous State Laboratory, The Catholic University of America, Washington, DC.

Kot WK, Klatt K, Hao G, Pegg IL, Cooley SK, Bates DJ, and Piepel GF. 2004a. *Regulatory Testing of WTP HLW Glasses for Compliance with Delisting Requirements, Final Report,* VSL-03R3780-1, Rev 1. Vitreous State Laboratory and Battelle Pacific Northwest Division for Bechtel National, Inc., Richland, Washington.

Kot WK, Klatt K, Hao G, Pegg IL, Cooley SK, Bates DJ, and Piepel GF. 2004b. *Regulatory Testing of RPP-WTP HLW Glasses to Support Delisting Compliance, Final Report*, VSL-04R4780-1, Rev. 0. Vitreous State Laboratory and Battelle Pacific Northwest Division for Bechtel National, Inc., Richland, Washington. (Supplement 4 to this petition)

Lambert SL, Stegen GE, and Vienna JD. 1996. *Tank Waste Remediation System Phase I High-Level Waste Feed Processability Assessment Report*, WHC-SD-WM-TI-768. Westinghouse Hanford Company and Battelle Pacific Northwest Division, Richland, Washington.

Lide DR 2003. *Handbook of Chemistry and Physics*, 84th Edition, Chemical Rubber Company, Boca Raton, Florida.

Pickett JB and CM Jantzen. 2002. "TCLP Leaching Prediction from the "THERMO" Model for Borosilicate Glasses," *Ceramic Transactions* 132:323-333.

Piepel GF. 1999. *MIXSOFT–Software for the Design and Analysis of Mixture and Other Constrained Region Experiments*, User's Guide Version 2.4.1, MIXSOFT Mixture Experiment Software, Richland, Washington.

Piepel GF, Cooley SK, Gan H, Kot WK and Pegg IL. 2002. *Summary Report: Test Matrix to Support TCLP Model Development for RPP-WTP HLW Glasses*, 24590-101-TSA-W000-0009-105-02A, VSL-012S7800-1, Rev 0. Battelle Pacific Northwest Division, Richland, Washington, and Vitreous State Laboratory, The Catholic University of America, Washington, DC.

Riley BJ et al. 2001. *Impact of HLW Glass Crystallinity on the PCT Response*, PNNL-13491. Pacific Northwest National Laboratory, Richland, Washington, USA.

Schreiber HD and Hockman AL. 1987. "Redox Chemistry in Candidate Glasses for Nuclear Waste Immobilization," in *Journal of American Ceramic Society*, 70 [8], pp 591-594.

Vienna JD, Thimpke RP, Piepel GF, Smith DE, Elliott ML, Nakaoka RK, and Veazey GW. 1998. *Glass Development for Treatment of LANL Evaporator Bottoms Waste*, PNNL-11865, Pacific Northwest National Laboratory, Richland, WA.

VSL. 2002. *Crucible Melts*, Technical Procedure TPC-CM, Rev 1. Vitreous State Laboratory, The Catholic University of America, Washington, DC.

Welch WJ. 1987. *ACED, Algorithms for the Construction of Experimental Designs*, Users Guide Version 1.6.1, University of Waterloo, Waterloo, Ontario, Canada.

Wiemers KD, Meier K, Miller M, and Lerchen ME. 1998. *Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project*, PNNL-12040, Rev 0. Pacific Northwest National Laboratory, Richland, Washington.

WVNS. 1996. *Waste Form Qualification Report (WQR) for the West Valley Demonstration Project*, WVDP-186, Revision 2. West Valley Nuclear Services Company, West Valley, New York.

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6 Groundwater Monitoring [Part 6] 6-1

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6 Groundwater Monitoring [Part 6]

Groundwater monitoring will not be performed as part of the conditions of this petition.

The EPA's framework for delisting petitions (Appendix A) postulates four different land-based waste management scenarios that may require groundwater monitoring. None of them apply to the waste being petitioned. In particular, the petitioned waste has not yet been generated.

Any decision regarding whether groundwater monitoring is required for the National Geologic Repository (the planned final disposition of the petitioned waste) will be made by DOE with the concurrence of EPA and the NRC. Those decisions are outside the scope of this petition.

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APPENDIX A

FRAMEWORK FOR DELISTING PETITIONS

http://www.epa.gov/earth1r6/6pd/rcra_c/pd-o/delist3c.pdf

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APPENDIX A
FRAMEWORK FOR DELISTING PETITIONS

EPA DELISTING PETITION FRAMEWORK

PART 1: DELISTING ADMINISTRATIVE INFORMATION

1. Name of Petitioner.

   a. Name of individual or firm sending petition:

   _____

   b. Mailing address of individual or firm:

   Street/P.O. Box: _____

   City: _____

   State: _____ Zip Code: _____

   Telephone No.

   Fax No. _____

2. People to Contact for Additional Information Pertaining to this Petition.

   a.

Name	Title	Telephone No.
		( )
		( )
		( )

   b. Mailing address of contact(s) if different from petitioner.

   Street/P.O. Box: _____

   City: _____

   State: _____ Zip Code: _____

3. Facility Responsible for Generating Petitioned Waste.

a. Name of facility: _____

b. Location of facility:

Street: _____

City: _____

State: _____ Zip Code: _____

c. RCRA ID number: _____

4. Location of Petitioned Waste.

Same as facility name and address given in item 3;

or

a. Name of facility: _____

b. Location of facility:

Street: _____

City: _____
State: _____ Zip Code: _____

c. RCRA ID number: _____

5. Describe the proposed delisting action.

6. Provide a statement of the need and justification for the proposed action.

7. Signed Certification Statement.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that,

based on my inquiry of those individuals immediately responsible for getting the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for sending false information, including the possibility of fine and imprisonment.

Signed by Authorized Representative*,

_____

Typed Name: _____

Title: _____

*Note: An "authorized representative" is a person responsible for the overall operation of a facility or an operational unit (i.e., part of a facility), for example, a plant manager, superintendent, or person of equivalent responsibility. Consultants or other outside parties should not sign the certification statement.

PART 2: DELISTING WASTE AND WASTE MANAGEMENT INFORMATION

BASIS FOR THE WASTE LISTING

1. Which of the following scenarios best describes the petitioned waste? (Choose the most appropriate scenario and provide the information requested for the chosen scenario.)

   a. Petitioned waste is not a mixture of two or more listed hazardous wastes.

      Common name of petitioned waste: _____

      EPA Hazardous Waste Number: _____

      Hazardous waste description: _____

   b. Petitioned waste is a mixture of two or more listed hazardous wastes.

      Common name of mixture: _____

      For all listed wastes provide:

      EPA Hazardous Waste Number: _____

      Hazardous waste description: _____

      Common name: _____

   c. Petitioned waste is a mixture of one or more solid non-hazardous wastes and one or more listed hazardous wastes, as described in 40 CFR §261.3(a)(2)(iii-iv).

      Common name of mixture: _____

      Solid waste(s) common name(s): _____

For all listed wastes provide:

EPA Hazardous
Waste Number: _____

Hazardous waste
description: _____

Common name: _____

d. Petitioned waste is generated from the treatment, storage, or disposal of one or more listed hazardous wastes (or solid non-hazardous and listed hazardous waste mixture), as described in 40 CFR §261.3(c)(2)(i).

Description of
petitioned waste: _____

Common name of
petitioned waste: _____

Solid waste(s)
common name(s): _____

For all listed wastes provide:

EPA Hazardous
Waste Number: _____

Hazardous waste
description: _____
Common name: _____

2. Describe the physical form of the petitioned waste (e.g., solid, liquid).

3. If the physical form is sludge or liquid, estimate based on waste analysis the percentage of solids (e.g., provide a range).

HISTORY OF WASTE GENERATION

4. Which of the following describes the generation of the

petitioned waste: (Indicate those that apply and provide the information requested for each item.)

a. Waste has been generated in the past.

Provide the year when waste was first generated: _____

Provide the year when waste generation ended (if applicable): _____

b. Waste is presently being generated.

Provide the year when waste was first generated: _____

c. Waste will be generated in the future.

VOLUME OF PETITIONED WASTE

5. Is the petition for a waste of fixed quantity (e.g., a discrete volume of waste contained in a unit)?

Yes **[Answer item 5a]**
No **[Answer item 5b]**

a. Petitioned waste is/will be a fixed quantity.

Estimated volume: _____ _____
Quantity Unit of measurement

Describe the method of volume estimation.

b. Petitioned waste is/will be generated on a routine or continuous basis.

	Average Quantity	Maximum Quantity	Unit of Measurement
Monthly Volume	_____	_____	_____
Annual Volume	_____	_____	_____

Describe the method of volume estimation.

HISTORY OF WASTE MANAGEMENT

6. As appropriate, describe the present, past, and proposed waste management methods for the petitioned waste.

a. Present waste management methods, and off-site facility or facilities used (name, address, and waste management method).

b. Past waste management methods, if different from present, and off-site facility or facilities used (name, address, and waste management method).

c. Proposed waste management methods if delisting petition is granted, and off-site facility or facilities to be used (name, address, and waste management method).

PART 3: DELISTING PROCESS INFORMATION

GENERAL OPERATIONS AT THE GENERATING FACILITY

1. Describe facility business area(s) and operations. Include SIC code(s).

   SIC .)2)2)2)-: _____

   _____

   SIC .)2)2)2)-: _____

   _____

2. List and describe products manufactured at the facility.

3. List and describe all wastes (including all hazardous wastes) generated at the facility.

4. Describe your manufacturing and waste treatment areas and waste management units. Attach schematics showing the layout of the facility.

5. Describe the regulatory status of all on-site waste treatment, storage, and disposal units. Include a list of all hazardous waste permits and other permits issued under Federal and State environmental statutes. Include the permit numbers in this list.

CONTRIBUTING MANUFACTURING PROCESSES

6. Describe and include schematics of all "pre-process" steps used to prepare materials for processing before primary manufacturing operations, including surface and equipment preparation operations. Identify all pre-process material inputs and outputs in your descriptions and schematics.

7. Provide a step-by-step description and schematic of each manufacturing process contributing to the petitioned waste.

Include each process step, reactions occurring, flow rates, and material inputs and outputs, as well as reaction intermediates and byproducts. Identify and describe waste inputs and outputs on the schematic(s) and show how each waste is managed.

8. Describe, and identify on the schematic, exactly where the petitioned waste is generated (if generated by a manufacturing process).

9. List and describe all process equipment, including the function of each unit and the ranges of the operating parameters.

10. Describe all of your operating cycles (batch cycles, versus continuous operation, start-up, shut-down, maintenance, cleaning) on a daily, weekly, or other period basis, as appropriate. Identify periods when process wastes are not generated (e.g., plant shutdowns or routine equipment maintenance).

11. Assess the extent that all contributing manufacturing processes, operations, process materials, or generated wastes have varied in the past or may vary in the future.

12. Describe how the composition and generation rate of the petitioned waste may periodically vary due to any aspect of manufacturing process variability.

13. Does a waste treatment process contribute to the petitioned waste?

    Yes **[Continue with item 14]**
    No **[Skip to item 22]**

CONTRIBUTING WASTE TREATMENT PROCESSES

14. Provide a step-by-step description and schematic of each

waste treatment process contributing to the petitioned waste. Include process steps, reactions occurring, flow rates, material inputs, and waste inputs and outputs.

15. Describe, and identify on the schematic, exactly where the petitioned waste is generated (if applicable).

16. Identify and describe waste inputs and outputs on the schematic(s) and show how each waste is managed.

17. Describe all non-process wastes entering the waste treatment processes, including composition, rate of inputs, and source.

18. List and describe all process equipment, including the function of each unit and the ranges of the operating parameters.

19. Describe all of your operating cycles (batch cycles versus continuous operation, start-up, shut-down, maintenance, cleaning) on a daily, weekly, or other period basis, as appropriate. Identify periods when treatment wastes are not generated (e.g., plant shutdowns or routine equipment maintenance).

20. Assess the extent that all contributing treatment processes, operations, process materials, or generated wastes have varied in the past or may vary in the future.

21. Describe how the composition and generation rate of the petitioned waste may periodically vary due to any aspect of treatment process variability.

22. Has the petitioned waste been managed in a land-based unit?

    Yes **[Continue with item 23]**

No **[Skip to item 25]**

WASTE MANAGEMENT OPERATIONS

23. Provide the following information (items 23a through 23g) for each unit that is (or was) used to manage the petitioned waste:

    (If the petitioned waste is managed in more than one unit, assign a number to each unit (e.g., Unit #1, Unit #2, etc.) and use the unit numbers to associate a description with a specific unit.)

    a. Unit location/address (show if on- or off-site).

    b. Description of unit construction (current design and materials).

    c. History of unit design (e.g., chronological summary of any changes to original construction).

    d. Purpose and description of any unit design and operating changes.

    e. Estimated surface area.

    f. Estimated unit capacity volume.

    g. Listing of waste and material inputs which have occurred throughout the life of the unit, if known.

24. Provide detailed schematic(s) of the waste unit(s) showing (as appropriate) unit dimensions, influent point(s), effluent point(s), and waste thickness.

PROCESS MATERIALS

25. List all materials used in the operations that contribute

to the petitioned waste. The list should include:

a. The name of the material(s).

b. The process/operation in which it is used (i.e., manufacturing process, treatment process, waste management operations).

c. Function of each material in the process.

d. Approximate annual quantities used.

26. Provide Material Safety Data Sheets (MSDS) and any other compositional information for trade name and non-elemental materials. Include raw materials, cleaners, oils, solvents, strippers and any by-products generated by the process

27. Specify the source, quality (i.e., recycled or virgin), and quantity of oil, grease, and hydraulic fluids entering the processes.

SPECIAL INFORMATION

28. Are you requesting an upfront exclusion for a waste that is not currently generated but will be in the future?

    Yes **[Continue with item 29]**

    No **[Skip to item 32]**

29. Explain how the bench-scale or pilot-scale process demonstration adequately models the proposed full-scale process.

30. Explain any real or potential differences between the two processes.

31. Describe the impact of those differences on the character

of the petitioned waste.

32. Are you requesting an exclusion for a waste generated by a multiple waste treatment facility (MWTF)?

    Yes **[Continue with item 33]**

    No **[Skip to Part 4]**

33. Describe your procedure for prescreening clients and wastes and how this procedure will be carried outed should your waste be excluded.

34. Describe the procedures by which you will make sure that: (1) treatment levels needed by an exclusion are maintained and (2) a hazardous waste is not disposed improperly as non-hazardous.

PART 4: DELISTING ANALYTICAL PLAN DEVELOPMENT

1. Provide a complete list of the constituents and parameters of concern identified for your petitioned waste based on appropriate waste constituent analyses and the results of an engineering analysis. Identify those constituents quantitated by laboratory analysis and those quantitated using mass balance demonstrations.

2. Provide mass balance demonstrations for those constituents of concern in your list for which analyses were not conducted. Provide all calculations and assumptions.

3. Explain why any other delisting constituent of concern is not on the constituent of concern list for your petitioned waste.

4. Explain why your petitioned waste does not exhibit any hazardous waste characteristic for which analysis was not conducted.

PART 5: DELISTING SAMPLE AND ANALYSIS INFORMATION

1. Has a draft sampling and analysis plan been submitted to EPA for review before petition preparation?

   Yes **[Answer items 1a and 1b]**
   No **[Skip to item 2]**

   a. Submittal date of sampling and analysis plan __/__/__

   b. Log number assigned by EPA to your draft submittal _____

WASTE SAMPLING INFORMATION

2. Were all sampling-related activities performed by in-house staff?

   No **[Answer items 2a and 2b]**
   Yes **[Answer item 2b]**

   a. Name and address of the organization(s) or company(s) responsible for designing the sampling strategy and collecting the samples.

   Name _____
   Street _____

   City _____ State _____ Zip _____
   Telephone (___)_____

   b. For each individual person (in-house and otherwise) who designed the sampling plan, the quality control plan, and/or participated in sample collection, please provide a resume of qualifications and the following information:

   Name _____

   Affiliation _____

   Title _____

SAMPLING STRATEGY

3. Provide the following information (items 3a through 3f) on the sampling strategy you followed to make sure that the samples were representative.

   a. Identify which process point discharges, containment areas (e.g., lagoons), or other areas (e.g., soil) were sampled and why these areas were selected for sample collection.

   b. Describe the techniques and guidelines used to select waste sampling points (e.g., random sampling procedure or fixed transect and offset sampling procedure).

   c. Describe the sampling and subsampling (i.e., transferring of sample aliquots into containers specific to certain analyses) procedures used during the sample collection process, including the particular days and times selected for sample collection, the number of grab samples collected for each composite sample, and why these procedures were used.

   d. Describe the sampling devices used for sample collection and the basis for selecting the devices.

   e. Identify and discuss any deviations from your original sampling plan and strategy and the impact of these deviations on waste characterization.

   f. Explain why you believe the samples collected are non-biased and sufficiently represent the petitioned waste. In this explanation, fully address the potential for waste uniformity or spatial and temporal variability and how the strategy ensured collection of representative samples.

SAMPLE SPECIFIC INFORMATION

4. How many samples of the petitioned waste were collected?

   Is the number of samples taken different from the number of samples agreed upon during the pre-petition scoping meeting?
   Explain the deviation.

5. For each individual sample collected, please provide the following sample-specific information (items 5a through 5g).
   a. For each sample included in item 4, provide the sample identification number (as it appears in your field logbook and other records), the date that the sample was taken, an indication as to what type of sample it is (waste sample versus quality control sample and whether or not it is a composite sample).

   b. Describe how each sample was collected, and its point of collection from the petitioned waste. If a sample is a composite of grabs, provide the number of grab samples collected for the composite sample, the sampling location for each grab sample, the volume of each grab sample, and the volume of the composite sample.

   c. Describe the general sampling location (e.g., which quadrant of a surface impoundment) and the specific sampling points (e.g., specific location in the quadrant). You may refer to numbered sampling points shown in a diagram.

   d. Describe how each sample was composited (e.g., equipment used and manner of mixing).

   e. Provide a physical description of each sample at time of collection (e.g., color, odor, whether phase separation occurred soon after collection).

   f. For each composite sample, specify the time and date when the grab samples were collected and the time and date when the sample was composited, as applicable.

   g. Describe the handling and preparation techniques used for each sample (including types of containers used and techniques employed for container preparation) and types and amounts of preservatives used.

OTHER GENERAL INFORMATION

6. Describe the weather conditions during sampling (if conducted outdoors).

7. Describe any facility activities separate from sampling

that occurred at the same time and might have affected sample representativeness.

8. Describe sampling device decontamination; and note when disposable devices were used for sample collection.

Sample Identification Number	Date Sample Was Taken	Type of Sample [Mark one box only] Waste Sample	Quality Control Sample	Composite Sample Yes	No
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G
		G	G	G	G

9. Were the chain-of-custody procedures specified in SW-846 followed?

   Yes **[Skip to item 11]**
   No **[Continue with item 10]**

10. Provide a description of the quality control procedures and documentation system used to track sample location and maintain sample integrity during transportation to the laboratory. Copies of the chain-of-custody forms may be provided, but are not needed.

LOCALIZED AREA OF CONTAMINATION

11. Have you collected samples to characterize a localized area of contamination (a "hot spot") within the petitioned waste?

    Yes **[Continue with item 12]**
    No **[Skip to item 16]**

12. Discuss your basis for believing a hot spot may or does exist (e.g., records of a one-time discharge of a concentrated material at a specific location).

13. Describe the known or predicted location (on a diagram) and the dimensions (e.g., depth, width and length) of the hot spot.

14. Identify the samples specifically collected to characterize the hot spot.

15. Explain why the samples sufficiently represent the hot spot.

MULTIPLE WASTE TREATMENT FACILITY

16. Have you collected samples to characterize a waste generated by a multiple waste treatment facility (MWTF)?

    Yes **[Continue with item 17]**
    No **[Skip to item 21]**

17. List and describe the untreated wastes that were treated and are represented by the treatment residue samples collected during the sampling period.

18. Provide the percentage of total wastes treated annually that was represented by the sampling period.

19. List and briefly describe the untreated wastes that also are treated at the facility but were not represented by the sampling period.

20. Explain why the wastes not represented by the sampling

period are not expected to contain any other hazardous constituents of concern, different levels of constituents of concern, or other different characteristics than that represented by the sampling period.

WASTE ANALYSIS INFORMATION

21. Was sample analyses done by in-house staff?

No **[Answer items 21a and 21b]**
Yes **[Answer item 21b]**

a. Name and address of the organization(s) or company(s) responsible for sample analyses.

Name _____
Street _____

City _____State_____Zip Code_____

Telephone ( ) _____

b. For each individual person (in-house and otherwise) who conducted analyses or was responsible for data reduction, validation, and laboratory quality control, please provide a resume of qualifications and the following information:

Name _____

Affiliation _____

Title _____

22. Provide your signed laboratory data reporting forms from all analyses, including results from quality control analyses.

23. Provide the following information on each sample and each analysis.

a. Sample identification numbers as logged during collection and as assigned by the laboratory.

b. Type of sample (e.g., waste sample, waste sample

replicate, equipment blank, field blank).

c. Date of sample receipt by the laboratory.

d. The sample workup or preparation method and reference for the method (e.g., SW-846 Method 3500).

e. The date of sample workup or preparation.

f. The name of the person conducting the analysis.

g. The date of extraction and analysis.

h. The test method used and the source of the test method (e.g., SW-846 Method 8020).

i. The specific constituent, parameter, or hazard for which analysis was conducted.

j. The test results, expressed in appropriate units (e.g., mg/L, mg/kg).

k. The basis for the analysis (e.g., wet/dry weight).

l. The quantitation limits.

24. Provide the names and model numbers of all equipment used during analysis.

25. Provide all other information necessary to fully interpret the test procedures or results.

26. For each quality control analysis that involved a matrix or a surrogate spike and spike duplicate analysis, provide the following information.

a. The name of the spike analyte added.

b. The concentration of the spike analyte in the unspiked

sample.

c. The amount of the spike analyte added.

d. The measured amount of the spike in both spiked samples.

e. The calculated percent recovery of the spike and method of calculation.

f. The acceptance criterion for recovery of each matrix spike.

g. The relative percent difference (RPD) between the duplicate results.

h. The acceptance criterion for the RPD.

27. Identify whether the waste analytical data was corrected based on quality control results (e.g., blank analysis) and explain how the correction was made.

28. Explain any inconsistencies or deviations found in the reported analytical results. The discussion should include any observed analytical interferences and what actions were taken to resolve the problems.

29. If any calculations are necessary, (i.e., in use of the Oily Waste Extraction Procedure, for the Mobile Metal Concentration) please include all calculation sheets

PART 6: DELISTING GROUNDWATER MONITORING INFORMATION

1. Show which of the following describes the management of the petitioned waste.

   a. The petitioned waste is currently managed in a land-based waste management unit (on-site or off-site), and ground-water monitoring is needed under 40 CFR Part 264 or 265 or authorized State equivalent, or other Federal, state, or local requirements; or if ground-water monitoring information is otherwise available for the unit.
   [Go to item 2]

   b. The petitioned waste was once managed (but is no longer) in a land-based waste management unit (on-site or off-site) and ground-water monitoring was needed under 40 CFR Part 264 or 265 or authorized State equivalent, or other Federal, state, or local requirements; or if ground-water monitoring information is otherwise available for the unit.
   [Go to item 2]

   c. The petitioned waste is currently managed, or was once managed, in a land-based waste management unit, but ground-water monitoring requirement has been waived.
   [Go to item 9]

   d. The petitioned waste is currently managed, or was once managed, in one or more land-based waste management units containing also significant amounts of other wastes, and you consider ground-water data from these non-dedicated units are immaterial in evaluating the petitioned waste's impact on ground-water quality.
   [Go to item 10]

   e. None of the above management scenarios apply.
   [Go to item 11]

2. Has the appropriate responsible party previously submitted ground-water monitoring information for the subject units to an EPA Regional office or an authorized State in response to 40 CFR Part 264 or 265 requirements (or authorized State equivalent)?

   Yes **[Continue with item 3]**

No **[Skip to item 5]**

3. Do you wish that we directly get the ground-water monitoring information from the EPA Region or State?

   Yes **[Complete item 4 and continue with item 6]**
   No **[Skip to item 5]**

4. Indicate the EPA Regional or State contact for getting the ground-water monitoring information (include name of contact, affiliation, mailing address, and phone number).

   a. Name of contact: _____

   b. Affiliation: _____
   c. Title of report (if applicable): _____
   d. Street/P.O. Box: _____

   City: _____
   State: _____ Zip Code: _____

   e. Phone: ( ) _____

5. Provide all available and relevant (e.g., for each unit used to manage the petitioned waste) ground-water monitoring information and reports which, at a minimum, should include:

   a. A description of site geology and hydrology.

   b. A description of the ground-water monitoring systems for the units in which the petitioned waste is (or was) managed.

   c. The results obtained from the analysis of ground-water samples.

   d. A discussion of sampling and analytical procedures followed in getting and analyzing the ground-water samples.

   e. Any additional information necessary to characterize the petitioned waste's impact on ground-water quality.

f. An analysis and discussion of whether the above-listed information and data that show contamination of the ground-water is attributable to the petitioned waste.

6. Is the unsaturated (vadose) zone monitored at any of the subject units?

   Yes **[Continue with item 7]**
   No **[Skip to item 8]**

7. Provide the following information on vadose zone monitoring (e.g., lysimeter information) in as much detail as possible (as requested for ground-water monitoring systems).

   a. A description of regional, local, and unit-specific geology and hydrology, and soil characteristics.

   b. A description of the monitoring system(s) (e.g., design and construction).

   c. A description of the sampling and analytical procedures followed.

   d. Analytical and QC data obtained from sample analysis.

   e. An interpretation of the information and data presented.

8. Discuss whether ground-water contamination exists on the site and, if it does, identify the source. If the source is not the petitioned waste, explain, with supporting information, why the petitioned waste has not contributed to the contamination.

9. Provide documentation on the waiver or exemption of ground-water monitoring at the land-based waste management unit containing the petitioned waste.

10. Identify the units in question, provide estimates of the relative volumes of the petitioned and other wastes disposed in the units, and discuss in detail why you consider ground-water data from these non-dedicated units are immaterial in evaluating the petitioned waste's impact on ground-water quality.

11. Describe why ground-water monitoring is not needed for your petitioned waste.

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APPENDIX B

MATERIAL SAFETY DATA SHEETS

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APPENDIX B
MATERIAL SAFETY DATA SHEETS

Material Safety Data Sheets for the following glass formers are included in this appendix:

Kyanite ($Al_2O_3 \cdot SiO_2$) B-1
Alumina (Al_2O_3) B-5
Boric Acid (H_3BO_3) B-12
10M Borax ($Na_2B_4O_7 \cdot 10H_2O$) B-16
Na_2CO_3 (Anhydrous) B-20
Wollastonite ($CaSiO_3$) B-25
Fe_2O_3 ..... B-30
Li_2CO_3 ..... B-32
Olivine B-41
SiO_2 ..... B-47
Rutile (TiO_2/Fe_2O_3) B-54
ZnO B-61
$ZrSiO_4$ B-65
Sugar B-68

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Kyanite ($Al_2O_3 \cdot SiO_2$)

MSDS

Material Safety Data Sheet

Kyanite Mining Corporation
Material Safety Data Sheet #0001

Revised: August 1, 2003
Printed: August 1, 2003

Page 1 of 4 . . .

Kyanite

NFPA Rating: Health 3 Flammability: 0 Reactivity: 0 Pers. Protection E

SECTION 1: PRODUCT IDENTIFICATION

Trade Name: Kyanite
Chemical Name: Aluminum Silicate
Chemical Forumula: $3Al_2O_3$ $3SiO_2$ **Molecular Weight:** 486.15
Synonyms: Cyanite, Disthene, Rhoetizite
CASRN: 1302-76-7

Technical Contact:	Telephone Number:	Emergency Telephone Number:
Bill Kerber	(434) 983-2085	(434) 983-2043

SECTION 2: HAZARDOUS COMPOSITION

CHEMICAL:	CAS NO:	RATIO (%):
Alumina*	1344-28-1	54 - 61%
Silica, Free Crystalline	14808-60-7	2.2% **

**This component is listed by EPCRA Section 313*
***This is a typical percentage of naturally occurring free crystalline silica*

SECTION 3: HEALTH HAZARD DATA

Crystalline Silica	**OSHA TWA:**	Respirable	$10 mg/m^3$ / % SiO_2 + 2

Page 2 . . .

SECTION 3: HEALTH HAZARD DATA (continued)

Crystalline Silica	**OSHA TWA:**	Total Dust	$\frac{30\ mg/m^3}{\%\ SiO_2 + 2}$
Cristobalite	**OSHA TWA:**	1/2 the value from the mass formlae for quartz	
Alumina	**OSHA TWA:**	10 mg/m^3 as Dust	

ROUTES OF EXPOSURE:

Inhalation	Y	**Dermal**	N	**Oral**	Y

SKIN AND EYE CONTACT: Contact with dust can cause irritation

INHALATION: Health hazards can occur from excessive inhalation to silica dust
Smoking can increase the risk of injury

CHRONIC EFFECTS: Exposure to crystalline silica may cause silicosis or pneumoconiosis
Respiratory infections due to silicosis can progress with continued exposure and advanced age

SIGNS AND SYMPTOMS OF EXPOSURE: Symptoms of silicosis are usually delayed

CARCINOGEN LISTING: This material and / or components of the material are listed by the IARC and the NTP as a carcinogen
This product is listed by the State of California as a carcinogen

SPECIAL PRECAUTIONS: This product contains crystalline silica; a chemical known to the State of California to cause cancer

SECTION 4: FIRST AID MEASURES

SKIN AND EYE CONTACT:

EYES:	Never rub eyes if exposed to dust Flush immediately with liberal amounts of water for at least 15 mins. Consult a physician if irritation persists
SKIN:	Wash with soap and water
INHALATION:	Remove victim to fresh air Consult a physician if irritation persists
ORAL INGESTION:	Consult a physician immediately

SECTION 5: FIRE FIGHTING MEASURES

Flash Point:	N/AP	**Test Method:**	N/AP
Lower Flammable Limit:	N/AP	**Upper Flammable Limit:**	N/AP

Page 3...

RECOMMENDED EXTINGUISHING MEDIA:	Any type or style extinguisher
USUAL FIRE AND EXPLOSION HAZARDS:	This mineral is non-combustible Extinguishing apparatus in the surrounding area is useable and sufficient Non-flammable
SPECIAL FIRE FIGHTING PROCEDURES:	No special procedures required

SECTION 6: ACCIDENTAL RELEASE MEASURES

It is recommended that a NIOSH approved N95 particulate respirator be worn at all times when visible dust is present either during product installation, removal or accidental releases

SECTION 7: HANDLING AND STORAGE

Use with adequate general and local ventilation
Notify safety personnel of major breakage, spill, wastes, etc.

SECTION 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

VENTILATION REQUIREMENTS:	Use adequate, general and local systems for ventilation
PERSONAL PROTECTIVE EQUIPMENT	
EYE PROTECTION:	It is recommended that workers wear safety glasses / goggles when handling the raw material
SKIN PROTECTION:	It is recommended that workers wear appropriate clothing and gloves when handling the raw material
RESPIRATORY PROTECTION:	A NIOSH approved N95 particulate respirator should be worn at all times

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE:	Solid Mineral
ODOR:	None
APPEARANCE:	Vitreous to pearly - greyish color
pH:	N/AP
BOILING POINT:	N/AP
MELTING POINT:	P.C.E. 36-37
SOLUBILITY IN WATER:	Insoluble
SPECIFIC GRAVITY:	3.5 - 3.7
EVAPORATION RATE:	N/AP
VAPOR DENSITY:	N/AP
VAPOR PRESSURE:	N/AP

Page 4 . . .

SECTION 10: STABILITY AND REACTIVITY

NORMALLY STABLE:	Highly stable under ordinary conditions and in itself non-toxic
INCOMPATIBLE MATERIALS:	None
HAZARDOUS DECOMPOSITION PRODUCTS:	In high temperature, quartz can change crystal structure to form cristobalite (>1470°C) and has greater health hazards than quartz
HAZARDOUS POLYMERIZATION:	There are no repeating structural units of the original molecules Hazardous polymerization will not occur

SECTION 11: TOXICOLOGICAL INFORMATION

TEST TYPE:	RESULT TYPE:	ANIMAL SPECIES:	HAZARD RANK:
N/D	N/D	N/D	N/D

SECTION 12: ECOLOGICAL INFORMATION

N/D

SECTION 13: DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Dispose of product in accordance with applicable federal, state and local regulations
Use waste containers suitable for transportation and disposal in accordance with federal, state and local regulations

SECTION 14: TRANSPORTATION INFORMATION

DOT HAZARD CLASS:	N/AP
DOT HAZARDOUS MATERIALS:	N/AP

SECTION 15: REGULATORY INFORMATION

In the event of a spill, containerize the material in accordance with all Federal, State and Local regulations.
Follow all Federal, State and Local regulations for waste disposal.
Follow all applicable SARA Title III reporting guidelines for this product.

SECTION 16: OTHER INFORMATION

The information and recommendations contained herein are based upon data believed to be correct. However, no guaranty or warranty of any kind, expressed or implied, is made with respect to the information contained herein.

This information is solely for your consideration and interpretation.

Alumina (Al_2O_3)

Alcoa Inc. ALCOA

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/14/2003 Reviewed on 04/14/2003

* 1 Chemical Product and Company Identification

· **Product Name: CALCINED ALUMINA** 151
Ground, unground, superground, jet milled and dispersable

· **Other Designations:**
All A-, APC-, IS-, P- and RG-grades (except those produced by Alcoa Chemie), CL-3000, CL-3500, CTC-50, E-40, Enriched 5359, Fusion Grade 5116, Grade A Special, Metallurgical Grade 5115, Mixed Phase Coarse, Mixed Phase Fines, OF-2000, NA-WRA, PCT, Refractory Grade, Smelter Grade Alumina, Special Catalytic, SGA, SRP-A-2, SRP-A-5, SRP-A-20, SRP-A-22, SRP-A-30, SRP-A-32, SRP-A-66, SRP-A-67, SRP-A-68, SRP-A-71, SRP-A-74, SRP-A-90E, and Wear Grades.

· **Application of the substance / the preparation**
Refractory
Absorbent
Preparation of ceramic parts and coatings

· **Manufacturer/Supplier:**

Alcoa World Alumina LLC
201 Isabella Street
Pittsburgh, PA 15212-5858 USA
Health & Safety: +1-412-553-4649

· **Emergency Information:** USA: Chemtrec: +1-703-527-3887 +1-800-424-9300 ALCOA: +1-412-553-4001

* 2 Composition/Data on components:

· **Chemical characterization**

· CAS No:	Component	
1344-28-1	Aluminum oxide (non fibrous)	>98.6%

* 3 Hazards identification

· **EMERGENCY OVERVIEW:** Non-combustible.
· **EYES:** Can cause mild irritation.
· **SKIN:** Can cause mild irritation.
· **INHALATION:** Can cause mild upper respiratory tract irritation.
· **INGESTION:** Can cause mild irritation.
· **Chemical ingredient and possible processing hazards:**

Alumina: Low health risk by inhalation. Generally considered to be biologically inert.

· **Hazard description:**
· **Medical conditions aggravated by exposure to the product:**
Asthma, chronic lung disease, and skin rashes.
· **Information pertaining to particular dangers for man and environment** See item 11.
· **Classification system**
The classification was made according to the latest editions of the EU-lists, and expanded upon from company and literature data.

* 4 First aid measures

· **After inhalation**
Remove to fresh air.
Check for clear airway, breathing, and presence of pulse.

(Contd. on page 2)

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/14/2003 Reviewed on 04/14/2003

Product Name: CALCINED ALUMINA **151**
Ground, unground, superground, jet milled and dispersable

(Contd. from page 1)

Provide cardiopulmonary resuscitation for persons without pulse or respirations.
Consult a physician.
· **After skin contact**
Wash with soap and water for at least 15 minutes.
Consult a physician if irritation persists.
· **After eye contact**
Flush eyes with plenty of water for at least 15 minutes.
Consult a physician.
· **After swallowing**
Do not induce vomiting.
Never give anything by mouth to a convulsing or unconscious person.
If swallowed, dilute by drinking large amounts of water.
Consult a physician.

* 5 Fire fighting measures

· **Fire/Explosion Hazards:** Non-combustible.
· **Suitable extinguishing agents**
Use fire fighting methods and materials that are appropriate for surrounding fire.
· **Protective equipment:**
Fire fighters should wear NIOSH approved, positive pressure, self- contained breathing apparatus and full protective clothing when appropriate.

* 6 Accidental release measures

· **Person-related safety precautions:**

Wear protective clothing.

· **Measures for environmental protection:** No special measures required.
· **Measures for cleaning/collecting:** Clean up using dry procedures; avoid dusting.

* 7 Handling and storage

· **Handling**
· **Information for safe handling:**
Avoid contact with eyes and skin.
Avoid generating dust.
Provide adequate ventilation if dust is formed.
· **Information about protection against explosions and fires:** No special measures required.
· **Storage**
· **Requirements to be met by storerooms and receptacles:** Keep material dry.
· **Further information about storage conditions:** None.

* 8 Exposure controls and personal protection

· **Additional information about design of technical systems:**
Use with adequate ventilation to meet the limits listed in Section 8.

(Contd. on page 3)

USA

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/14/2003 Reviewed on 04/14/2003

Product Name: CALCINED ALUMINA **151**
Ground, unground, superground, jet milled and dispersable

(Contd. from page 2)

· **Components with limit values that require monitoring at the workplace:**

1344-28-1 Aluminum oxide (non fibrous)	
OSHA PEL	15*/5** mg/m³ *Total dust **Respirable fraction
ACGIH TLV	10 mg/m³ (e)

· **Personal protective equipment**
· **General protective and hygienic measures**
Avoid contact with the eyes and skin.
Do not inhale dust.
· **Breathing equipment:**
Use suitable respiratory protection in case of insufficient ventilation.
Suitable respiratory protective device recommended:
Filter NIOSH N95.
· **Protection of hands:** Wear appropriate gloves to avoid any skin injury.
· **Material of gloves** Strong gloves
· **Penetration time of glove material** Not applicable
· **Eye protection:** Safety glasses with full side shields or goggles recommended.

* 9 Physical and chemical properties:

· **General Information**	
Form:	Crystalline powder
Color:	White
Odor:	Characteristic
· **Change in condition**	
Melting point/Melting range:	2050°C (3722°F)
Boiling point/Boiling range:	Undetermined
· **Flash point:**	Not applicable
· **Auto igniting:**	Product is not self igniting.
· **Danger of explosion:**	Product does not present an explosion hazard.
· **Density at 20°C (68°F):**	3.6-3.9 g/cm³ 0.130-0.140 lb/in3
· **Bulk density at 20°C (68°F):**	770-1000 kg/m3 48.0-62.4 lb/ft3
· **Solubility in / Miscibility with Water:**	Insoluble
· **pH-value at 20°C (68°F):**	9.0-10 (100 g/l H2O)
· **Organic solvents:**	0.0 %
· **Solids content:**	100 %

*10 Stability and reactivity

· **Thermal decomposition / conditions to be avoided:**
Stable under normal conditions of use, storage, and transportation.
· **Materials to be avoided:**
· **Reactions:** Heating occurs when water is added.

(Contd. on page 4)

USA

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/14/2003 Reviewed on 04/14/2003

Product Name: CALCINED ALUMINA **151**
Ground, unground, superground, jet milled and dispersable

(Contd. from page 3)

· **Dangerous products of decomposition:** No dangerous decomposition products known.
· **Additional information:** Non-corrosive.

*11 Toxicological information

· **Primary irritant effect:**
· **On the skin:** Can cause mild irritation.
· **On the eye:** Can cause mild irritation.
· **Inhalation:** Can cause mild upper respiratory tract irritation.
· **Ingestion:** Can cause mild irritation.

*12 Ecological information:

· **Additional ecological information:**
· **General notes:** Generally not hazardous for water.

*13 Disposal considerations

· **Product:**
· **Recommendation** If reuse or recycling is not possible, material may be disposed of at an industrial landfill.
· **Uncleaned packagings:**
· **Recommendation:** Disposal must be made according to local or governmental regulations.

· **RCRA Status:**
Not federally regulated in the U.S. if disposed of "as is".
Otherwise, characterize in accordance with applicable regulations (40 CRF 261 or state equivalent in the U.S.).

*14 Transport information

· **DOT regulations:**	
· **Remarks:**	U.S.A. DOT: Not regulated - Enter the proper freight classification. "MSDS Number," and "Product Name" on the shipping paperwork. Canadian TDG Hazard Class & PIN: Not regulated.
· **Land transport ADR/RID (cross-border)**	
· **Remarks:**	Not regulated
· **Maritime transport IMDG:**	
· **Marine pollutant:**	No
· **Remarks:**	Not regulated
· **Air transport ICAO-TI and IATA-DGR:**	
· **Remarks:**	Not regulated

*15 Regulations

· **U.S. Federal Regulations:**
· **TSCA STATUS:** All components of this product are listed on the TSCA inventory.
· **CERCLA REPORTABLE QUANTITY:** None.

(Contd. on page 5)

USA

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/14/2003 Reviewed on 04/14/2003

Product Name: CALCINED ALUMINA **151**
Ground, unground, superground, jet milled and dispersable

(Contd. from page 4)

· **SARA TITLE III:**
Section 302 Extremely Hazardous Substances:
None.
· **Section 311/312 Hazardous Categories:** None.
· **Section 313 Toxic Categories:** None.
· **OTHER INFORMATION:**
In reference to Title VI of the Clean Air Act of 1990, this material does not contain nor was it manufactured using ozone-depleting chemicals.
· **International Regulations:**
· **CANADIAN DOMESTIC SUBSTANCES LIST:** All components of this product are listed on the Canadian DSL.
· **AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES:**
All components of this product are listed on the AICS.
· **Japan - Existing and New Chemical Substances (ENCS)**
All components of this product are listed on ENCS.

*16 Other information:

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Department issuing MSDS:**
Hazardous Materials Control Committee
Preparer: Jon N. Peace, +1-412-553-2293
Alcoa Inc., 201 Isabella Street, Pittsburgh, PA 15212-5858 USA
14 Apr 03 Supersedes 29 Mar 01
Replaces: MSDS 508
· **Alcoa MS #:** 103386
· **Appendix:**
- Guide to Occupational Exposure Values 2002, Compiled by the American Conference of Governmental Industrial Hygienists (ACGIH).
- Documentation of the Threshold Limit Values and Biological Exposure Indices, Sixth Edition, 1991, Compiled by the American Conference of Governmental Industrial Hygienists, Inc. (ACGIH).
- NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, June 1994.
- Dangerous Properties of Industrial Materials, Sax, N. Irving, Van Nostrand Reinhold Co., Inc., 1984.
- Patty's Industrial Hygiene and Toxicology: Volume II: Toxicology, 4th ed., 1994, Patty, F. A.; edited by Clayton, G. D. and Clayton, F. E.: New York: John Wiley & Sons, Inc.
- TOMES CPS(TM), MICROMEDEX, Inc., 2001
· **LEGEND:**

ACGIH	American Conference of Governmental Industrial Hygienists
AICS	Australian Inventory of Chemical Substances
CAS	Chemical Abstract Services
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPR	Cardio-pulmonary Resusitation
DOT	Department of Transportation
DSL	Domestic Substances List (Canada)
EINECS	European Inventory of Existing Commercial Chemical Substances
ENCS	Japan - Existing and New Chemical Substances
EWC	European Waste Catalogue
EPA	Environmental Protective Agency
IARC	International Agency for Research on Cancer
LC	Lethal Concentration
LD	Lethal Dose
MAK	Maximum Workplace Concentration (Germany) "maximale Arbeitsplatz-Konzentration"

(Contd. on page 6)

Material Safety Data Sheet

acc. to 91/155/EEC

Printing date 04/14/2003 Reviewed on 04/14/2003

Product Name: CALCINED ALUMINA **151**
Ground, unground, superground, jet milled and dispersable

(Contd. from page 5)

NDSL	Non-Domestic Substances List (Canada)
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
OEL	Occupational Exposure Limit
OSHA	Occupational Safety and Health Administration
PIN	Product Identification Number
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
STEL	Short Term Exposure Limit
TCLP	Toxic Chemicals Leachate Program
TDG	Transportation of Dangerous Goods
TLV	Threshold Limit Value
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average
WHMIS	Workplace Hazardous Materials Information System

m meter, cm centimeter, mm millimeter, in inch,
g gram, kg kilogram, lb pound, µg microgram,
ppm parts per million, ft feet

*** Data compared to the previous version altered.**

USA

CALCINED ALUMINA

⚠ WARNING

Hazards: Can cause mild irritation of eyes, skin, and upper respiratory tract.

Precautions: Avoid inhalation of dust. Use with adequate ventilation to meet exposure limits.

Use appropriate personal protective equipment (safety glasses/gloves) to avoid contact. Use suitable respiratory protective device (N95) in case of insufficient ventilation.

Fire Fighting: Product is non-combustible. Use fire fighting measures that suit the environment.

First Aid: EYES: Flush eyes with plenty of water for at least 15 minutes. Consult a physician. SKIN: Wash skin with soap and water for at least 15 minutes. Consult a physician if irritation persists. INHALATION: Remove to fresh air. Check for clear airway, breathing, and presence of pulse. Provide CPR for persons without pulse or respirations. Consult a physician. INGESTION: If swallowed, dilute by drinking large amounts of water. Never give anything by mouth to a convulsing or unconscious person. Do **not** induce vomiting. Consult a physician.

Accidental Release: Clean up using dry procedures; avoid dusting.

See Alcoa Material Safety Data Sheet No. 151 for more information about use and disposal.

Emergency Phone: (412) 553-4001.

INGREDIENTS:	CAS NUMBERS:
Aluminum oxide (non fibrous)	(1344-28-1)

Alcoa World Alumina LLC
201 Isabella Street, Pittsburgh PA 15212-5858 USA
04/03 151

ALCOA

Boric Acid (H_3BO_3)

20 MULE TEAM®

Optibor® Boric Acids

Material Safety Data Sheet
DATE OF ISSUE May 2000
Supersedes November 1999 Version

1 Chemical product and company identification

Product name: *Optibor*
Grade: Technical, NF, S.Q.
Product use: Industrial manufacturing
Chemical formula: H_3BO_3
Chemical name/synonyms: Boric acid, orthoboric acid, boracic acid
Chemical family: Inorganic borates
CAS registry number: 10043-35-3 (11113-50-1)
(Refer to Section 15 for TSCA/DSL chemical inventory listing)

MANUFACTURER:
U.S. Borax Inc.
26877 Tourney Road
Valencia, CA 91355-1847

EMERGENCY PHONE NUMBERS:
24 Hr. Medical Info. Service . . . (661) 284-5200
Chemtrec (Spills): . . . . . (800) 424-9300

2 Composition/information on ingredients

This product contains greater than 99 percent (%) boric acid (H_3BO_3), which is hazardous under the OSHA Hazard Communication Standard and under the Canadian Controlled Products Regulations of the Hazardous Products Act (WHMIS), based on animal chronic toxicity studies. Refer to Sections 3 and 11 for details on hazards.

3 Hazard identification

Emergency overview
Optibor is a white, odorless, powder substance that is not flammable, combustible, or explosive and has low acute oral and dermal toxicity.

Potential ecological effects
Large amounts of *Optibor* can be harmful to plants and other species. Therefore, releases to the environment should be minimized.

Potential health effects
Routes of exposure: Inhalation is the most significant route of exposure in occupational and other settings. Dermal exposure is not usually a concern because *Optibor* is poorly absorbed through intact skin.
Inhalation: Occasional mild irritation effects to the nose and throat may occur from inhalation of *Optibor* dust at levels greater than 10 mg/m^3.
Eye contact: *Optibor* is non-irritating to the eyes in normal industrial use.
Skin contact: *Optibor* does not cause irritation to intact skin.
Ingestion: Products containing *Optibor* are not intended for ingestion. *Optibor* has a low acute toxicity. Small amounts (e.g., a teaspoon) swallowed accidentally are not likely to cause effects; swallowing amounts larger than that may cause gastrointestinal symptoms.
Cancer: *Optibor* is not a known carcinogen.
Reproductive/developmental: Animal ingestion studies in several species, at high doses, indicate that borates cause reproductive and developmental effects. A human study of occupational exposure to borate dust showed no adverse effect on reproduction.
Target organs: No target organ has been identified in humans. High dose animal ingestion studies indicate the testes are the target organs in male animals.
Signs and symptoms of exposure: Symptoms of accidental over-exposure to *Optibor* have been associated with ingestion or absorption through large areas of damaged skin. These may include nausea, vomiting and diarrhea, with delayed effects of skin redness and peeling.
Refer to Section 11 for details on Toxicological data.

4 First aid measures

Inhalation: If symptoms such as nose or throat irritation are observed, remove person to fresh air.
Eye contact: Use eye wash fountain or fresh water to cleanse the eye. If irritation persists for more than 30 minutes, seek medical attention.
Skin contact: No treatment necessary because non-irritating.
Ingestion: Swallowing small quantities (one teaspoon) will cause no harm to healthy adults. If larger amounts are swallowed, give two glasses of water to drink and seek medical attention.
Note to physicians: Observation only is required for adult ingestion in the range of 4-8 grams of *Optibor*. For ingestion of larger amounts, maintain adequate kidney function and force fluids. Gastric lavage is recommended for symptomatic patients only. Hemodialysis should be reserved for massive acute ingestion or patients with renal failure. Boron analyses of urine or blood are only useful for documenting exposure and should not be used to evaluate severity of poisoning or to guide treatment[1]. Refer to Section 11 for details.

BORAX®

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1 of 4

Optibor

5 Firefighting measures

General hazard: None, because *Optibor* is not flammable, combustible or explosive. The product is itself a flame retardant.

Extinguishing media: Any fire extinguishing media may be used on nearby fires.
Flammability classification (29 CFR 1910.1200): Non-flammable solid.

6 Accidental release measures

General: *Optibor* is a water-soluble white powder that may, at high concentrations, cause damage to trees or vegetation by root absorption. (Refer to Ecological information, Section 12, for specific information.)

Land spill: Vacuum, shovel or sweep up *Optibor* and place in containers for disposal in accordance with applicable local regulations. Avoid contamination of water bodies during cleanup and disposal. Personal protective equipment is not needed to cleanup land spills.

Spillage into water: Where possible, remove any intact containers from the water. Advise local water authority that none of the affected water should be used for irrigation or for the abstraction of potable water until natural dilution returns the boron value to its normal environmental background level. (Refer to Sections 12, 13 and 15 for additional information.) *Optibor* is a non-hazardous waste when spilled or disposed of, as defined in the Resource Conservation and Recovery Act (RCRA) regulations (40 CFR 261). (Refer to Regulatory information, Section 15, for additional references.)

7 Handling and storage

General: No special handling precautions are required, but dry, indoor storage is recommended. To maintain package integrity and to minimize caking of the product, bags should be handled on a first-in, first-out basis. Good housekeeping procedures should be followed to minimize dust generation and accumulation.

Storage temperature:	Ambient
Storage pressure:	Atmospheric
Special sensitivity:	Moisture (caking)

8 Exposure controls/personal protection

Engineering controls: Use local exhaust ventilation to keep airborne concentrations of *Optibor* dust below permissible exposure levels.
Personal protection: Where airborne concentrations are expected to exceed exposure limits, NIOSH/MSHA certified respirators should be used. Eye goggles and gloves are not required for normal industrial exposures, but may be warranted if environment is excessively dusty.

Occupational exposure limits: *Optibor* is treated by OSHA, Cal OSHA and ACGIH as "Particulate Not Otherwise Classified" or "Nuisance Dust".

ACGIH/TLV:	10 mg/m^3
Cal OSHA/PEL:	10 mg/m^3
OSHA/PEL (total dust):	15 mg/m^3
OSHA/PEL (respirable dust):	5 mg/m^3

9 Physical and chemical properties

Appearance:	White, odorless, crystalline solid	**Melting point:**	170.9°C (340°F) (heated in closed space)
Specific gravity:	1.51	**pH @ 20°C:**	6.1 (0.1% solution); 5.1 (1.0% solution); 3.7 (4.7% solution)
Vapor pressure:	Negligible @ 20°C		
Solubility in water:	4.7% @ 20°C; 27.5% @ 100°C	**Molecular weight:**	61.84

10 Stability and reactivity

General: *Optibor* is a stable product, but when heated it loses water, first forming metaboric acid (HBO_2), and on further heating it is converted into boric oxide (B_2O_3).

Incompatible materials and conditions to avoid: *Optibor* reacts as a weak acid which may cause corrosion of base metals. Reaction with strong reducing agents, such as metal hydrides or alkali metals, will generate hydrogen gas, which could create an explosive hazard.

Hazardous decomposition: None.

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Optibor

11 Toxicological information

Acute toxicity

Ingestion: Low acute oral toxicity; LD_{50} in rats is 3,500 to 4,100 mg/kg of body weight.
Skin/dermal: Low acute dermal toxicity; LD_{50} in rabbits is greater than 2,000 mg/kg of body weight. *Optibor* is poorly absorbed through intact skin.
Inhalation: Low acute inhalation toxicity; LC_{50} in rats is greater than 2.0 mg/L (or g/m^3).
Skin irritation: Non-irritant.
Eye irritation: Draize test in rabbits produced mild eye irritation effects. Fifty years of occupational exposure to *Optibor* indicates no adverse effects on human eye. Therefore, *Optibor* is not considered to be a human eye irritant in normal industrial use.
Sensitization: *Optibor* is not a skin sensitizer.

Other

Reproductive/developmental toxicity: Animal feeding studies in rat, mouse and dog, at high doses, have demonstrated effects on fertility and testes[2]. Boric acid studies in rat, mouse and rabbit, at high doses, demonstrate developmental effects on the fetus, including fetal weight loss and minor skeletal variations[3, 4]. The doses administered were many times in excess of those to which humans would normally be exposed[5].
Carcinogenicity/mutagenicity: No evidence of carcinogenicity in mice[6]. No mutagenic activity was observed for boric acid in a battery of short-term mutagenicity assays.
Human data: Human epidemiological studies show no increase in pulmonary disease in occupational populations with chronic exposures to boric acid dust and sodium borate dust. A recent epidemiology study under the conditions of normal occupational exposure to borate dusts indicated no effect on fertility[7].

12 Ecological information

Ecotoxicity data

General: Boron (B) is the element in boric acid (*Optibor*) which is used by convention to report borate product ecological effects. It occurs naturally in sea-water at an average concentration of 5 mg B/L and generally occurs in fresh water at concentrations up to 1 mg B/L. In dilute aqueous solutions the predominant boron species present is undissociated boric acid. To convert boric acid into equivalent boron (B) content, multiply by 0.1748.
Phytotoxicity: Boron is an essential micronutrient for healthy growth of plants; however, it can be harmful to boron sensitive plants in high quantities. Care should be taken to minimize the amount of *Optibor* released to the environment.
Algal toxicity:
Green algae, *Scenedesmus subspicatus*
96-hr EC_{10} = 24 mg B/L†
Invertebrate toxicity[8]:
Daphnids, *Daphnia magna straus*
48-hr LC_{50} = 133 mg B/L‡
21-day NOEC-LOEC = 6-13 mg B/L‡

Test substance: † sodium tetraborate
‡ boric acid

Fish toxicity:
Sea-water[8]:
Dab, *Limanda limanda*
96-hr LC_{50} = 74 mg B/L†
Fresh water[10]:
Rainbow trout, *S. gairdneri* (embryo-larval stage)
24-day LC_{50} = 150 mg B/L‡
32-day LC_{50} = 100 mg B/L‡
Goldfish, *Carassius auratus* (embryo-larval stage)
7-day LC_{50} = 46 mg B/L‡
3-day LC_{50} = 178 mg B/L‡

Environmental fate data

Persistence/degradation: Boron is naturally occurring and ubiquitous in the environment. *Optibor* decomposes in the environment to natural borate.
Octanol/water partition coefficient: Log P_{ow}: -0.7570 at 25°C.
Soil mobility: *Optibor* is soluble in water and is leachable through normal soil.

13 Disposal considerations

Disposal guidance: Small quantities of *Optibor* can usually be disposed of at landfill sites. No special disposal treatment is required, but local authorities should be consulted about any specific local requirements. Tonnage quantities of product should, if possible, be used for an appropriate application.

RCRA (40 CFR 261): *Optibor* is not listed under any sections of the Federal Resource Conservation and Recovery Act (RCRA).
NPRI (Canada): *Optibor* is not listed on the Canadian National Pollutant Release Inventory.
Refer to Section 15 for additional regulatory information.

14 Transport information

DOT hazardous classification: *Optibor* is not regulated by the U.S. Department of Transportation (DOT) and is therefore not considered a hazardous material/substance.
TDG Canadian transportation: Boric acid (*Optibor*) is not regulated under Transportation of Dangerous Goods (TDG).

International transportation: Boric acid (*Optibor*) has no UN Number, and is not regulated under international rail, road, water or air transport regulations.

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Optibor

15 Regulatory information

OSHA/Cal OSHA: This MSDS document meets the requirements of both OSHA (29 CFR 1910.1200) and Cal OSHA (Title 8 CCR 5194 (g)) hazard communication standards. Refer to Section 8 for regulatory exposure limits.
WHMIS classification: Boric acid (*Optibor*) is classified as Class D- Division 2A under Canadian WHMIS guidelines.
Chemical inventory listing: Boric acid (*Optibor*) (10043-35-3) appears on several chemical inventory lists (including the EPA TSCA inventory, Canadian DSL, European EINECS, Japanese MITI, Australian and Korean lists) under the CAS No. representing the anhydrous form of this inorganic salt.

U.S. EPA TSCA Inventory	10043-35-3
Canadian DSL	10043-35-3
EINECS	233-139-2
South Korea	1-439
Japanese MITI	(1)-63

RCRA: Boric acid (*Optibor*) is not listed as a hazardous waste under any sections of the Resource Conservation and Recovery Act (RCRA) or regulations (40 CFR 261 *et seq*).
Superfund: CERCLA/SARA. Boric acid (*Optibor*) is not listed under CERCLA (Comprehensive Environmental Response Compensation and Liability Act) or its 1986 amendments, SARA (Superfund Amendments and Reauthorization Act), including substances listed under Section 313 of SARA, Toxic Chemicals, 42 USC 11023, 40 CFR 372.65, Section 302 of SARA, Extremely Hazardous Substances, 42 USC 11002, 40 CFR 355, or the CERCLA Hazardous Substances list, 42 USC 9604, 40 CFR 302.
Safe Drinking Water Act (SDWA): Boric acid (*Optibor*) is not regulated under the SDWA, 42 USC 300g-1, 40 CFR 141 *et seq*. Consult state and local regulations for possible water quality advisories regarding boron compounds.
Clean Water Act (CWA) (Federal Water Pollution Control Act): 33 USC 1251 *et seq*.

a) Boric acid (*Optibor*) is not itself a discharge covered by any water quality criteria of Section 304 of the CWA, 33 USC 1314.
b) It is not on the Section 307 List of Priority Pollutants, 33 USC 1317, 40 CFR 129.
c) It is not on the Section 311 List of Hazardous Substances, 33 USC 1321, 40 CFR 116.

Canadian drinking water guideline: An "Interim Maximum Acceptable Concentration" (IMAC) for boron is currently set at 5 mg B/L.
IARC: The International Agency for Research on Cancer (IARC) (a unit of the World Health Organization) does not list or categorize boric acid as a carcinogen.
NTP Biennial Report on Carcinogens: Boric acid is not listed.
OSHA carcinogen: Boric acid is not listed.
California Proposition 65: Boric acid (*Optibor*) is not listed on the Proposition 65 list of carcinogens or reproductive toxicants.
Federal Food, Drug and Cosmetic Act: *Pursuant* to 21 CFR 175.105, 176.180 and 181.30, *Optibor* is approved by the FDA for use in adhesive components of packaging materials, as a component of paper coatings on such materials, or for use in the manufacture thereof, which materials are expected to come in contact with dry food products.
Clean Air Act (Montreal Protocol): *Optibor* was not manufactured with and does not contain any Class I or Class II ozone depleting substances.

16 Other information

References

1. Litovitz T L, Norman S A, Veltri J C, Annual Report of the American Association of Poison Control Centers Data Collection System. Am. J. Emerg. Med. 4: 427-458 (1986).
2. Weir R J, Fisher R S, Toxicol. Appl. Pharmacol. 23: 351-364 (1972).
3. Fail *et al.*, Fund. Appl. Toxicol. 17: 225-239 (1991).
4. Price *et al.*, J. Am. Coll. Toxicol. 14: (2), 173 (Abst. P-17) (1995).
5. Murray F J, Regul. Toxicol. Pharmacol. (Dec. 1995).
6. National Toxicology Program (NTP)–Toxicology and carcinogenesis studies of boric acid in $B6C3F_1$ mice, Tech. Report Ser. No. 324, U.S. Dept. of Health and Human Services. NIH Publ. No. 88-2580 (1987).
7. Whorton *et al.*, Occup. Environ. Med. 51: 761-767 (1994).
8. Schöberl *et al.*, Tenside Surfactants Detergents 25: 99-107 (1988).
9. Hugman S J, Mance G, Water Research Centre Report 616-M (1983).
10. Butterwick L, de Oude N, Raymond K, Ecotoxicol. Environ. Safety 17: 339-371 (1989).

For general information on the toxicology of inorganic borates, see Patty's Industrial Hygiene and Toxicology, 4th Ed. Vol II, (1994), Chap. 42, Boron; ECETOC Tech. Report No. 63 (1995).

Product label text hazard information*:
Do not ingest.
Ingestion may cause reproductive harm or birth defects based on animal data.
Avoid contamination of food or feed.
Not for use in food, drug, or pesticides+.
Refer to MSDS.
KEEP OUT OF REACH OF CHILDREN.
*The WHMIS panel format is used for Canadian product.
+Except for NF (pharmaceutical grade) products.

National Fire Protection Assoc. (NFPA) Classification:

Health	0
Flammability	0
Reactivity	0

Hazardous Materials Information Systems (HMIS):

Red: (Flammability)	0
Yellow: (Reactivity)	0
Blue: (Acute Health)	1*

*Chronic Effects

For further information contact:
U.S. Borax Inc.
Occupational Health & Product Safety Department
(661) 287-6050

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10M Borax ($Na_2B_4O_7 \cdot 10H_2O$)

20 MULE TEAM®

Borax Decahydrate

Material Safety Data Sheet
DATE OF ISSUE May 2000
Supersedes November 1999 Version

1 Chemical product and company identification

Product name: Borax
Grade: Technical, NF, SQ
Product use: Industrial manufacturing
Chemical formula: $Na_2B_4O_7 \cdot 10H_2O$
Chemical name/synonyms: Sodium tetraborate decahydrate, disodium tetraborate decahydrate, borax decahydrate, Borax 10 Mol
Chemical family: Inorganic borates
CAS registry number: 1303-96-4

(Refer to Section 15 for TSCA/DSL Chemical inventory listing)

MANUFACTURER:
U.S. Borax Inc.
26877 Tourney Road
Valencia, CA 91355-1847

EMERGENCY PHONE NUMBERS:
24 Hr. Medical Info. Service ... (661) 284-5200
Chemtrec (Spills): ..... (800) 424-9300

2 Composition/information on ingredients

This product contains greater than 99 percent (%) Sodium tetraborate decahydrate, $Na_2B_4O_7 \cdot 10H_2O$, which is hazardous under the OSHA Hazard Communication Standard and under the Canadian Controlled Products Regulations of the Hazardous Products Act (WHMIS), based on animal chronic toxicity studies. Refer to Sections 3 and 11 for details on hazards.

3 Hazard identification

Emergency overview
Borax is a white, odorless, powder substance that is not flammable, combustible, or explosive and has low acute oral and dermal toxicity.

Potential ecological effects
Large amounts of Borax can be harmful to plants and other species. Therefore, releases to the environment should be minimized.

Potential health effects
Routes of exposure: Inhalation is the most significant route of exposure in occupational and other settings. Dermal exposure is not usually a concern because Borax is poorly absorbed through intact skin.
Inhalation: Occasional mild irritation effects to the nose and throat may occur from inhalation of Borax dust at levels greater than 10 mg/m^3.
Eye contact: Borax is non-irritating to the eyes in normal industrial use.
Skin contact: Borax does not cause irritation to intact skin.
Ingestion: Products containing Borax are not intended for ingestion. Borax has a low acute toxicity. Small amounts (e.g., a teaspoon) swallowed accidentally are not likely to cause effects; swallowing amounts larger than that may cause gastrointestinal symptoms.
Cancer: Borax is not a known carcinogen.
Reproductive/developmental: Animal ingestion studies in several species, at high doses, indicate that borates cause reproductive and developmental effects. A human study of occupational exposure to borate dust showed no adverse effect on reproduction.
Target organs: No target organ has been identified in humans. High dose, animal ingestion studies indicate the testes are the target organs in male animals.
Signs and symptoms of exposure: Symptoms of accidental over-exposure to Borax might include nausea, vomiting and diarrhea, with delayed effects of skin redness and peeling. These symptoms have been associated with the accidental over-exposure to the chemically related substance boric acid. Refer to Section 11 for details on Toxicological data.

4 First aid measures

Inhalation: If symptoms such as nose or throat irritation are observed, remove person to fresh air.
Eye contact: Use eye wash fountain or fresh water to cleanse the eye. If irritation persists for more than 30 minutes, seek medical attention.
Skin contact: No treatment necessary because non-irritating.
Ingestion: Swallowing small quantities (one teaspoon) will cause no harm to healthy adults. If larger amounts are swallowed, give two glasses of water to drink and seek medical attention.
Note to physicians: Observation only is required for adult ingestion in the range of 4-8 grams of Borax. For ingestion of larger amounts, maintain adequate kidney function and force fluids. Gastric lavage is recommended for symptomatic patients only. Hemodialysis should be reserved for massive acute ingestion or patients with renal failure. Boron analyses of urine or blood are only useful for documenting exposure and should not be used to evaluate severity of poisoning or to guide treatment[1]. Refer to Section 11 for details.

BORAX®

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Borax

5 Firefighting measures

General hazard: None, because Borax is not flammable, combustible or explosive. The product is itself a flame retardant.

Extinguishing media: Any fire extinguishing media may be used on nearby fires.
Flammability classification (29 CFR 1910.1200): Non-flammable solid.

6 Accidental release measures

General: Borax is a water-soluble white powder that may, at high concentrations, cause damage to trees or vegetation by root absorption. (Refer to Ecological information, Section 12, for specific information.)

Land spill: Vacuum, shovel or sweep up Borax and place in containers for disposal in accordance with applicable local regulations. Avoid contamination of water bodies during cleanup and disposal. Personal protective equipment is not needed to cleanup land spills.

Spillage into water: Where possible, remove any intact containers from the water. Advise local water authority that none of the affected water should be used for irrigation or for the abstraction of potable water until natural dilution returns the boron value to its normal environmental background level. (Refer to Sections 12, 13 and 15 for additional information.) Borax is a non-hazardous waste when spilled or disposed of, as defined in the Resource Conservation and Recovery Act (RCRA) regulations (40 CFR 261). (Refer to Regulatory information, Section 15, for additional references.)

7 Handling and storage

General: No special handling precautions are required, but dry, indoor storage is recommended. To maintain package integrity and to minimize caking of the product, bags should be handled on a first-in, first-out basis. Good housekeeping procedures should be followed to minimize dust generation and accumulation.

Storage temperature: Ambient

Storage pressure: Atmospheric

Special sensitivity: Moisture (caking)

8 Exposure controls/personal protection

Engineering controls: Use local exhaust ventilation to keep airborne concentrations of Borax dust below permissible exposure levels.

Personal protection: Where airborne concentrations are expected to exceed exposure limits, NIOSH/MSHA certified respirators should be used. Eye goggles and gloves are not required for normal industrial exposures, but may be warranted if environment is excessively dusty.

Occupational exposure limits: Sodium tetraborate decahydrate (Borax) is regulated by OSHA, Cal OSHA and ACGIH.

ACGIH/TLV:	5 mg/m^3
Cal OSHA/PEL:	5 mg/m^3
OSHA/PEL (total dust):	10 mg/m^3

9 Physical and chemical properties

Appearance:	White, odorless, crystalline solid	**Melting point:**	62°C (144°F) (heated in closed space)
Specific gravity:	1.71	**pH @ 20°C:**	9.3 (0.1% solution); 9.2 (1.0% solution); 9.3 (4.7% solution)
Vapor pressure:	Negligible @ 20°C	**Molecular weight:**	381.37
Solubility in water:	4.71% @ 20°C; 65.64% @ 100°C		

10 Stability and reactivity

General: Borax is a stable product, but when heated it loses water, eventually forming anhydrous borax ($Na_2B_4O_7$).

Incompatible materials and conditions to avoid: Reaction with strong reducing agents, such as metal hydrides or alkali metals, will generate hydrogen gas, which could create an explosive hazard.

Hazardous decomposition: None.

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Borax

11 Toxicological information

Acute toxicity

Ingestion: Low acute oral toxicity; LD_{50} in rats is 4,500 to 5,000 mg/kg of body weight.
Skin/dermal: Low acute dermal toxicity; LD_{50} in rabbits is greater than 10,000 mg/kg of body weight. Borax is poorly absorbed through intact skin.
Inhalation: Low acute inhalation toxicity; LC_{50} in rats is greater than 2.0 mg/L (or g/m^3).
Skin irritation: Non-irritant.
Eye irritation: Draize test in rabbits produced eye irritation effects. Fifty years of occupational exposure to Borax indicates no adverse effects on human eye. Therefore, Borax is not considered to be a human eye irritant in normal industrial use.
Sensitization: Borax is not a skin sensitizer.

Other

Reproductive/developmental toxicity: Animal feeding studies in rat, mouse and dog, at high doses, have demonstrated effects on fertility and testes[2]. Studies with the chemically related boric acid in the rat, mouse and rabbit, at high doses, demonstrate developmental effects on the fetus, including fetal weight loss and minor skeletal variations[3, 4]. The doses administered were many times in excess of those to which humans would normally be exposed[5].
Carcinogenicity/mutagenicity: No evidence of carcinogenicity in mice[6]. No mutagenic activity was observed for boric acid in a battery of short-term mutagenicity assays.
Human data: Human epidemiological studies show no increase in pulmonary disease in occupational populations with chronic exposures to boric acid dust and sodium borate dust. A recent epidemiology study under the conditions of normal occupational exposure to borate dusts indicated no effect on fertility[7].

12 Ecological information

Ecotoxicity data

General: Boron (B) is the element in sodium tetraborate decahydrate (Borax) which is used by convention to report borate product ecological effects. It occurs naturally in sea-water at an average concentration of 5 mg B/L and generally occurs in fresh water at concentrations up to 1 mg B/L. In dilute aqueous solutions the predominant boron species present is undissociated boric acid. To convert sodium tetraborate decahydrate into the equivalent boron (B) content, multiply by 0.1134.
Phytotoxicity: Boron is an essential micronutrient for healthy growth of plants; however, it can be harmful to boron sensitive plants in high quantities. Care should be taken to minimize the amount of Borax released to the environment.
Algal toxicity:
Green algae, *Scenedesmus subspicatus*
96-hr EC_{10} = 24 mg B/L†
Invertebrate toxicity[8]:
Daphnids, *Daphnia magna straus*
24-hr EC_{50} = 242 mg B/L†

Test substance: † sodium tetraborate

Fish toxicity:
Sea-water[9]:
Dab, *Limanda limanda*
96-hr LC_{50} = 74 mg B/L†
Fresh water[10]:
Rainbow trout, *S. gairdneri* (embryo-larval stage)
24-day LC_{50} = 88 mg B/L†
32-day LC_{50} = 54 mg B/L†
Goldfish, *Carassius auratus* (embryo-larval stage)
7-day LC_{50} = 65 mg B/L†
3-day LC_{50} = 71 mg B/L†

Environmental fate data

Persistence/degradation: Boron is naturally occurring and ubiquitous in the environment. Borax decomposes in the environment to natural borate.
Octanol/water partition coefficient: No value. In aqueous solution Sodium tetraborate decahydrate is converted substantially into undissociated boric acid.
Soil mobility: Borax is soluble in water and is leachable through normal soil.

13 Disposal considerations

Disposal guidance: Small quantities of Borax can usually be disposed of at landfill sites. No special disposal treatment is required, but local authorities should be consulted about any specific local requirements. Tonnage quantities of product should, if possible, be used for an appropriate application.

RCRA (40 CFR 261): Borax is not listed under any sections of the Federal Resource Conservation and Recovery Act (RCRA).
NPRI (Canada): Borax is not listed on the Canadian National Pollutant Release Inventory.

Refer to Section 15 for additional regulatory information.

14 Transport information

DOT hazardous classification: Sodium tetraborate decahydrate (Borax) is not regulated by the U.S. Department of Transportation (DOT) and is therefore not considered a hazardous material/substance.

TDG Canadian transportation: Sodium tetraborate decahydrate (Borax) is not regulated under Transportation of Dangerous Goods (TDG).
International transportation: Sodium tetraborate decahydrate (Borax) has no UN Number, and is not regulated under international rail, road, water or air transport regulations.

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Borax

15 Regulatory information

OSHA/Cal OSHA: This MSDS document meets the requirements of both OSHA (29 CFR 1910.1200) and Cal OSHA (Title 8 CCR 5194 (g)) hazard communication standards. Refer to Section 8 for regulatory exposure limits.

WHMIS classification: Sodium tetraborate decahydrate (Borax) is classified as Class D- Division 2A under Canadian WHMIS guidelines.

Chemical inventory listing: Sodium tetraborate decahydrate (Borax), 1303-96-4, appears on several chemical inventory lists (including the EPA TSCA inventory, Canadian DSL, European EINECS, Japanese MITI, Australian and Korean lists) under the CAS No. representing this inorganic salt.

U.S. EPA TSCA Inventory	1303-96-4
Canadian DSL	1303-96-4
EINECS	215-540-4
South Korea	9212-848
Japanese MITI	(1)-69

RCRA: Sodium tetraborate decahydrate is not listed as a hazardous waste under any sections of the Resource Conservation and Recovery Act (RCRA) or regulations (40 CFR 261 *et seq*).

Superfund: CERCLA/SARA. Sodium tetraborate decahydrate is not listed under CERCLA or its 1986 amendments, SARA, including substances listed under Section 313 of SARA, Toxic Chemicals, 42 USC 11023, 40 CFR 372.65, Section 302 of SARA, Extremely Hazardous Substances, 42 USC 11002, 40 CFR 355, or the CERCLA Hazardous Substances list, 42 USC 9604, 40 CFR 302.

Safe Drinking Water Act (SDWA): Sodium tetraborate decahydrate is not regulated under the SDWA, 42 USC 300g-1, 40 CFR 141 *et seq*. Consult state and local regulations for possible water quality advisories regarding boron compounds.

Clean Water Act (CWA) (Federal Water Pollution Control Act): 33 USC 1251 *et seq*.

a) Sodium tetraborate decahydrate (Borax) is not itself a discharge covered by any water quality criteria of Section 304 of the CWA, 33 USC 1314.
b) It is not on the Section 307 List of Priority Pollutants, 33 USC 1317, 40 CFR 129.
c) It is not on the Section 311 List of Hazardous Substances, 33 USC 1321, 40 CFR 116.

Canadian drinking water guideline: An "Interim Maximum Acceptable Concentration" (IMAC) for boron is currently set at 5 mg B/L.

IARC: The International Agency for Research on Cancer (IARC) (a unit of the World Health Organization) does not list or categorize Sodium tetraborate decahydrate as a carcinogen.

NTP Biennial Report on Carcinogens: Sodium tetraborate decahydrate is not listed.

OSHA carcinogen: Sodium tetraborate decahydrate is not listed.

California Proposition 65: Sodium tetraborate decahydrate (Borax) is not listed on the Proposition 65 list of carcinogens or reproductive toxicants.

Federal Food, Drug and Cosmetic Act: Pursuant to 21 CFR 175.105, 176.180 and 181.30, Borax is approved by the FDA for use in adhesive components of packaging materials, as a component of paper coatings on such materials, or for use in the manufacture thereof, which materials are expected to come in contact with dry food products.

Clean Air Act (Montreal Protocol): Borax was not manufactured with and does not contain any Class I or Class II ozone depleting substances.

16 Other information

References

1) Litovitz T L, Norman S A, Veltri J C, Annual Report of the American Association of Poison Control Centers Data Collection System. Am. J. Emerg. Med. **4**: 427-458 (1986).
2) Weir R J, Fisher R S, Toxicol. Appl. Pharmacol. **23**: 351-364 (1972).
3) Fail *et al.*, Fund. Appl. Toxicol. **17**: 225-239 (1991).
4) Price *et al.*, J. Am. Coll. Toxicol. **14**: (2), 173 (Abst. P-17) (1995).
5) Murray F J, Regul. Toxicol. Pharmacol. (Dec. 1995).
6) National Toxicology Program (NTP)–Toxicology and carcinogenesis studies of boric acid in $B6C3F_1$ mice, Tech. Report Ser. No. 324, U.S. Dept. of Health and Human Services. NIH Publ. No. 88-2580 (1987).
7) Whorton *et al.*, Occup. Environ. Med. **51**: 761-767 (1994).
8) Schöberl *et al.*, Tenside Surfactants Detergents **25**: 99-107 (1988).
9) Hugman S J, Mance G, Water Research Centre Report 616-M (1983).
10) Butterwick L, de Oude N, Raymond K, Ecotoxicol. Environ. Safety **17**: 339-371 (1989).

For general information on the toxicology of inorganic borates, see Patty's Industrial Hygiene and Toxicology, 4th Ed. Vol II, (1994), Chap. 42, Boron; ECETOC Tech. Report No. 63 (1995).

Product label text hazard information*:

- Do not ingest.
- Ingestion may cause reproductive harm or birth defects based on animal data.
- Avoid contamination of food or feed.
- Not for use in food, drugs or pesticides+.
- Refer to MSDS.
- KEEP OUT OF REACH OF CHILDREN.

*The WHMIS panel format is used for Canadian product.
+Except for NF (pharmaceutical grade) products.

National Fire Protection Assoc. (NFPA) Classification:

Health	0
Flammability	0
Reactivity	0

Hazardous Materials Information Systems (HMIS):

Red: (Flammability)	0
Yellow: (Reactivity)	0
Blue: (Acute Health)	1*

*Chronic Effects

For further information contact:

U.S. Borax Inc.
Occupational Health & Product Safety Department
(661) 287-6050

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Na_2CO_3 (Anhydrous)

MATERIAL SAFETY DATA SHEET NUMBER 002

Solvay Minerals, Inc., Green River, WY.
Date: July 7, 2003
Supersedes edition: 04/07/03
Purpose of revision: Phone numbers & sections 11.2, 15.9
Issued by: P. J. Luzmoor, Safety/Training Dept.

HAZARDOUS MATERIAL INFORMATION SYSTEM(HMIS®) H = 2 F = 0 R = 0 PERSONAL PROTECTION = E

The following information is based upon our current knowledge and experience of our product and is not exhaustive. It applies to the product as defined by the specifications. In case of combinations of mixtures, one must confirm that no new hazards are likely to exist. In any case, the user is not exempt from observing all legal, administrative and regulatory procedures relating to the product, personal hygiene, and integrity of the work environment. (Unless noted to the contrary, the technical information applies only to pure product).

MANUFACTURER: Solvay Minerals, Inc., PO BOX 27328-Houston, TX. 77227-7328 Telephone No. 800-443-2785
Visit us on the WEB @ www.solvayminerals.com
Telephone No. - Emergencies (USA): 1-307-872-6688 (Solvay Minerals, Green River, WY.)
Telephone No. - Emergencies (USA): 1-800-424-9300 (CHEMTREC)
Telephone No. - Emergencies (INTERNATIONAL/MARITIME): 1-703-527-3887 (CHEMTREC)
Telephone No. - Emergencies (CANADA): 1-613-996-6666 (CANUTEC)
Telephone No. - Emergencies (MEXICO): 1-800-00-214-00 (MEX. REPUBLIC)-0-11-52-5-559-1588 (Elsewhere)

1. PRODUCT IDENTIFICATION

1.1 **Product Name: SODA ASH**
1.2 **Chemical Name:** Sodium carbonate, anhydrous.
1.3 **Synonyms:** Soda salt, soda crystal, disodium carbonate.
1.4 **Trade Names:** Dense soda ash, chemical grade soda ash.
1.5 **Recommended uses:** Glass industry, chemical intermediates, metallurgy, soaps & detergents, pulp & paper, flue gas emissions, coal treatment, ion exchange
1.6 **Formula:** Na_2CO_3
1.7 **Molecular Weight:** 105.99
1.8 **CAS No.:** 497-19-8
1.9 **EINECS No.:** 207-838-8

2. COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENTS/FORMULA	CAS #	PERCENT
Sodium Carbonate- Na_2CO_3	497-19-8	99.8%
Water-H_2O	7732-18-5	.1%
Sodium Sulfate-Na_2SO_4	7757-82-6	.05%
Sodium Chloride-NaCl	7647-14-5	.05%

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3. HAZARD IDENTIFICATION

3.1 **Sodium carbonate is an odorless, white granular solid.**

3.2 **Route(s) of Entry:** Inhalation: Yes Skin: Yes Ingestion: Yes

3.3 **Effects of exposure:** Irritating to mucous membranes and eyes.

Inhalation (dust): May be irritating to the nose, throat, and respiratory tract. Repeated exposure may cause nosebleeds.

Eyes (dust): Severe eye irritation, watering, redness and swelling of the eyelids. Risk of serious or permanent eye lesions.

Skin: May cause skin irritation, seen as redness and swelling. In the presence of moisture or sweat, irritation may become more severe leading to rash. May cause dry and chapped skin.

Ingestion: May cause severe irritation and risk of burns to the mouth, throat, esophagus and stomach. Ingestion of large quantities can cause nausea and vomiting (bloody) abdominal cramps and diarrhea (bloody).

4. FIRST AID MEASURES

4.1 **Inhalation:** Remove subject to a dust free environment and blow nose. If breathing is difficult or has stopped, administer artificial respiration. If any irritation is present, seek medical attention.

Eyes: Recommendation: In cases of splashing of concentrated solution in the eyes and face, treat the eyes first, and then continue first aid as defined under "contact with the skin."

WITHOUT LOSS OF TIME: Rinse the eyes with running water for 15 minutes, maintaining the eyelids wide open to eliminate the product. Protect the eyes from strong light. Consult a physician or ophthalmologist in all cases. Transport subject to a medical facility.

Skin: Remove shoes and contaminated clothing, under a shower if necessary. Wash the affected area with luke-warm water. Dry carefully. In case of persistent pain or reddening, consult a physician. Provide clean clothes.

Ingestion: DO NOT ATTEMPT TO GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON. Do not induce vomiting. Remove any evidence of the product from the person's mouth. If the person is conscious and alert, give 8-12 ounces of water. SEEK MEDICAL ATTENTION.

4.2 **Medical Conditions Aggravated by Exposure:**

Skin irritation may be aggravated in persons with existing skin lesions. Breathing of dust may aggravate asthma or other chronic pulmonary diseases.

5. FIRE FIGHTING MEASURES

5.1 **Flash Point:** Non combustible. Method: Not applicable.

5.2 **Auto-ignition Temperature:** Not applicable.

5.3 **Flammability Limits: Upper & Lower Limit:** Non flammable.

5.4 **Fire Fighting Procedures**: Not applicable.

5.5 **Common Extinguishing Methods** : In case of fire in close proximity, all means of extinguishing are acceptable.

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6. ACCIDENTAL RELEASE MEASURES

6.1 **Spills:** Shovel back into the original dry, uncontaminated container or waste receptacle. Flush area with water; contain runoff, dispose of waste in accordance with applicable federal, state, and local environmental laws and regulations.

7. HANDLING AND STORAGE

7.1 **Handling:** Avoid prolonged or repeated contact with the skin or eyes. Do not wear contact lenses without proper eye protection when using this product. Avoid prolonged or repeated breathing of dusts. Use vacuum or wet mop to clean up dust.

7.2 **Storage:** Keep in a closed, properly labeled container in a dry area away from acids. Protect from physical damage.

7.3 **For all operations:** DO NOT TAKE INTERNALLY.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 **Exposure Limits:** OSHA Permissible Exposure Limit (PEL) Nuisance Dust-5 mg/m^3 (Respirable Fraction), 15 mg/m^3 (Total Dust).

8.2 **Ventilation:** In places with the possibility for creating excessive dust in excess of exposure limits, ventilation should be provided.

8.3 **Respiratory Protection:** In case of significant or accidental dust emissions, a NIOSH/MSHA approved dust respirator should be worn.

8.4 **Protective Gloves:** Chemical resistant gloves.

8.5 **Eye Protection:** In cases of significant dust, dust proof goggles are recommended.

8.6 **Other Protective Clothing or Equipment:** Chemical protective clothing in dusty areas. An eyewash and safety shower should be nearby and ready for use. Use good hygiene practices when handling this product including changing work clothes after use. Do not eat, drink or smoke in areas where this material is handled.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 **Appearance:** Granular solid. **Color:** white. **Odor:** odorless

9.2 **Melting Point**: 851°C (1564°F).

9.3 **Boiling Point**: Not applicable.

9.4 **Specific Gravity** (H_2O=1): 2.533 @ 25°C (77°F)

9.5 **Coefficient of Water/Oil Distribution:** Not applicable

9.6 **Vapor Density** (air=1): Not applicable.

9.7 **Vapor Pressure**: Not listed.

9.8 **Solubility**: 33% maximum by weight in water.

9.9 **Decomposition Temperature**: Beginning at 400°C (752°F).

9.10 **Viscosity**: Not listed.

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9.11 **pH**: 11.6 (1% solution)
9.12 **Percent volatile (by volume):** Not applicable
9.13 **Evaporation Rate:** Not Applicable.
9.14 **Other information:** Bulk Density: 62.0 lbs/ft^3.

10. STABILITY AND REACTIVITY

10.1 **Stability:** Stable at ambient temperature and atmospheric pressure.
10.2 **Hazardous Decomposition Products:** Carbon dioxide (CO_2) is evolved at very high temperatures (1000°C, 1832°F) or when mixed with acids.
10.3 **Conditions to Avoid:** Hydroscopic; protect from moisture. Mixing of acid and sodium carbonate solutions could cause CO_2 evolution and severe splattering.
10.4 **Materials and Substances to Avoid:** Reacts with strong acids. Under certain conditions, may react with Al, P_2O_5, F_2, Li and 2, 4, 6-trinitrotoluene. Reacts with acids and releases large volumes of CO_2 gas and heat. Soda ash and lime dust in the presence of moisture may form caustic soda, which may cause burns.

11. TOXICOLOGICAL INFORMATION

11.1 **Acute toxicity:** Oral route, LD_{50}, rat, >2,000 mg/kg. Inhalation, LC_{50}, 2 h, rat, 2.3 mg/l. Dermal route, LD_{50}, rabbit, >2,000 mg/kg
11.2 **Chronic toxicity:** Inhalation, rat, target organ: lungs, 0.07 mg/l, observed effect. In vitro, no mutagenic effect. Oral route (gavage), various species, 179 mg/kg, 10 days, no teratogenic effect.
11.3 **Irritation:** Rabbit, non-irritant (skin). Rabbit, irritant (eyes).

12. ECOLOGICAL INFORMATION

12.1 **Irrigation of fields or vegetable gardens:** Less than 60 mg/l - minimal risk; between 60 mg/l and 130 mg/l - medium risk; more than 130 mg/l - risk for legumes of vegetable gardens, wheat, etc.
12.2 **Acute Ecotoxicity: Crustaceans,** Daphnia magna, EC_{50}, 48 hours, 265 mg/l. **Fishes,** Lepomis macrochirus, LC_{50}, 96 hours, 300 mg/l. **Algae**, Nitszcheria linearis, EC_{50}, 5 day, 242 mg/l.
12.3 **Chronic Ecotoxicity:** Phytoplankton, EC, biomass, 7 day, 14 mg/l.

13. DISPOSAL CONSIDERATIONS

13.1 **Waste treatment:** Sodium Carbonate is not a listed hazardous waste under 40 CFR 261. However, state and local regulations for waste disposal may be more restrictive. Spilled product should be disposed of in an EPA approved disposal facility in accordance with applicable national, state and local environmental laws and regulations.
13.2 **RCRA waste #:** Not listed.

14. TRANSPORT INFORMATION

14.1 **UN #:** Not listed

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14.2 **DOT ERG guide #:** Not listed (use guide # 111 as a general reference).
14.3 **STCC #:** 28-123-22

15. REGULATORY INFORMATION

15.1 **NFPA:** *Health-2 Flammability–0 Reactivity–0 Special-None*
HMIS: *Health-2 Fire-0 Reactivity-0 Personal Protection-E*
WHMIS: D-2-B. This product has been classified in accordance with the hazard criteria of the ***Controlled Products Regulations*** and the MSDS contains all the information required by the ***Controlled Products Regulations***.
15.2 **Regulatory/Carcinogenicity Status: NTP, IARC, OSHA:** None (2001)
15.3 **CERCLA RQ** (40 CFR 302): Not listed.
15.4 **SARA TITLE III 302 & 303**(40 CFR 355) Extremely hazardous substance listing: Not listed.
15.5 **SARA TITLE III 311 & 312**(40 CFR 370)
Hazardous Categories (product): Fire: No Sudden release of pressure: No Reactive: No
Acute health: No Chronic health: Yes
15.6 **SARA TITLE III 313** (40 CFR 372): **LISTED TOXIC CHEMICAL:** No
REPORTING THRESHOLD: Not Applicable.
15.7 **Canadian DSL Registration:** Yes
15.8 **US TSCA STATUS** (CFR 40 710-712.3): Yes
15.9 **EEC Labeling:** Name of dangerous products-sodium carbonate.
According to Annex I of Dir. 67/548/EEC (19th ATP: Dir. 93/72/EEC):

Symbols	Xi	Irritant
Phrases R	36	Irritating to eyes
Phrases S	(2)	Keep out of reach of children
	22	Do not breathe dust
	26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

Labeling "Dangerous for the environment". Not dangerous Provisional classification of WG from EU-DGXI-1/3-04-98.

16. OTHER INFORMATION

16.1 The National Sanitation Foundation (NSF) recommends that the maximum usage level is 100 mg/l for potable water treatment.

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Wollastonite ($CaSiO_3$)

Minera NYCO, S.A de C.V.

Health Hazard	1
Fire Hazard	0
Reactivity	0
Personal Protection	b

HMIS RATING

MATERIAL SAFETY DATA SHEET

NFPA RATING

SECTION I - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: NYAD®, NYGLOS®, NYCOR®, RRIMGLOS®
Various grades, untreated

MSDS Number: M100

Synonyms: Wollastonite, Calcium silicate

Revision: 1

Manufacturer: Minera NYCO, S.A de C.V.

Date issued: 5 March 2003

Address: Carret. Mina Pilares Km 0.0, Carret, Nogales Km 15.5
Hermosillo, Sonora, Mexico

Emergency Phone: 011-52-662-289 1000

Manufacturer FAX: 011-52-662-289-1090

SECTION II - COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS Number	EINECS No.	%	TLV	PEL
Natural wollastonite	13983-17-0	237-772-5	>99.5	3 mg/m^3 (PNOC)	5 mg/m^3 (PNOR)

Key: TLV = ACGIH, 8 hr. time weighted average (TWA); PEL = OSHA permissible exposure limit.
PNOC = Particulates Not Otherwise Classified (ACGIH - Inhalable), PNOR = Particulates Not Otherwise Regulated (OSHA - Total dust)

SECTION III - HAZARDS IDENTIFICATION

Specific Risks: Airborne particulate created during handling is considered nuisance dust and should be minimized through the use of good work practices and adequate ventilation.

HMIS Rating: **Health:** 1 **Fire:** 0 **Reactivity:** 0 **Personal Protection:** B

Primary Routes of Entry: Via respirable dust to the lungs and respiratory system and via coarse dust and particulate to the eyes.

Primary Target Organs: Lungs, respiratory system and eyes.

Potential Health Effects:

Inhalation: Irritating to the mucous membranes and respiratory tract. Excessive exposures to dust may cause sore throat, coughing or upper respiratory irritation.

Skin Contact: Possible dryness or irritation resulting from long term exposures to product dust.

Eye Contact: A mechanical irritant which can cause moderate to severe eye irritation.

Ingestion: Non-hazardous when ingested. Potentially a mild irritant to the GI tract if excessive quantity is ingested.

Medical Conditions Aggravated by Exposure: Pre-existing chronic upper respiratory and lung diseases such as, but not limited to, bronchitis, emphysema and asthma.

Carcinogenicity: This product is not classified by NTP or OSHA. IARC classifies wollastonite as Group 3: Unclassifiable as to carcinogenicity to humans.

SECTION IV - FIRST AID MEASURES

Inhalation: Remove to fresh air. Drink water to clear throat and blow nose to evacuate dust. If coughing and irritation develop, call a physician.

Eye Contact: Flush with large amounts of water until irritation subsides, as least 15 minutes. See a physician if irritation persists.

Skin Contact: Normal good personal hygiene practices. Wash with mild soap and warm water after each exposure.

Ingestion: Emergency procedures not normally required. May be a temporary irritant to the GI system.

SECTION V - FIREFIGHTING MEASURES

NFPA Rating: **Health:** 0 **Fire:** 0 **Reactivity:** 0 **Other:** 0

Flashpoint and Method: This is a non-flammable product **LEL:** N/Ap **UEL:** N/Ap

Extinguishing Method Not applicable. Product will not burn.

Special Firefighting Procedures: Not applicable.

Fire or explosion Hazards: None

SECTION VI - ACCIDENTAL RELEASE MEASURES

Clean-up Procedures: Scoop up or shovel material into waste container taking care to minimize dust. Wet down if necessary to control dust. Vacuum clean dust with equipment fitted with an efficient secondary filter.

Personal Precautions: If dusty conditions exist, wear a face mask approved for use with dusts such as 3M 8511, N-95 or equivalent.

Environmental Precautions: None normally required. Product contains naturally occurring minerals.

SECTION VII - HANDLING AND STORAGE

Storage Requirements: Store in dry area. Always segregate materials by major hazard class.

Special Sensitivity or Incompatibility: Avoid contact with strong acids.

Handling Precautions: Assure proper respiratory protection if dust potential exceeds PEL/TLV.

SECTION VIII - EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory Protection: When over PEL/TLV wear an approved face mask such as 3M 8511, N-95 or equivalent, to protect against dust.

Eye Protection: Wear safety glasses with side shields or goggles to protect eyes against dust and particulate

Skin Protection: Under normal conditions the wearing of protective gloves and clean, body-covering clothing should be adequate.

Engineering Controls: Maintain sufficient mechanical or natural ventilation to assure dust concentrations remain below PEL/TLV. Use local exhaust if necessary. Power equipment should be equipped with properly designed dust collection devices.

SECTION IX - PHYSICAL and CHEMICAL PROPERTIES

Physical Form: White acicular, free flowing non-metallic mineral powder. No characteristic odor.

Melting Point: 1540° C

Density: 2.9 g/mL

Solubility in Water: 0.01 g/100 cc

pH: 9.9 Aqueous Solution

SECTION X - STABILITY and REACTIVITY

Stability: Product is stable under normal conditions.

Hazardous Polymerization: Cannot occur.

Incompatibilities: None in designed use.

Conditions to Avoid: None in designed use.

Decomposition Products: No hazardous products of decomposition.

SECTION XI - TOXICOLOGICAL INFORMATION

LD_{50}: N/Av

LC_{50}: N/Av

Toxicological Hazards: Some medical studies of wollastonite mine and mill workers suggest that long term cumulative exposures to wollastonite dust may cause decreased pulmonary function or mild industrial bronchitis, particularly in workers who smoke.

The International Agency for Research on Cancer (IARC)has classified wollastonite as ,Group 3: Unclassifiable as to carcinogenicity to humans.

The German MAK Commission evaluation states: In all probability, wollastonite fibers do not have any carcinogenic affects.

Teratogenicity, Mutagenicity, other Reproductive Effects: None known

SECTION XII - ECOLOGICAL INFORMATION

Ecological Hazards: Wollastonite is a naturally occurring mineral. Unless contaminated in service, this product is neutral to the environment.

SECTION XIII - DISPOSAL CONSIDERATIONS

Waste Disposal Method: May be disposed in an approved landfill unless contaminated in service. If contaminated with hazardous materials, place waste in suitable container. Seal and properly label the waste container. Send the container to an approved Transportation, Storage and Disposal (TSD) facility via an approved waste hauler. Be sure manifests have been completed and an adequate "Paper trail" has been established.

SECTION XIV - TRANSPORTATION INFORMATION

US DOT Shipping Name: Not regulated

DOT Label: None

UN/NA Number: None

Canadian TGD Shipping Description: Not regulated as dangerous goods according to Canadian TDGA

International Dangerous Goods Information:

IMO: Not regulated as dangerous goods according to the IMDG Code.

ICAO: Not regulated as dangerous goods according to the IACO Technical Instructions.

SECTION XV - REGULATORY INFORMATION

International Occupational Exposure Limits:

Denmark	1 fiber/cm^3 (wollastonite)
Sweden	0.5 fibers/ml (natural fibers)
Canada, Quebec	1 fibre/cm^3 (wollastonite TWAEV)

Australia: **AICS:** Wollastonite is included in the *Australian Inventory of Chemical Substances*, June 1996 Ed.,

Canada: **DSL, NDSL and CEPA:** All components of this product are included in the DSL, NDSL and CEPA Chemical Inventories.
WHMIS: Not controlled by WHMIS.

China: **IECSC:** Wollastonite is included in the *Inventory of Existing Substances in China*.

EEC: **EINECS/ELINCS:** All components of this product are included in the EINECS AND ELINCS EEC Chemical Inventories.
IUCLID: Chemical information on wollastonite has been submitted for inclusion in the *International Uniform Chemical Information Database*.
67/548/EEC: ALTox a/s has on 27/7/98 evaluated and determined that wollastonite is not to be classified according to EEC directive (67/548/EEC).
95/3/EC, Annex III: Listed for use in "Plastic materials and articles intended to come into contact with foodstuffs.

Japan: **ENCS:** Wollastonite is exempt from the list of *Existing and New Chemical Substances* as a naturally occurring mineral.

Korea: **ECL:** Wollastonite is included in the *Korean Existing Chemical List*, ECL Number KE-35416.

Philippines: **PICCS:** Wollastonite is included in the *Philippine Inventory of Chemicals and Chemical Substances*.

USA: **EPA-TSCA:** Wollastonite is exempt from the *TSCA Inventory* as a naturally occurring mineral. All proprietary surface treatments are included on the *TSCA Inventory*.
EPA-CERCLA Reportable Quantity: N/Ap
EPA-SARA Title III: Substances in this product are not reportable under Section 313.
EPA-FIFRA: Wollastonite is present on the list of Pesticide Product Inert Ingredients.
FDA: Approved as pigment or colorant in food contact surface coatings, 21 CFR 175.300.
OSHA: Particulate is regulated as nuisance dust - Particulate Not Otherwise Regulated (PNOR).
ACGIH: Particulate is regulated as a nuisance dust - Particulate Not Otherwise Classified (PNOC).

SECTION XVI - OTHER INFORMATION

References:

IARC Monograph 68, 283-305, 1997.
Heikki O Koskinen, et al, Fibrosis of the lung and pleura and long term exposure to wollastonite, Scand J work Environ Health, 1997; vol 23, 41-47.
TOMES®: Hazardous Substances Data Bank, Registry of Toxic Effects Chemical Substances.

Prepared by: Compliance Consulting Group, Inc. **Approval Date:** 5 March 2003

Reason for Issue: Add NYCOR® and RRIMGLOS® **Supersedes Date:** 22 January 2001

Disclaimer:

Product Name: NYAD®, NYGLOS®, NYCOR®, RRIMGLOS® - Various grades, untreated MSDS Number: M100

As of the date of this document, the foregoing information is believed to be accurate and is provided in good faith to comply with applicable federal and state laws. However, no warranty or representation of law or fact, with respect to such information, is intended or given.

Fe_2O_3

Material Safety Data Sheet

Substance Identification

Identity: RED IRON OXIDE **CAS #:** 1309-37-1
Trade Names: Rouge
Prince Item Numbers: 07-3700 series, 07-3800 series, 07-3900 series, 07-4900 series, 07-5000 series

Manufacturer: The Prince Manufacturing Co.
One Prince Plaza
Quincy, IL 62305
217-222-8854

Emergency: Chemtrec
1-800-424-9300

Components and Contaminants

Chemical Name:	CAS #	OSHA PEL	ACGIH TLV	Percent
Iron Oxide	1309-37-1	10 mg/m^3	5 mg/m^3 (TWA)	80-99% Fe_2O_3
Silica, Crystalline Quartz (respirable)	14808-60-7	(10 mg/m^3)/(%SiO_2 + 2)	0.05 mg/m^3 (TWA)	1-9% SiO_2
Aluminum Oxide (total)	1344-28-1	15 mg/m^3	10 mg/m^3 (TWA)	0.5-3% Al_2O_3
(respirable)		5 mg/m^3	---	
Magnesium Oxide	1309-48-4	---	---	0.1-1% MgO
Calcium Oxide	1305-78-8	5 mg/m^3	2 mg/m^3 (TWA)	0.1-1% CaO

Physical Data

Boiling Point: NA
Vapor Pressure (mm/Hg): NA
Vapor Density (Air=1): NA
Solubility in Water: insoluble
Specific Gravity (H_2O=1): 4.5 - 5.0
Melting Point: 1300-1700° C
Evaporation Rate (Butyl Acetate=1): NA
Appearance and Odor: Red, reddish-brown, maroon, dark gray or black powder, no odor.

Fire and Explosion Hazard Data

Flash Point: Not combustible
Flammable Limits: LEL NA UEL NA
Extinguishing Media: Foam, CO_2, dry chemical or water.
Special Fire Fighting Procedures: In the event of fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full face piece operated in the pressure demand or other positive pressure mode.
Unusual Fire and Explosion Hazards: Not combustible.

Reactivity Data

Stability: Stable under ordinary conditions of use and storage.
Conditions to Avoid: None known
Incompatibility (materials to avoid): Aluminum, Ethylene Oxide, $Ca(OCl)_2$, N_2H_4.
Hazardous Decomposition or Byproducts: None known
Hazardous Polymerization: Will not occur.

Health Hazard Data

Route of Entry:
INHALATION: May cause irritation of mucous membrane if dust is inhaled over a prolonged period of time. Prolonged exposure to silica dust may result in silicosis, a fibrotic lung disease.
SKIN: No
INGESTION Ingestion of mineral compounds may cause abdominal pain and nausea.

Red Iron Oxide, Page 1
Reviewed: May 2003 Unchanged since May 2003

Health Hazard Data (cont.)

Health Hazards (Acute and Chronic):	Respiratory disease may result from prolonged overexposure. Can cause eye irritation.
Carcinogenicity:	NTP: Yes (Silica) IARC Monographs: Yes (Silica)
Signs and Symptoms of Exposure:	Excessive inhalation of dust may result in shortness of breath and reduced pulmonary function. Symptoms of silicosis include impaired pulmonary function and wheezing.
Aggravation of Pre-existing Conditions:	Persons with impaired respiratory function may be more susceptible to the effect of this substance.
Emergency and First Aid Procedures:	**IF INHALED**, remove to fresh air and seek medical attention for any breathing difficulty. **IN CASE OF SKIN CONTACT**, wash with soap & water. Seek medical attention if red & irritated. **IN CASE OF EYE CONTACT**, flush eyes immediately with water for at least 15 minutes. Seek medical attention if irritation persists. **IF INGESTED**, induce vomiting immediately by giving two glasses of water and sticking finger down throat. Never give anything by mouth to an unconscious person. Call a physician immediately.

Precautions for Safe Handling and Use

Material Release or Spill Precautions:	Should a spill occur, ventilate area. Clean-up personnel require respiratory protection. Recover uncontaminated material for use. Vacuum or sweep remaining material, keeping dust to a minimum.
Waste Disposal Method:	Dispose of unreclaimable material in a RCRA-approved waste facility.
Handling and Storing Precautions:	Protect containers from damage and keep closed when not in use.
Other Precautions:	Observe good personal hygiene. Wash after handling.

Control Measures

Respiratory Protection:	Use NIOSH approved particulate respirator if dust generation occurs or is anticipated. OSHA standard 1910.134 or ANSI Z88.2-1980 specifications are recommended.
Ventilation:	A system of local and/or general exhaust is recommended to keep employee exposures below the airborne exposure limits. Local exhaust is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, "Industrial Ventilation, A Manual of Recommended Practices", most recent edition, for details.
Protective Gloves:	Yes
Eye Protection:	Safety goggles are recommended.
Other Protective Clothing or Equipment:	Use other protective equipment when necessary in order to avoid prolonged exposure to skin.
Work and Hygienic Practices:	Observe good personal hygiene. Wash after handling.

SARA Title III Section 313 Supplier Notification

This product does not contain chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 and of 40 CFR 372.45

This information must be included in all MSDS's that are copied and distributed for this material.

Li_2CO_3

MATERIAL SAFETY DATA SHEET

LITHIUM CARBONATE

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

Manufacturer	SQM Chemicals Alcantara 44, 4th Floor, Las Condes Santiago, Chile	**Telephone:**	011-56-2-209-5413 (Chile) 1-800-635-5880 (USA)
		Emergency:	call Chemtrec 1-800-424-9300
Substance	Lithium Carbonate		
Synonyms	DILITHIUM CARBONATE, DILITHIUM SALT, CARBONIC ACID, LITHIUM SALT, LITHIUM CARBONATE (Li_2Co_3)		
Chemical Family	Inorganic Salt		

SECTION 2 COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT	FORMULA	CAS NUMBER	PERCENTAGE
LITHIUM CARBONATE	Li_2Co_3	554-13-2	99%

SECTION 3 HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4):	HEALTH = 1	FIRE = 0	REACTIVITY= 0	
HMIS RATINGS (SCALE 0-4):	HEALTH = 1	FIRE = 0	REACTIVITY= 0	PPE = E

EMERGENCY OVERVIEW:

White crystalline powder.
Causes eye irritation.
Avoid breathing dust. Avoid contact with eyes, skin and clothing. Keep container tightly closed. Wash thoroughly after handling. Use only with adequate ventilation. Handle with caution.

POTENTIAL HEALTH EFFECTS:

INHALATION:

SHORT TERM EFFECTS: May cause sore throat.
LONG TERM EFFECTS: No information available.

SKIN CONTACT:

SHORT TERM EFFECTS: May cause redness of the skin
LONG TERM EFFECTS: No information available.

Continued

SQM
CHEMICALS

SECTION 3 HAZARDS IDENTIFICATION (CONTINUED)

POTENTIAL HEALTH EFFECTS:

EYE CONTACT:

SHORT TERM EFFECTS: May cause irritation.

LONG TERM EFFECTS: Same effects as short-term exposure.

INGESTION:

SHORT TERM EFFECTS: May cause redness of the skin, vomiting, digestive disorders, frequent urination or inability to urinate, irregular heartbeat, disorientation, twitching, blurred vision, kidney damage, nerve damage and coma.

LONG TERM EFFECTS: May cause effects as reported in other routes of exposure. In addition skin disorders, metallic taste, low body temperature or fever, ringing in the ears, stomach pain, frequent urinatio, involuntary defecation and/or urination, difficulty speaking, low blood pressure, headache, drunkenness, numbness, intolerance of the eyes to light, blindness, lung effects, brain damage, convulsions and shock may occur. May also cause tumors.

SECTION 4 FIRST AID

INHALATION:

FIRST AID: Remove from exposure area to fresh air immediately. Perform artificial respiration if necessary. Keep person warm and at rest. Treat symptomatically and supportively. Get medical attention immediately.

SKIN CONTACT:

FIRST AID: Remove contaminated clothing and shoes immediately. Wash with soap or mild detergent and large amounts of water until no evidence of chemical remains (at least 15-20 minutes). Get medical attention immediately.

EYE CONTACT:

FIRST AID: Wash eyes immediately with large amounts of water or normal saline, occasionally lifting upper and lower lids, until no evidence of chemical remains (at least 15-20 minutes). Get medical attention immediately.

INGESTION:

FIRST AID: If victim is conscious and productive vomiting has not already occurred, remove poison by ipecac emesis or gastric lavage, maintain airway, respiration and blood pressure. Get medical attention. Qualified medical personnel should perform administration of gastric lavage.

NOTE TO PHYSICIAN

ANTIDOTE:

No specific antidote. Treat symptomatically and supportively.

LITHIUM POISONING: In single ingestion episodes, give syrup of ipecac and/or perform gastric lavage if productive vomiting has not already occurred. Activated charcoal does not bind lithium effectively and is not useful in isolated lithium toxicity. Raising the sodium intake does not increase lithium clearance.

SECTION 5 FIRE FIGHTING

FIRE AND EXPLOSION HAZARD:
Negligible fire hazard when exposed to heat or flame.

EXTINGUISHING MEDIA:
Extinguish using agent suitable for type of surrounding fire.

FIRE FIGHTING:
No acute hazard. Move container from fire area if possible. Avoid breathing vapors or dusts, keep upwind.

FLASH POINT:	not applicable
LOWER FLAMMABLE LIMIT:	not applicable
UPPER FLAMMABLE LIMIT:	not applicable
AUTOIGNITION:	not applicable

HAZARDOUS COMBUSTION PRODUCTS:
Thermal decomposition products may include toxic oxides of carbon.

SECTION 6 ACCIDENTAL RELEASE

OCCUPATIONAL SPILL:
For large spills, weep up with a minimum of dusting and place into suitable clean, dry containers for reclamation or later disposal.

Residue should be cleaned up using a high-efficiency particulate filter vacuum.

WATER SPILL:
The California Safe Drinking, Water and Toxic Enforcement Act of 1986 (Proposition 65) prohibits contaminating any known source of drinking water with substance known to cause cancer and/or reproductive toxicity. Lithium carbonate is listed as a reproductive toxin in Proposition 65.

SECTION 7 HANDLING AND STORAGE

Observe all regulations when storing this substance.

Store away from incompatible substances.

SECTION 8 EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:

No occupational exposure limits established by OSHA, ACGIH, or NIOSH. Use the ACGIH nuisance dust limit.

Subject to SARA Section 313 Annual Toxic Chemical Release Reporting

Subject to California proposition 65 cancer and/or reproductive toxicity warning and release requirements. (January 1, 1991)

VENTILATION:

Provide local exhaust ventilation system.

EYE PROTECTION:

Employee must wear splash-proof or dust-resistant safety goggles to prevent eye contact with this substance.

Emergency eyewash: Where there is any possibility that an employee's eyes may be exposed to this substance, the employer should provide an eye wash fountain within the immediate work area for emergency use.

CLOTHING:

Protective clothing not required. Avoid repeated or prolonged contact with this substance.

GLOVES:

Employee must wear appropriate protective gloves to prevent contact with this substance.

RESPIRATOR:

The specific respirator selected must be based on the specific operation; must not exceed the working limits of the respirator and must be jointly approved by the local Occupational Safety and Health Administration.

FOR FIRE FIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode.

Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode.

DESCRIPTION	White crystalline powder
MOLECULAR WEIGHT	73.89
MOLECULAR FORMULA	Li_2Co_3
BOILING POINT	2390 °F (1310 °C) (decomposes)
MELTING POINT	1333 °F (723 °C)
VAPOR PRESSURE	Effectively 0 at 20°C
VAPOR DENSITY	Not applicable
SPECIFIC GRAVITY	2.11
WATER SOLUBILITY	1.54% @ 0°C
pH	11.2 @ 1% solution
ODOR THRESHOLD	No data available
EVAPORATION RATE	Not applicable
SOLVENT SOLUBILITY	Insoluble in alcohol, acetone, ammonia

SECTION 10 STABILITY AND REACTIVITY

REACTIVITY:
Stable under normal temperatures and pressures.

CONDITIONS TO AVOID
Prevent dispersion of dust in air

INCOMPATIBILITIES:
ACIDS (DILUTE): Decomposes
ACIDS (STRONG): May react violently.
FLUORINE: Decomposes with incandescence.
METALS: May be corrosive in the presence of moisture.

HAZARDOUS DECOMPOSITION:
Thermal decomposition products may include toxic oxides of carbon.

POLYMERIZATION:
Hazardous polymerization has not been reported to occur under normal temperatures and pressures.

TOXICITY DATA:
4111 mg/kg oral-human TDLo; 54 mg/kg oral-man TDLo; 1080 mg/kg/13 weeks-intermittent oral-man TDLo; 120 mg/kg 10 days-intermittent oral-woman TDLo; 525 mg/kg oral-rat LD50; 531 mg/kg oral-mouse LD50; 500 mg/kg oral-dog LD50; 434 mg/kg subcutaneous-rat LD50; 413 mg/kg subcutaneous-mouse LD50; 241 mg/kg intravenous-rat LD50; 487 mg/kg intravenous-mouse LD50; 156 mg/kg intraperitoneal-rat LD50; 236 mg/kg intraperitoneal-mouse LD50; 556 mg/kg/32 days unreported-woman TDLo; mutagenic data (RTECS); reproductive effects data (RTECS); tumorigenic data (RTECS).

CARCINOGEN STATUS: None
LOCAL EFFECTS: Irritant -eye.
ACUTE TOXICITY LEVEL: Moderately toxic by ingestion.
TARGET EFFECTS: Poisoning may affect the nervous system, kidneys and thyroid.
AT INCREASED RISK FROM EXPOSURE: Persons with significant cardiovascular or renal disease, sodium and water imbalance, and pre-existing hypothyroidism.

HEALTH EFFECTS
INHALATION:

ACUTE EXPOSURE: Inhalation may cause coughing, sore throat and irritation.
CHRONIC EXPOSURE: No data available.

HEALTH EFFECTS

SKIN CONTACT:

ACUTE EXPOSURE: Application of 0.5 grams to rabbit skin under occlusive wrap for 4 hours produced minimal irritation. A grade of 0.3 on a scale of 0 to 8 was reported following a 30-minute interval after the skin was rinsed. One rabbit in the study had slight arrhythmia on days 1-4 following the exposure.

CHRONIC EXPOSURE: No data available.

EYE CONTACT:

IRRITANT

ACUTE EXPOSURE: Insulation of 0.10 grams into rabbit eyes produced moderate irritation. Slight to mild corneal opacities, iritis, slight to moderate conjunctivities, hemorrhages and white areas on the conjunctiva were noted. A grade of 41 on a scale of 0-110 was reported after 24 hours. No effects were noted by day 7 of the study. Washing the eyes with tap water shortly after exposure decreased both the severity and duration of effects with recovery occurring in 4 days.

CHRONIC EXPOSURE: Repeated or prolonged exposure to irritants may cause conjunctivitis.

Continued

SECTION 11 TOXICOLOGICAL INFORMATION (CONTINUED)

HEALTH EFFECTS CONTINUED

INGESTION:

ACUTE EXPOSURE: Ingestion of a large dose may cause severe gastroenteritis and effects on the central nervous system, renal function and fluid and electrolyte balance. Symptoms possibly delayed may include nausea, vomiting, thirst, anorexia, diarrhea, blurred vision, drowsiness, weakness, tremor, staggering, bradycardia and coma. More unusual reactions may include delirium with EEG changes, action myoclonus, rhabdomyolysis, ECG changes, glycosuria, and allergic erythema.

A painful discoloration of the fingers and toes and coldness of the extremities within 1 day of therapeutic use has been reported. In severe cases, death may occur due to renal failure or cardiac or pulmonary complications. Some survivors may have long-lasting or permanent sequelae, mostly of cerebellar nature but sometimes with peripheral neuropathy or Parkinsonism.

CHRONIC EXPOSURE: Repeated or prolonged ingestion may cause symptoms as detailed in acute ingestion. In addition, a metallic taste, dry mouth, excessive thirst, abdominal pain and incontinence of urine and feces may occur. Nervous system effects may include a dazed feeling, confusion, giddiness, mental lapses, dyspraxia, drowsiness, vertigo, headache, apathy, restlessness, anxiety, some suppression of the rem phases of sleep, positive Romberg sign, blackout spells, stupor, tinnitus, and unconsciousness. Neurologic asymmetry, psychomotor retardation, slurred speech, nystagmus and epileptiform seizures may occur. Pseudotumor cerebri (increased intracranial pressure and papilledema) has been reported and may possibly result in enlargement of the blind spot, constriction of visual fields and eventual blindness due to optic atrophy. Photophobia has been reported. Muscular effects may include tremors, ataxia, muscular and reflex hyperirritability with fasciculations, twitching and spastic or choreo-athetoic movements, cogwheel rigidity, parkinsonism and dystonia. Two cases involving severe generalized sensorimotor peripheral neuropathy have been reported. Cardiac arrhythmia, hypotension, peripheral circulatory collapse, and interstitial myocarditis are possible. Leukocytosis is fairly common. Endocrine effects may include disturbed iodine metabolism, stimulation of antithyroidal auto-antibodies, hypothyroidism with myxedema, or rarely hyperthyroidism. Osteoporosis, an increase in serum total calcium, ionized calcium and parathyroid hormone and independently functioning parathyroid adenomas have been reported. Transitory nephrotic syndrome and acquired nephrogenic diabetes insipidus may occur. Transient hyperglycemia, lowered urinary concentrating ability leading to hypernatremia and hyperosmolality, sodium depletion, polyuria, glycosuria, oliguria, anuria, and azotemia are possible. Morphologic changes with glomerular and interstitial fibrosis and nephron atrophy have been reported. However, a causal relationship has not been established. Dermatologic effects may include cutaneous hyperalgesia or anesthesia, xerosis cutis, chronic folliculitis, generalized pruritus with or without rash, development or exacerbation of acne or psoriasis, cutaneous ulcers and alopecia. Hyper or hypothermia, weight gain, edema of the ankles and wrists, and sexual dysfunction have been reported. Death may occur due to renal failure, brain damage or pulmonary complications. Lithium readily crosses the placental barrier and is excreted in breast milk. The use of lithium in pregnancy has been associated with neonatal goiter, cardiac anomalies, especially ebsteins, central nervous system depression and hypotonia. Marked functional and structural changes in the kidneys of newborn rats exposed to lithium via their mother's milk have been reported. Adverse effects on nidation in rats and embryo viability in mice have been attributed to lithium, as have teratogenicity in submammalian species and cleft palates in mice. However, other studies in rats, rabbits and monkeys have shown no evidence of lithium-induced developmental defects. Leukemia has been reported during lithium treatment. However, an epidemiologic study involving a population of 173,000 persons yielded negative results.

Continued.

SECTION 11 TOXICOLOGICAL INFORMATION (CONTINUED)

Avoid exposure of pregnant women to environments where this product is in excess of 5 mg/m^3.

SECTION 12 ECOLOGICAL INFORMATION

ENVIRONMENTAL IMPACT RATING (0-4) no data available

ACUTE AQUATIC TOXICITY: no data available.

DEGRADABILITY: no data available

LOG BIOCONCENTRATION FACTOR (BCF): no data available

LOG OCTANOL/WATER PARTITION COEFFICIENT: no data available

SECTION 13 DISPOSAL CONSIDERATIONS

Observe all national, state and local regulations when disposing of this substance.

SECTION 14 TRANSPORT INFORMATION

DOT (U.S.A.)

DOT Proper Shipping Name:	Lithium Carbonate, Chemicals, N.O.I.
DOT Classification:	None.
DOT Labels:	None.
DOT Marking:	Lithium Carbonate
DOT Placard:	None.
UN Number:	None.

IMCO

IMCO Proper Shipping Name:	Lithium Carbonate, Chemicals, N.O.I.
IMCO Hazard Classification:	None.
IMCO Hazard Class:	None.
DOT Labels:	None.
DOT Marking:	Lithium Carbonate

49 STCC NUMBER None.

EMERGENCY ACCIDENT

Precautions and Procedures: None.
Precautions to be taken in transportation: None.

SECTION 15 REGULATORY INFORMATION

TSCA STATUS: Y

CERCLA SECTION 103 (40CFR302.4):	No
SARA SECTION 302 (40CFR355.30):	No
SARA SECTION 304 (40CFR355.40):	No
SARA SECTION 313 (40CFR372.65):	Yes
OSHA PROCESS SAFETY (29CFR1910.119):	No
CALIFORNIA PROPOSITION 65:	Yes

CALIFORNIA PROPOSITION 65: On 1 January 91 the State of California added lithium carbonate o its list: Chemicals known to the State to cause reproductive toxicity". In California workers exposed to lithium carbonate must each be warned as follows: "Warning: This product contains a chemical known to the Sate of California to cause birth defects or other reproductive harm."

SARA HAZARD CATEGORIES, SARA SECTIONS 311/312 (40CFR 370.21)

ACUTE HAZARD:	Yes
CHRONIC HAZARD:	No
FIRE HAZARD:	No
REACTIVITY HAZARD:	No
SUDDEN RELEASE HAZARD:	No

Effective January 1, 1995, Lithium Carbonate is subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

SECTION 16 OTHER INFORMATION

Avoid exposure of pregnant women to environments where this product is in excess of 5 mg/m3.

Olivine

MATERIAL SAFETY DATA SHEET

MSDS No: 037

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/ UNDERTAKING

UNIMIN CORPORATION
258 Elm Street
New Canaan, CT 06840

Emergency Telephone Number
(203) 966-8880

Telephone Number for Information
(203) 966-8880

PRODUCT NAME: Olivine, various grades

SYNONYMS: Magnesium Iron Silicate

Date Prepared: August 2003

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

CAS# / EINECS #	Component	Percentage	EU Classification (67/548/EEC)
1317-71-1/ 215-281-7	Olivine	>99.3%	Not Applicable
7440-02-0 / 231-111-4	Nickel Compounds	0.1-0.3%	Xn R40, R43
7440-47-3 / 231-157-5	Chromium Compounds	0.1-0.4%	Not Applicable

Refer to section 16 for further information on EU Classification.

See Section 8 for occupational exposure limit information

SECTION 3: HAZARDS IDENTIFICATION

This product is a chemically inert, non-combustible mineral.

EMERGENCY OVERVIEW
WARNING!

Excessive inhalation of dust may cause mucous membrane and respiratory irritation and lung injury with symptoms of shortness of breath and reduced pulmonary function. Cancer Hazard. Contains nickel compounds, which can cause cancer. Risk of injury is dependent on the duration and level of exposure. A single exposure will not result in serious adverse effects. **See "Health Hazards" in Section 11 for detailed information.** See exposure limit presentation in Section 8 for further information.

Avoid creating dust when handling, using or storing. Use with adequate ventilation to keep exposure below recommended exposure limits.

EU Classification of Substance/Preparation: Not classified as a dangerous preparation.

SECTION 4: FIRST AID MEASURES

Gross Inhalation: Remove victim to fresh air. If breathing has stopped, perform artificial respiration. If breathing is difficult have qualified personnel administer oxygen. Get prompt medical attention.

Skin Contact: No first aid should be needed since dermal contact with this product does not affect the skin. Wash exposed skin with soap and water before breaks and at the end of the shift.

Eye Contact: Flush the eyes immediately with large amounts of running water, lifting the upper and lower lids occasionally. If irritation persists or for imbedded foreign body, get immediate medical attention.

MSDS No: 037

Ingestion: If large amounts are swallowed, get immediate medical attention.

SECTION 5: FIREFIGHTING MEASURES

Flash Point (Method Used): Fully oxidized, will not burn.

Autoignition Temp: Will not burn.

Flammable Limits: LEL: Not applicable UEL: Not applicable

Extinguishing Media: This product will not burn but is compatible with all extinguishing media. Use any media that is appropriate for the surrounding fire.

Special Fire Fighting Procedures: None required with respect to this product. Firefighters should always wear self-contained breathing apparatus for fires indoors or in confined areas.

Unusual Fire and Explosion Hazards: None.

Hazardous Combustion Products: None.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Wear appropriate protective equipment. If uncontaminated, collect using dustless method (HEPA vacuum or wet method) and place in appropriate container for use. If contaminated: a) use appropriate method for the nature of contamination, and b) consider possible toxic or fire hazards associated with the contaminating substances. Collect for appropriate disposal.

SECTION 7: HANDLING AND STORAGE

Avoid breathing dust. Use normal precautions against bag breakage or spills of bulk material. Avoid creation of respirable dust. Use good housekeeping in storage and use areas to prevent accumulation of dust in work area.

Use adequate ventilation and dust collection. Maintain, use, clean and fit test respirators in accordance with OSHA regulations. Maintain and test ventilation and dust collection equipment. Launder clothing that has become dusty. Empty containers (bags, bulk containers, storage tanks, etc.) retain product residue and must be handled in accordance with the provisions of this Material Safety Data Sheet. **WARN and TRAIN** employees in accordance with state and federal regulations.

WARN YOUR EMPLOYEES (AND YOUR CUSTOMERS AND USERS IN CASE OF RESALE) BY POSTING, AND OTHER MEANS, OF THE HAZARDS AND OSHA PRECAUTIONS AND ANY OTHER APPLICABLE REGULATORY PRECAUTIONS TO BE USED. PROVIDE TRAINING FOR YOUR EMPLOYEES ABOUT OSHA PRECAUTIONS.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Limits

Definitions:
MSHA means Mine Safety and Health Administration.
NIOSH means National Institute for Occupational Safety and Health.
OSHA means Occupational Safety and Health Administration.
PEL means OSHA Permissible Exposure Limit.
REL means the NIOSH Recommended Exposure Limit.
TLV means American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value.
TWA means time-weighted average.

Olivine: PEL - 5mg/m^3 TWA (respirable fraction), 15 mg/ m^3 TWA (total dust) as Particulates not Otherwise Classified
TLV- None established (refer to ACGIH guidance for Particulates (insoluble or poorly soluble) Not Otherwise Specified)
MSHA - 5mg/m^3 TWA (respirable fraction), 15 mg/ m^3 TWA (total dust) as Particulates not Otherwise Classified

Nickel Compounds: (as Nickel)
PEL - 1mg/ m^3 TWA
TLV - 0.2mg/m^3 TWA (inhalable fraction)
MSHA - 1 mg/m^3 TWA

Chromium Compounds: (as Chromium)
PEL - 0.5mg/ m^3 TWA
TLV - 0.5mg/m^3 TWA
MSHA - 0.5mg/m^3 TWA

Ventilation: Use local exhaust as required to maintain exposures below applicable occupational exposure limits. See also ACGIH "Industrial Ventilation - A Manual for Recommended Practice" (current edition). Control of exposure to dust must be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general or local exhaust ventilation and substitution of less toxic materials).

Respiratory Protection: When effective engineering controls are not feasible, or while they are being implemented, appropriate respiratory protection must be used. Use appropriate respiratory protection for respirable particulates based on consideration of airborne workplace concentrations and duration of exposure arising from intended end use. Refer to the most recent standards of ANSI (Z88.2), OSHA (29 CFR 1910.134), MSHA (30 CFR Parts 56 and 57) and NIOSH Respirator Decision Logic.

Gloves: Protective gloves recommended.

Eye Protection: Safety glasses or goggles recommended.

Other Protective Equipment/Clothing: As appropriate for the work environment. Dusty clothing should be laundered before reuse.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance and Odor: Light green to gray-green sand-size granules, odorless.

pH: Not applicable
Boiling Point: Not applicable
Melting Point: Melting Point: 2800 - 3200°F
Solubility in Water: Insoluble
Percent Volatile: 0%
Autoignition Temp: Will not burn

Specific Gravity (water=1): 2.3-3.6
Vapor Pressure: Not applicable
Vapor Density: Not applicable
Evaporation Rate: Not applicable
Flash Point (Method Used): Fully oxidized, will not burn
Flammable Limits: LEL: Not applicable
UEL: Not applicable

SECTION 10: STABILITY AND REACTIVITY

Stability: Stable
Conditions to Avoid: None.

Incompatibility: None known

Hazardous Decomposition Products: None known.

Hazardous Polymerization: Will not occur.
Conditions to Avoid: None

MSDS No: 037

SECTION 11: TOXICOLOGICAL INFORMATION

HEALTH HAZARDS:

Inhalation: Inhalation of dust may cause irritation of the nose, throat and respiratory passages.

Skin Contact: No adverse effects expected.

Eye Contact: Contact may cause mechanical irritation and possible injury.

Ingestion: No adverse effects expected for normal, incidental ingestion.

Chronic Health Effects: Prolonged overexposure to any nuisance dust may cause lung injury. Symptoms include cough, shortness of breath, and reduced pulmonary function. This product contains small amounts of nickel and chromium compounds. Hexavalent chromium has not been detected in this product (detection limit 0.1%). Overexposure to nickel and chromium compounds may cause respiratory and skin sensitization.

Cancer Status: Nickel compounds are classified by IARC as "carcinogenic to humans" (Group 1) and by NTP as "reasonably anticipated to be a carcinogen". None of the other components are listed as carcinogens or suspected carcinogens by IARC, NTP or OSHA.

Medical Conditions Aggravated by Exposure: Individuals with respiratory disease, including but not limited to, asthma and bronchitis, or subject to eye irritation should be excluded from exposure.

Signs and Symptoms of Exposure: Overexposure to nuisance dusts may cause mucous membrane and respiratory irritation, cough, sore throat, nasal congestion, sneezing and shortness of breath

Acute Toxicity Values: No acute toxicity data is available for product or components .

SECTION 12: ECOLOGICAL INFORMATION

No ecotoxicity data is available. This product is not expected to present an environmental hazard.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal Method: Olivine is not classified as a hazardous waste under US EPA RCRA regulations. If uncontaminated, dispose as an inert, non-metallic mineral. If contaminated, dispose in accordance with all applicable local, state/provincial and federal regulations in light of the contamination present. Local regulations may be more stringent than regional and national requirements. It is the responsibility of the waste generator to determine the toxicity and physical characteristics of the material to determine the proper waste identification and disposal in compliance with applicable regulations.

SECTION 14: TRANSPORT INFORMATION

U.S. DOT HAZARD CLASSIFICATION
- Proper Shipping Name: Not Regulated
- Technical Name: N/A
- UN Number: N/A
- Hazard Class/Packing Group: N/A
- Labels Required: None
- DOT Packaging Requirements: N/A
- Exceptions: N/A

MSDS No: 037

SECTION 15: REGULATORY INFORMATION

SARA 311/312: Hazard Categories for SARA Section 311/312 Reporting: Chronic Health

SARA 313 This Product Contains the Following Chemicals Subject to Annual Release Reporting Requirements Under the SARA Section 313 (40 CFR 372): Nickel Compounds 0.1 - 0.3% Chromium Compounds 0.1 - 0.4%.

CERCLA Section 103 Reportable Quantity: None

California Proposition 65: This product contains nickel compounds which are known to the State of California to cause cancer.

Toxic Substances Control Act: All of the components of this product are listed on the EPA TSCA Inventory or exempt from premanufacture notification requirements.

European Inventory of Commercial Chemical Substances: All of the components of this product are listed on the EINECS Inventory or exempt from notification requirements.

European Community Labeling: No labeling required.

Canadian Environmental Protection Act: All the components of this product are listed on the Canadian Domestic Substances List or exempt from notification requirements.

Canadian WHMIS Classification: Class D, Division 2, Subdivision A (Very Toxic Material causing other Toxic Effects)

This MSDS has been prepared according to the criteria of the Controlled Products Regulation (CPR) and the MSDS contains all of the information required by the CPR.

Japan METI: All of the components of this product are existing chemical substances as defined in the Chemical Substance Control Law.

Australian Inventory of Chemical Substances: All of the components of this product are listed on the AICS inventory or exempt from notification requirements.

Korea: All of the components of this product are listed on the ECL inventory or exempt from notification requirements.

Philippines: All of the components of this product are listed on the PICCS inventory or exempt from notification requirements.

16: OTHER INFORMATION

EU Classes and Risk Phrases for Reference (See Sections 2 and 3)
Xn Harmful
R40 Limited evidence of a carcinogenic effect.
R43 May cause sensitization by skin contact.

NFPA Hazard Rating:	Health: 1	Fire: 0	Reactivity: 0
HMIS Hazard Rating:	Health: 1*	Fire: 0	Reactivity: 0

*Warning - Chronic health effect possible

MSDS No: 037

References:

Registry for Toxic Effects of Chemical Substances (RTECS), 2003
Patty's Industrial Hygiene and Toxicology
NTP Tenth Report on Carcinogens, 2002
IARC Monograph Volume 49, Nickel and Nickel Compounds, 1990
Hazardous Substances Data Bank (HSDB), 2003
Toxline, 2003

Revision Summary: Revised Composition (Section 2), Revised Exposure Limits (Sections 2 and 8), Revised Hazards Identification (Section 3), Handling and Storage (Section 7). Revised Ventilation and Respiratory Protection (Section 8), Moved Health Hazard Data (Section 11), Revised Disposal Information (Section 13), Added Canadian, EU, Japanese, Australian, Korean and Philippine Inventory Status (Section 15).

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process. The information set forth herein is based on technical data the Unimin Corporation believes reliable. It is intended for use by persons having technical skill and at their own discretion and risk. Since conditions of use are outside the control of Unimin Corporation, no warranties, expressed or implied, are made and no liability is assumed in connection with any use of this information. Any use of these data and information must be determined by the user to be in accordance with federal, state and local laws and regulations.

SiO_2

U. S. SILICA COMPANY

MSDS - MATERIAL SAFETY DATA SHEET

SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Names/Trade Names:

Silica Sand sold under various names: ASTM TESTING SANDS • GLASS SAND • FLINT SILICA • DM-SERIES • F-SERIES • FOUNDRY SANDS • FJ-SERIES • FP-SERIES • H-SERIES • L-SERIES • N-SERIES • NJ-SERIES • OK-SERIES • P-SERIES • T-SERIES • HYDRAULIC FRACING SANDS • MIN-U-SIL® • MYSTIC WHITE® • #1 DRY • #1 SPECIAL • PENN SAND® • Q-ROK® • SIL-CO-SIL® • SUPERSIL®.

Synonyms/Common Names: Sand, Silica Sand, Quartz, Crystalline Silica, Flint, Ground Silica.

Manufacturer's Name:
U. S. Silica Company
P. O. Box 187
Berkeley Springs, WV 25411

Emergency Telephone Number: 304-258-2500
304-258-8295 (fax)

Date Prepared: September 15, 2000

SECTION 2 - COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients:

	Chemical Formula	Typical %, By Weight	CAS #
Crystalline Silica (quartz)	SiO_2	99.0 - 99.9	14808-60-7
Aluminum Oxide	Al_2O_3	< .8	1344-28-1
Iron Oxide	Fe_2O_3	< .1	1309-37-1
Titanium Oxide	TiO_2	< .1	13463-67-7

Exposure Limits for Hazardous Ingredients:

	OSHA PEL	ACGIH TLV	NIOSH REL
Crystalline Silica (Quartz)	$\frac{10\ mg/m^3}{\%\ SiO_2 + 2}$	.05	.05

The exposure limits are time-weighted average concentrations for an 8-hour workday and a 40-hour workweek.

Crystalline silica exists in several forms, the most common of which is quartz. If crystalline silica (quartz) is heated to more than 870°C, it can change to a form of crystalline silica known as trydimite, and if crystalline silica (quartz) is heated to more than 1470°C, it can change to a form of crystalline silica known as cristobalite. The OSHA PEL for crystalline silica as trydimite and cristobalite is one-half of the OSHA PEL for crystalline silica (quartz).

SECTION 3 - HAZARD IDENTIFICATION

EMERGENCY OVERVIEW:

The U. S. Silica Company material is a white or tan sand, or ground sand. It is not flammable, combustible or explosive. It does not cause burns or severe skin or eye irritation. A single exposure will not result in serious adverse health effects. Crystalline silica (quartz) is not known to be an environmental hazard.

Crystalline silica (quartz) is incompatible with hydrofluoric acid, fluorine, chlorine trifluoride or oxygen difluoride.

POTENTIAL HEALTH EFFECTS:

Inhalation:

a. Silicosis	Respirable crystalline silica (quartz) can cause silicosis, a fibrosis (scarring) of the lungs. Silicosis may be progressive; it may lead to disability and death.
b. Cancer	Crystalline silica (quartz) inhaled from occupational sources is classified as carcinogenic to humans.
c. Autoimmune Diseases	There are some studies that show excess numbers of cases of scleroderma and other connective tissue disorders in workers exposed to respirable crystalline silica.
d. Tuberculosis	Silicosis increases the risk of tuberculosis.
e. Nephrotoxicity	There are some studies that show an increased incidence of chronic kidney disease and end-stage renal disease in workers exposed to respirable crystalline silica.

Eye Contact: Crystalline silica (quartz) may cause abrasion of the cornea.

Skin Contact: Not applicable.

Ingestion: Not applicable.

Chronic Effects: The adverse health effects -- silicosis, cancer, autoimmune diseases, tuberculosis, and nephrotoxicity -- are chronic effects.

Signs and Symptoms of Exposure: Generally, there are no signs or symptoms of exposure to crystalline silica (quartz).

Medical Conditions Generally Aggravated by Exposure: The condition of individuals with lung disease (e.g., bronchitis, emphysema, chronic obstructive pulmonary disease) can be aggravated by exposure.

See Section 11, Toxicological Information, for additional detail on potential adverse health effects.

SECTION 4 - FIRST AID MEASURES

Inhalation: No specific first-aid is necessary since the adverse health effects associated with exposure to crystalline silica (quartz) result from chronic exposures. If there is a gross inhalation of crystalline silica (quartz), remove the person immediately to fresh air, give artificial respiration as needed, seek medical attention as needed.

Eye Contact: Wash immediately with water. If irritation persists, seek medical attention.

Skin Contact: Not applicable.

Ingestion: Not applicable.

SECTION 5 - FIRE FIGHTING MEASURES

Crystalline silica (quartz) is not flammable, combustible or explosive.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

Spills: Use dustless methods (vacuum) and place into closable container for disposal, or flush with water. Do not dry sweep. Wear protective equipment specified below.

Waste Disposal Method: See Section 13.

SECTION 7 - HANDLING AND STORAGE

Precautions During Handling and Use: Do not breath dust. Use adequate ventilation and dust collection. Keep airborne dust concentrations below PEL. Do not rely on your sight to determine if dust is in the air. Silica may be in the air without a visible dust cloud. If dust cannot be kept below permissible limits, wear a respirator approved for silica dust when using, handling, storing or disposing of this product or bag. Practice good housekeeping. Do not permit dust to collect on walls, floors, sills, ledges, machinery, or equipment. Maintain, clean, and fit test respirators in accordance with OSHA regulations. Maintain and test ventilation and dust collection equipment. Wash or vacuum clothing that has become dusty. See also control measures in Section 8.

Precautions During Storage: Avoid breakage of bagged material or spills of bulk material. See control measures in Section 8.

Do not use U. S. Silica Company materials for sandblasting.

The OSHA Hazard Communication Standard, 29 CFR Sections 1910.1200, 1915.1200, 1917.28, 1918.90, 1926.59 and 1928.21, and state and local worker or community "right-to-know" laws and regulations should be strictly followed. WARN YOUR EMPLOYEES (AND YOUR CUSTOMERS IN CASE OF RESALE) BY POSTING AND OTHER MEANS OF THE HAZARDS AND THE REQUIRED OSHA PRECAUTIONS. PROVIDE TRAINING FOR YOUR EMPLOYEES ABOUT THE OSHA PRECAUTIONS.

See also American Society for Testing and Materials (ASTM) standard practice E 1132-99a, "Standard Practice for Health Requirements Relating to Occupational Exposure to Respirable Crystalline Silica."

SECTION 8 - EXPOSURE CONTROLS/PERSONAL PROTECTION

Local Exhaust: Use sufficient local exhaust to reduce the level of respirable crystalline silica to below the PEL. See ACGIH "Industrial Ventilation, A Manual of Recommended Practice" (latest edition).

Respiratory Protection: The following chart specifies the types of respirators which may provide respiratory protection for crystalline silica.

Particulate Concentration	MINIMUM RESPIRATORY PROTECTION*
10 x PEL or less	Any particulate respirator, except single-use or quarter-mask respirator. Any fume respirator or high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
50 x PEL or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
500 x PEL or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 500 x PEL or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
***Use only NIOSH-approved or MSHA-approved equipment. See 29 CFR §1910.134 and 42 CFR §84.**	

See also ANSI standard Z88.2 (latest revision) "American National Standard for Respiratory Protection".

Permissible Exposure Levels:

			Exposure Guidelines						
		Percentage	OSHA		ACGIH		NIOSH		
Component	CAS No.	(by wt.)	TWA	STEL	TWA	STEL	TWA	STEL	Unit
Crystalline Silica (quartz)	14808-60-7	99.0-99.9	$\frac{10}{\% SiO_2 + 2}$	None	.05	None	.05	None	mg/m^3

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	White or tan sand; granular, crushed, or ground.		
Boiling Point:	4046°F	**Odor:**	None
Vapor Pressure (mm Hg.):	None	**Specific Gravity (Water = 1):**	2.65
Vapor Density (Air = 1):	None	**Melting Point:**	3110°F
Solubility in Water:	Insoluble in water	**Evaporation Rate (Butyl Acetate = 1):**	None

SECTION 10 - STABILITY AND REACTIVITY

Stability: Crystalline silica (quartz) is stable.

Incompatibility (Materials to Avoid): Contact with powerful oxidizing agents, such as fluorine, chlorine trifluoride and oxygen difluoride, may cause fires.

Hazardous Decomposition or Byproducts: Silica will dissolve in hydrofluoric acid and produce a corrosive gas - silicon tetrafluoride.

Hazardous Polymerization: Will not occur.

SECTION 11 - TOXICOLOGICAL INFORMATION

A. SILICOSIS

The major concern is silicosis, caused by the inhalation and retention of respirable crystalline silica dust. Silicosis can exist in several forms, chronic (or ordinary), accelerated, or acute.

Chronic or Ordinary Silicosis (often referred to as Simple Silicosis) is the most common form of silicosis, and can occur after many years of exposure to relatively low levels of airborne respirable crystalline silica dust. It is further defined as either simple or complicated silicosis.

Simple silicosis is characterized by lung lesions (shown as radiographic opacities) less than 1 centimeter in diameter, primarily in the upper lung zones. Often, simple silicosis is not associated with symptoms, detectable changes in lung function or disability.

Simple silicosis may be progressive and may develop into complicated silicosis or progressive massive fibrosis (PMF). Complicated silicosis or PMF is characterized by lung lesions (shown as radiographic opacities) greater than 1 centimeter in diameter. Although there may be no symptoms associated with complicated silicosis or PMF, the symptoms, if present, are shortness of breath, wheezing, cough and sputum production. Complicated silicosis or PMF may be associated with decreased lung function and may be disabling. Advanced complicated silicosis or PMF may lead to death. Advanced complicated silicosis or PMF can result in heart disease secondary to the lung disease (cor pumonale).

Accelerated Silicosis can occur with exposure to high concentrations of respirable crystalline silica over a relatively short period; the lung lesions can appear within five (5) years of the initial exposure. The progression can be rapid. Accelerated silicosis is similar to chronic or ordinary silicosis, except that the lung lesions appear earlier and the progression is more rapid.

Acute Silicosis can occur with exposures to very high concentrations of respirable crystalline silica over a very short time period, sometimes as short as a few months. The symptoms of acute silicosis include progressive shortness of breath, fever, cough and weight loss. Acute silicosis is fatal.

B. CANCER

IARC - The International Agency for Research on Cancer ("IARC") concluded that there was "*sufficient evidence* in humans for the carcinogenicity of crystalline silica in the forms of quartz or cristobalite from occupational sources", and that there is "*sufficient evidence* in experimental animals for the carcinogenicity of quartz and cristobalite." The overall IARC evaluation was that "crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is *carcinogenic to humans (Group 1)*." The IARC evaluation noted that "carcinogenicity was not detected in all industrial circumstances studies. Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." For further information on the IARC evaluation, see IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 68, "Silica, Some Silicates..." (1997).

NTP - The National Toxicology Program, in its Ninth Annual Report on Carcinogens, classified "silica, crystalline (respirable)" as a known human carcinogen.

OSHA - Crystalline silica (quartz) is not regulated by the U. S. Occupational Safety and Health Administration as a carcinogen.

There have been many articles published on the carcinogenicity of crystalline silica, which the reader should consult for additional information; the following are examples of recently published articles: (1) "Crystalline Silica and Lung Cancer: The Problem of Conflicting Evidence", Indoor Built Environ, Volume 8, pp. 121-126 (1998); (2) "Crystalline Silica and the risk of lung cancer on the potteries", Occup. Environ. Med., Volume 55, pp. 779-785 (1998); (3) "Is Silicosis Required for Silica-Associated Lung Cancer?", American Journal of Industrial Medicine, Volume 37, pp. 252-259 (2000); (4) " Silica, Silicosis, and Lung Cancer: A Risk Assessment", American Journal of Industrial Medicine, Volume 38, pp. 8-18 (2000); (5) "Silica, Silicosis, and Lung Cancer: A Response to a Recent Working Group Report", Journal of Occupational and Environmental Medicine, Volume 42, pp. 704-720 (2000).

C. AUTOIMMUNE DISEASES

There is evidence that exposure to respirable crystalline silica (without silicosis) or that the disease silicosis is associated with the increased incidence of several autoimmune disorders, -- scleroderma, systemic lupus erythematosus, rheumatoid arthritis and diseases affecting the kidneys. For a review of the subject, the following may be consulted: "Occupational Exposure to Crystalline Silica and Autoimmune Disease", Environmental Health Perspectives, Volume 107, Supplement 5, pp. 793-802 (1999); "Occupational Scleroderma", Current Opinion in Rheumatology, Volume 11, pp. 490-494 (1999).

D. TUBERCULOSIS

Individuals with silicosis are at increased risk to develop pulmonary tuberculosis, if exposed to persons with tuberculosis. The following may be consulted for further information: Occupational Lung Disorders, Third Edition, Chapter 12, entitled "Silicosis and Related Diseases", Parkes, W. Raymond (1994); "Risk of pulmonary tuberculosis relative to silicosis and exposure to silica dust in South African gold miners," Occup Environ Med., Volume 55, pp.496-502 (1998).

E. KIDNEY DISEASE

There is evidence that exposure to respirable crystalline silica (without silicosis) or that the disease silicosis is associated with the increased incidence of kidney diseases, including end stage renal disease. For additional information on the subject, the following may be consulted: "Kidney Disease and Silicosis", Nephron, Volume 85, pp. 14-19 (2000).

SECTION 12 - ECOLOGICAL INFORMATION

Crystalline silica (quartz) is not known to be ecotoxic; i.e., there is no data which suggests that crystalline silica (quartz) is toxic to birds, fish, invertebrates, microorganisms or plants. For additional information on crystalline silica (quartz), see Sections 9 (physical and chemical properties) and 10 (stability and reactivity) of this MSDS.

SECTION 13 - DISPOSAL CONSIDERATIONS

General: The packaging and material may be landfilled; however, material should be covered to minimize generation of airborne dust.

RCRA: Crystalline silica (quartz) is not classified as a hazardous waste under the Resource Conservation and Recovery Act, or its regulations, 40 CFR §261 et seq.

The above applies to materials as sold by U.S. Silica Company. The material may be contaminated during use, and it is the responsibility of the user to assess the appropriate disposal of the used material.

SECTION 14 - TRANSPORT INFORMATION

Crystalline silica (quartz) is not a hazardous material for purposes of transportation under the U. S. Department of Transportation Table of Hazardous Materials, 49 CFR §172.101.

SECTION 15 - REGULATORY INFORMATION

UNITED STATES (FEDERAL AND STATE)

TSCA No.: Crystalline silica (quartz) appears on the EPA TSCA inventory under the CAS No. 14808-60-7.

RCRA: Crystalline silica (quartz) is not classified as a hazardous waste under the Resource Conservation and Recovery Act, or its regulations, 40 CFR §261 et seq.

CERCLA: Crystalline silica (quartz) is not classified as a hazardous substance under regulations of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), 40 CFR §302.

Emergency Planning and Community Right to Know Act: Crystalline silica (quartz) is not an extremely hazardous substance under Section 302 and is not a toxic chemical subject to the requirements of Section 313.

Clean Air Act: Crystalline silica (quartz) mined and processed by U.S. Silica Company was not processed with or does not contain any Class I or Class II ozone depleting substances.

FDA: Silica is included in the list of substances that may be included in coatings used in food contact surfaces, 21 CFR §175.300(b)(3)(xxvi).

NTP: Respirable crystalline silica (quartz) is classified as a carcinogen.

OSHA Carcinogen: Crystalline silica (quartz) is not listed.

California Proposition 65: Crystalline silica (quartz) is classified as a substance known to the State of California to be a carcinogen.

CANADA

Domestic Substances List: U. S. Silica Company products, as naturally-occurring substances, are on the Canadian DSL.

WHMIS Classification: D2A

OTHER

EINECS No.: 238-878-4

EEC Label (Risk/Safety Phrases): R 48/20, R 40/20, S22, S38

IARC: Crystalline silica (quartz) is classified in IARC Group 1.

National, state, provincial or local emergency planning, community right-to-know or other laws, regulations or ordinances may be applicable--consult applicable national, state, provincial or local laws.

SECTION 16 - OTHER INFORMATION

Hazardous Material Information System (HMIS):

Health	*
Flammability	0
Reactivity	0
Protective Equipment	E

* For further information on health effects, see Sections 3 and 11 of this MSDS.

National Fire Protection Association (NFPA):

Health	0
Flammability	0
Reactivity	0

Web Sites with Information about Effects of Crystalline Silica Exposure:

http://www.osha.gov - The Occupational Safety and Health Administration Home Page, click on "Technical Links", then click on "silica, crystalline".

http://www.cdc.gov/niosh/silicpag.html - NIOSH Hotlinks to Silicosis Prevention.

U. S. SILICA COMPANY DISCLAIMER

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Rutile (TiO_2/Fe_2O_3)

TITANIUM DIOXIDE, RUTILE

Division of Facilities Services

DOD Hazardous Material Information (ANSI Format)
For Cornell University Convenience Only

TITANIUM DIOXIDE, RUTILE

Section 1 - Product and Company Identification	Section 9 - Physical & Chemical Properties
Section 2 - Compositon/Information on Ingredients	Section 10 - Stability & Reactivity Data
Section 3 - Hazards Identification Including Emergency Overview	Section 11 - Toxicological Information
Section 4 - First Aid Measures	Section 12 - Ecological Information
Section 5 - Fire Fighting Measures	Section 13 - Disposal Considerations
Section 6 - Accidental Release Measures	Section 14 - MSDS Transport Information
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Section 1 - Product and Company Identification
TITANIUM DIOXIDE, RUTILE

Product Identification: TITANIUM DIOXIDE, RUTILE
Date of MSDS: 08/01/1993 **Technical Review Date:** 07/28/1994
FSC: 6810 **NIIN:** **LIIN:** 00N050338
Submitter: N EN
Status Code: C
MFN: 01
Article: N
Kit Part: N

Manufacturer's Information

Manufacturer's Name: HITOX CORP OF AMERICA
Manufacturer's Address1: 722 BURLESON ST
Manufacturer's Address2: CORPUS CHRISTI, TX 78402

Manufacturer's Country: US
General Information Telephone: 512-882-5175
Emergency Telephone: 512-883-5591
Emergency Telephone: 512-883-5591
MSDS Preparer's Name: N/P
Proprietary: N
Reviewed: N
Published: Y
CAGE: HTXCR
Special Project Code: N

Contractor Information

Contractor's Name: HITOX CORP OF AMERICA
Contractor's Address1: 722 BURLESON ST
Contractor's Address2: CORPUS CHRISTI, TX 78402
Contractor's Telephone: 512-883-5591
Contractor's CAGE: HTXCR

Section 2 - Compositon/Information on Ingredients
TITANIUM DIOXIDE, RUTILE

Ingredient Name: IRON (III) OXIDE; (FERRIC OXIDE)
Ingredient CAS Number: 1309-37-1 **Ingredient CAS Code:** M
RTECS Number: NO7400000 **RTECS Code:** M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: 2
% Enviromental Weight:
Other REC Limits: N/K
OSHA PEL: 10 MG/M3 (FE) **OSHA PEL Code:** M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: 5 MG/M3(FE) **ACGIH TLV Code:** M
ACGIH STEL: N/P **ACGIH STEL Code:**
EPA Reporting Quantity:
DOT Reporting Quantity:
Ozone Depleting Chemical: N

Ingredient Name: RUTILE; (TITANIUM DIOXIDE)
Ingredient CAS Number: 1317-80-2 **Ingredient CAS Code:** M
RTECS Number: VM2940000 **RTECS Code:** M
=WT: =WT Code:
=Volume: =Volume Code:

>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: 95
% Enviromental Weight:
Other REC Limits: N/K
OSHA PEL: 15 MG/M3 TDUST **OSHA PEL Code:** M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: 10 MG/M3 TDUST **ACGIH TLV Code:** M
ACGIH STEL: N/P **ACGIH STEL Code:**
EPA Reporting Quantity:
DOT Reporting Quantity:
Ozone Depleting Chemical: N

Ingredient Name: SILICA, AMORPHOUS, PRECEPITATED AND GEL; (SILICON DIOXIDE)
Ingredient CAS Number: 112926-00-8 **Ingredient CAS Code:** M
RTECS Number: VV7315000 **RTECS Code:** M
=WT: =WT Code:
=Volume: =Volume Code:
>WT: >WT Code:
>Volume: >Volume Code:
<WT: <WT Code:
<Volume: <Volume Code:
% Low WT: % Low WT Code:
% High WT: % High WT Code:
% Low Volume: % Low Volume Code:
% High Volume: % High Volume Code:
% Text: 1
% Enviromental Weight:
Other REC Limits: N/K
OSHA PEL: 6 MG/M3 (MFR) **OSHA PEL Code:** M
OSHA STEL: OSHA STEL Code:
ACGIH TLV: 10 MG/M3 (MFR) **ACGIH TLV Code:** M
ACGIH STEL: N/P **ACGIH STEL Code:**
EPA Reporting Quantity:
DOT Reporting Quantity:
Ozone Depleting Chemical: N

Section 3 - Hazards Identification, Including Emergency Overview
TITANIUM DIOXIDE, RUTILE

Health Hazards Acute & Chronic: DUST CAN CAUSE LUNG IRRITATION.

Signs & Symptoms of Overexposure:
COUGHING, SNEEZING.

Medical Conditions Aggravated by Exposure:
PULMONARY IRRITATION. BREATHING OR RESPIRATORY TRACT DISEASE OR DISORDER MAY BE AGGRAVATED BY EXPOSURE TO DUST FROM PRODUCT.

LD50 LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.

Route of Entry Indicators:
Inhalation: YES
Skin: NO
Ingestion: YES

Carcenogenicity Indicators
NTP: NO
IARC: NO
OSHA: NO

Carcinogenicity Explanation: NOT RELEVANT

Section 4 - First Aid Measures
TITANIUM DIOXIDE, RUTILE

First Aid:
EYE: FLUSH WITH GENEROUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES, CONSULT A PHYSICIAN. INHAL: REMOVE TO FRESH AIR. SKIN: WASH FROM SKIN W/SOAP AND WATER. INGEST: CONSULT A PHYS IF A LARGE QTY IS INGE STED.

Section 5 - Fire Fighting Measures
TITANIUM DIOXIDE, RUTILE

Fire Fighting Procedures:
WEAR NIOSH/MSHA APPROVED SCBA AND FULL PROTECTIVE EQUIPMENT (FP N).
Unusual Fire or Explosion Hazard:
NONE.
Extinguishing Media:
AS APPROPRIATE FOR SURROUNDING COMBUSTIBLES. DOES NOT BURN OR SUPPORT COMBUSTION.
Flash Point: Flash Point Text: NON-FLAMMABLE

Autoignition Temperature:
Autoignition Temperature Text: N/A
Lower Limit(s): N/A
Upper Limit(s): N/A

Section 6 - Accidental Release Measures
TITANIUM DIOXIDE, RUTILE

Spill Release Procedures:
MATERIAL MAY BE BLOWN AWAY AS DUST. PREVENT SPREAD OF MATERIAL AND KEEP DUST LEVEL DOWN. SCOOP UP MATERIAL OR USE VACUUM TECHNIQUIE AND

PLACE IN CLOSED CONTAINER. THOSE INVOLVED IN CLEAN-UP SHOULD USE RESPIRATORY PROTECTION.

Section 7 - Handling and Storage
TITANIUM DIOXIDE, RUTILE

Handling and Storage Precautions:

Other Precautions:

Section 8 - Exposure Controls & Personal Protection
TITANIUM DIOXIDE, RUTILE

Repiratory Protection:
USE NIOSH/MSHA APPROVED RESPIRATOR I/A/W AIR CONTAM STANDARD.
Ventilation:
LOCAL EXHAUST: PROVIDE SYSTEM TO MEET EXPOSURE LIMITS.
Protective Gloves:
IMPERVIOUS GLOVES (FP N).
Eye Protection: ANSI APPRVD CHEM WORKER GOGGLES (FP N).
Other Protective Equipment: NO SPECIAL REQUIREMENT. WEAR EASILY WASHABLE, ORDINARY WORK CLOTHES.
Work Hygenic Practices: GOOD INDUSTRIAL HYGIENE PRACTICES. WASH THORO W/SOAP & WATER BEFORE EATING, DRINKING, OR USING TOBACCO PRODUCTS.
Supplemental Health & Safety Information: BP: >4532F,>2500C.

Section 9 - Physical & Chemical Properties
TITANIUM DIOXIDE, RUTILE

HCC:
NRC/State License Number:
Net Property Weight for Ammo:
Boiling Point: Boiling Point Text: SUPP DATA
Melting/Freezing Point: Melting/Freezing Text: 3344F,1840C
Decomposition Point: Decomposition Text: N/K
Vapor Pressure: N/A **Vapor Density:** N/A
Percent Volatile Organic Content:
Specific Gravity: 4.1(H*2O=1)
Volatile Organic Content Pounds per Gallon:
pH: N/K
Volatile Organic Content Grams per Liter:
Viscosity: N/P
Evaporation Weight and Reference: NOT APPLICABLE
Solubility in Water: INSOLUBLE
Appearance and Odor: FINE BEIGE POWDER WITH NO ODOR
Percent Volatiles by Volume: N/K
Corrosion Rate: N/K

Section 10 - Stability & Reactivity Data
TITANIUM DIOXIDE, RUTILE

Stability Indicator: YES
Materials to Avoid:
NONE IN NORMAL OR EXPECTED USE.
Stability Condition to Avoid:
NONE IN NORMAL OR EXPECTED USE.
Hazardous Decomposition Products:
NONE IN NORMAL OR EXPECTED USE.
Hazardous Polymerization Indicator: NO
Conditions to Avoid Polymerization:
NOT RELEVANT

Section 11 - Toxicological Information
TITANIUM DIOXIDE, RUTILE

Toxicological Information:
N/P

Section 12 - Ecological Information
TITANIUM DIOXIDE, RUTILE

Ecological Information:
N/P

Section 13 - Disposal Considerations
TITANIUM DIOXIDE, RUTILE

Waste Disposal Methods:
DISPOSAL MUST BE MADE I/A/W FEDERAL, STATE, AND LOCAL REGULATIONS.

Section 14 - MSDS Transport Information
TITANIUM DIOXIDE, RUTILE

Transport Information:
N/P

Section 15 - Regulatory Information
TITANIUM DIOXIDE, RUTILE

SARA Title III Information:
N/P
Federal Regulatory Information:
N/P
State Regulatory Information:
N/P

Section 16 - Other Information
TITANIUM DIOXIDE, RUTILE

Other Information:
N/P

HAZCOM Label Information
Product Identification: TITANIUM DIOXIDE, RUTILE

CAGE: HTXCR
Assigned Individual: N
Company Name: HITOX CORP OF AMERICA
Company PO Box:
Company Street Address1: 722 BURLESON ST
Company Street Address2: CORPUS CHRISTI, TX 78402 US
Health Emergency Telephone: 512-883-5591
Label Required Indicator: Y
Date Label Reviewed: 07/28/1994
Status Code: C
Manufacturer's Label Number:
Date of Label: 07/28/1994
Year Procured: N/K
Organization Code: G
Chronic Hazard Indicator: N
Eye Protection Indicator: YES
Skin Protection Indicator: YES
Respiratory Protection Indicator: YES
Signal Word: CAUTION
Health Hazard: Slight
Contact Hazard: Slight
Fire Hazard: None
Reactivity Hazard: None

8/9/2002 8:35:02 AM

ZnO

ZINC CORPORATION OF AMERICA
300 FRANKFORT ROAD MONACA, PA 15061-2295 724-774-1020

MSDS FOR ZINC OXIDE: KADOX 911, 911P, 911H, 915, 920, 920P, 920H, 920G, 930, 930H, 930G ZC-X006

SECTION I - GENERAL INFORMATION

NAME: ZINC OXIDE

MANUFACTURER:
ZINC CORPORATION OF AMERICA
300 Frankfort Road
Monaca, PA 15061
724-774-1020

TRANSPORTATION EMERGENCY:
CHEMTREC: 800-424-9300

CHEMICAL FAMILY: Nonferrous Metal Oxide

CAS NO.: 1314-13-2

FORMULA: ZnO

DOT HAZARD CLASS: Not listed **UN NO.:** NAIF* **NA NO.:** NAIF*

SARA SECTION 313: This product is subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act and 40 CFR 372. The materials underlined below are present in quantities above the applicable deminimis concentrations and are listed as Toxic Chemicals in 40 CFR 372.65.

ISSUE DATE: 2/12/88 **REVISION DATE:** 11/15/01

* NAIF - No applicable information found.

SECTION II - INGREDIENTS

MATERIAL	CAS NO.	%
ZINC OXIDE	1314-13-2	99.9
CADMIUM	7440-43-9	0.005
LEAD	7439-92-1	0.001

LEAD AND CADMIUM ARE INHERENT IN THE MANUFACTURE OF ZINC AND ARE NOT PHYSICALLY ADDED IN THE MANUFACTURE OF ZINC OXIDE.

MSDS FOR ZINC OXIDE: KADOX 911, 911P, 911H, 915, 920, 920P, 920H, 920G, 930, 930H, 930G ZC-X006

SECTION III PHYSICAL DATA

BOILING POINT (760 MM HG): N/A

MELTING POINT: 3587°F

SPECIFIC GRAVITY: 5.81

EVAPORATION RATE (=1): N/A

VAPOR DENSITY (air = 1): N/A

SOLUBILITY IN WATER: Negligible

PERCENT VOLATILE BY VOLUME (%): N/A

VAPOR PRESSURE AT 20° F: N/A

APPEARANCE AND ODOR: White powder with no odor. (G, P and H suffix denote granular, pellets or hardened pellets respectively)

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED): N/A

FLAMMABLE LIMITS: LEL: N/A
UEL: N/A

NFPA FIRE RATING

HEALTH	0
FLAMMABILITY	0
REACTIVITY	0

EXTINGUISHING MEDIA: Zinc oxide does not burn. Water spray, dry chemical, or carbon dioxide extinguishers may be used for fires in storage areas.

SPECIAL FIRE FIGHTING PROCEDURES: Non-Flammable

UNUSUAL FIRE AND EXPLOSION HAZARDS: None

SECTION V - HEALTH HAZARD DATA

MATERIAL	FORM	OSHA-PEL TWA mg/m³	ACGIH-TLV TWA mg/m³	ACGIH-TLV STEL mg/m³
ZINC OXIDE	Total Dust	15	10	–
	Respirable (Fume)	5	5	10

ROUTES OF ENTRY

PRIMARY: Inhalation

SECONDARY: Ingestion

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MSDS FOR ZINC OXIDE: KADOX 911, 911P, 911H, 915, 920, 920P, 920H, 920G, 930, 930H, 930G ZC-X006

EFFECTS OF SHORT TERM OVEREXPOSURE:

ZINC OXIDE: Inhalation of high levels of zinc oxide may result in tightness of chest, metallic taste, cough, dizziness, fever, chills, headache, nausea, and dry throat. Overexposure may produce symptoms known as metal fume fever or "zinc shakes": an acute, self-limiting condition without recognized complications. Symptoms of metal fume fever include: chills, fever, muscular pain, nausea and vomiting. Like any finely divided particulate matter, zinc oxide may cause mechanical irritation to skin and eyes.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Inhalation of dust may be an irritant to pre-existing respiratory conditions.

EMERGENCY AND FIRST AID PROCEDURES: Symptoms resulting from inhalation overexposure usually disappear within 24 hours. Symptomatic treatment, such as bed rest and possibly aspirin is recommended to provide relief from fever and chills. Skin contact - flush areas with large amounts of water. Eye contact - flush eyes with copious amounts of water. In all cases, consult physician for medical attention.

EFFECTS OF LONG TERM OVEREXPOSURE:

ZINC OXIDE: Chronic exposure to zinc oxide may cause respiratory tract irritation with nasopharyngitis and laryngitis.

CARCINOGENIC ASSESSMENT:

NTP? No **IARC MONOGRAPH?** No **OSHA?** No

SECTION VI - REACTIVITY DATA

STABILITY: ( ) Unstable
(X) Stable

CONDITIONS TO AVOID: None

INCOMPATIBILITY (MATERIALS TO AVOID): None known.

HAZARDOUS DECOMPOSITION PRODUCTS: None

HAZARDOUS POLYMERIZATION: ( ) May occur
(X) Will not occur

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: As with any nuisance dust, avoid excessive dusting. Material should be contained for recycling.

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MSDS FOR ZINC OXIDE: KADOX 911, 911P, 911H, 915, 920, 920P, 920H, 920G, 930, 930H, 930G ZC-X006

WASTE DISPOSAL METHOD: Dispose in closed container or heavy bag. Material may be recycled or disposed of in accordance with Federal, State, and Local Environmental Regulations. This material may be regulated under CERCLA, TSCA, SARA, and/or RCRA Regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE): Use NIOSH/MSHA approved type respirator for protection against dust.

VENTILATION: Local exhaust or other ventilation that will reduce dust concentrations to less than permissible exposure limits.

PROTECTIVE GLOVES: Recommended to prevent skin irritation in hypersensitive individuals.

EYE PROTECTION: Use safety eyewear for protection against airborne particulate matter.

OTHER PROTECTIVE EQUIPMENT: Barrier creams may help prevent skin irritation in hypersensitive individuals.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: None.

OTHER PRECAUTIONS: Practice good personal hygiene when working in areas where this material is used. Avoid prolonged contact with skin.

DISCLAIMER: As the conditions or methods of use are beyond our control, we do not assume any responsibility and expressly disclaim any liability for any use of the material. Information contained herein is believed to be true and accurate, but all statements or suggestions are made without any warranty, express or implied, regarding accuracy of the information, the hazards connected with the use of the material, or the results to be obtained from the use thereof.

G:\MSDS\OXIDE\ZCX006

$ZrSiO_4$

MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION

Trade Name: Zirconium Silicate
Formula: $ZrSiO_4$
Synonyms: Hyacinth, (silicic acid, zirconium (4+) salt), Zircon, Zirconium Silicon Oxide
Chemical Nature: Metal Silicate
CAS #: 10101-52-7

II HAZARDOUS INGREDIENTS

Hazardous Components	%	OSHA/PEL	ACGIH/TLV
Zirconium Silicate*	0-100	5 mg/m³ (as Zr)	5 mg/m³ (as Zr)

*All zirconium materials contain 2-4% hafnium unless otherwise specified.

HMIS Hazard Rating: Health: 3 **Flammability:** 0 **Reactivity:** 1 **Personal Protection:** F

III PHYSICAL DATA

Boiling Point (°C): No Data
Specific Gravity: 1.92-2.02 gm/cc
Solubility in H_2O: Insoluble%
Appearance and Odor: White to yellow powder, no odor.
Melting Point: Dissociates above 1540 °C
Reaction with Water: May form silane
Volatile: N/A

IV FIRE AND EXPLOSION HAZARDS DATA

Flash Point: N/A
Explosive Limits: Lower: N/A **Upper:** N/A
Flammability: Non-flammable
Autoignition Temperature: N/A

Extinguishing Media: Use dry chemical, CO_2.
Special Fire Fighting Procedures: Wear a self-contained breathing apparatus and full protective clothing to prevent contact with skin and eyes.

Unusual Fire and Explosion Hazards: Material may emit toxic fumes if involved in a fire.

V HEALTH HAZARD INFORMATION

Effects of Exposure:

Due to the chemical inertness of zirconium it is considered to be of low toxicity. Soluble alkaline silicates act locally like mild alkalies. The dust of certain silicates, such as asbestos (hydrated magnesium silicate) and talc, can produce fibrotic changes in the lungs and are implicated as experimental carcinogens.

Zirconium is not an important industrial poison. Most zirconium compounds in common use are insoluble and considered inert. Pulmonary granuloma in zirconium workers has been reported and sodium zirconium lactate has been held responsible for skin granulomas. Avoid inhalation of Zr- containing aerosols, which can cause lung granulomas.

Acute Effects:

Inhalation: May be a nuisance dust. Cough, sneezing may result.
Skin: Abrasive irritant.
Eye: Abrasive irritant.

Chronic Effects:

Inhalation: Chronic exposure may cause pulmonary granulomas. May cause irritation of the mucous membranes of the nose and throat.
Skin: Chronic exposure may cause dermatitis and skin granulomas.
Eye: Inflammation and redness possible.

Routes of Entry: Inhalation.

Medical Conditions Generally Aggravated by Exposure: Respiratory disorders.
Carcinogenicity: Suspect **NTP:** No **IARC Monographs:** No **OSHA regulated:** No

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove to fresh air; give oxygen if breathing is difficult. Seek medical attention.
INGESTION: Give 2 cups of water. Induce vomiting if large amounts were ingested. Seek medical attention.
SKIN: Brush off skin, wash area with soap and water. Seek medical attention.
EYE: Flush eyes with lukewarm water for 15 minutes and seek medical attention.

VI REACTIVITY DATA

Stability: Unstable

Conditions to Avoid: High heat
Incompatibility (Material to Avoid): Lithium

Hazardous Decomposition Products: SixOy, ZrxOy, Zr-, Si-.
Hazardous Polymerization: Will not occur

VII SPILL OR LEAK PROCEDURES

Steps to Be Taken in Case Material Is Released or Spilled: Wear a self-contained breathing apparatus and full protective clothing. Isolate the area where the spill occurred, insure proper ventilation is available and that water/moisture are kept out of the area. Vacuum up the spill using a high efficiency unit and place in a container for proper disposal. Take care not to raise dust.

Waste Disposal Method: Dispose of in accordance with Local, State and Federal Waste Disposal Regulations.

VIII SPECIAL PROTECTION INFORMATION

Respiratory Protection (Specify Type): Wear a NIOSH-approved dust-mist-fume cartridge respirator.
Ventilation: Handle in a dry, controlled atmosphere. Use local exhaust to maintain exposure below TLV. General exhaust recommended

Protective Gloves: Neoprene**Eye Protection:** Safety Glasses
Other Protective Equipment: Wear protective apparel to prevent contamination of skin and clothing.

IX SPECIAL PRECAUTIONS

Precautions to Be Taken in Handling and Storage: Store in tightly closed containers in a cool, dry place. Wash hands and face thoroughly after handling and before meals.

Work Practices: Implement engineering and work practice controls to reduce and maintain concentration of exposure. Use good housekeeping and sanitation practices. Do not use tobacco or food in work area. Wash thoroughly before eating or smoking. Do not blow dust off clothing or skin with compressed air.

The above information is believed to be correct, but does not purport to be all inclusive and shall be used only as a guide. ESPI shall not be held liable for any damage resulting from handling or from contact with the above product.

Prepared by: S. Dierks
Dated: January 1991

Sugar

10/14/2003 14:50 FAX 002

THE AMALGAMATED SUGAR COMPANY LLC

2427 LINCOLN AVENUE • OGDEN, UT 84401
P.O. BOX 1520 • OGDEN, UT 84402
PHONE: (801) 399-3431 • FAX: (801) 393-8042

MATERIAL SAFETY DATA SHEET
Granulated Sugar (Sucrose)

Section I: Product Identification

Description and Use:	Carbohydrate, Human or Animal Food
Manufacturer:	The Amalgamated Sugar Company, LLC 2427 Lincoln Avenue P.O. Box 1520 Ogden, Utah 84402
Emergency Contact:	The Amalgamated Sugar Company LLC Technical Services Department Charles L. Schmalz (801) 399-3431

Section II: Hazardous Material Identification

Hazard Description:	1. Nuisance Dust 2. Dust Explosion Potential
Chemical Name:	Sucrose
Chemical Formula:	$C_{12}H_{22}O_{11}$
Percent of Product:	100%
CAS Number:	57-50-1

Section III: Physical and Chemical Data

Description:	White granulated, crystalline solid
Melting Point:	186° C
Decomposition:	Slow decomposition above 186° C
Volatility:	Nil
Specific Gravity:	1.55
Solubility:	200 grams per 100 cc water at 20° C
pH:	6 to 7 at 50 percent water solution
Reactivity:	Nil at normal temperature and use

Section IV: Fire and Explosion Hazard Data

Combustion Data:	Class "A" combustible material
Fire Control Material:	Water
Critical Dust Concentration:	0.045 oz. per cu. ft. suspended in air
Ignition Temperature, Dust:	420° C

Section V: Reactivity Data

Stability:	Stable product at normal temperature
Melting Point:	186° C
Decomposition:	Slow decomposition above 186° C
Decomposition Products:	Water and Carbon Dioxide
Polymerization Products:	Do not occur

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Page 2
Granulated Sugar

Section VI: Health Hazard Data

Description:	Nuisance Particulate, Non-Toxic	
Exposure Route:	Inhalation:	Nose, Mouth, Lungs
	Direct Contact:	Eyes, Skin
	Absorption:	N.A.
	Ingestion:	N.A.
TLV:	10 mg/m³ (AGGIH)	
	Total Dust	Respirable Fraction
PEL:	15 mg/m³	5 mg/m³
TWA:	15 mg/m³	5 mg/m³
Symptoms:	Eye and respiratory discomfort may be experienced at high dust concentrations. Pre-existing respiratory conditions or allergies may be aggravated.	
Emergency Treatment:	Respiratory:	Provide ventilation
	Eyes and Skin:	Flush with water
	Severe or abnormal reactions involving respiratory problems may require immediate medical attention.	
Personal Protection:	Respiratory:	Provide NIOSH-approved dust mask for use in dusty conditions.
	Eyes:	Goggles - optional
	Other:	N.A.
Carcinogenic:	Not Carcinogenic	

Section VII: Safe Handling and Control Measures

Storage:	Store at ambient temperature and humidity. Temperature should be less than 90° F. Relative humidity should be less than 70%.
Spill and Clean Up:	Normal clean-up procedure. Sweep up solid material or flush to sewer.
Waste Disposal:	No special requirements. Observe municipal, state, and Federal regulations relative to waste disposal.
Dust Control:	Dust collection equipment should include fire and explosion suppression devices.
Housekeeping:	Minimize accumulation on floors, ledges, beams, etc.
Ignition Sources:	Eliminate possibility of ignition from open flames, sparks, welding operations, or other.

January, 1998

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APPENDIX C

IMMOBILIZED HIGH-LEVEL WASTE SURROGATE SAMPLE DATA

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APPENDIX C
IMMOBILIZED HIGH-LEVEL WASTE SURROGATE SAMPLE DATA

This appendix provides all the sample data applicable to this project.

ND = nondetect at the estimated quantitation limit (EQL).

The laboratory flags used are as follows:

B Estimated result; result is less than the EQL or reporting limit.

J Method blank contamination. The associated method blank contains the analyte above the method detection limit (MDL) and below the EQL. Note that in no cases were the method blank analyte concentrations observed to be above the EQL for the analyte.

N % Recovery out of limits for batch.

* % Relative percent difference (RPD) out of limits for batch.

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IHLW SURROGATE SAMPLE DATA - SPIKED GLASS

Lab ID	H3D070127002	**EDD**	H3D070127
Client ID	HLW98-77E	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Typical Spike 1	**Collection Date**	3/31/2003
Composition Space	HLW98-77	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	29.6	30	14.5	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Barium	439	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	9.8	15	2.7	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Cadmium	24	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	19.6	30	7.2	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Copper	45.1	75	11.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Lead	136	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	0.000057	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003	B	KD
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Nickel	126	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	61.3	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	72.7	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	153	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	41.2	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	565	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/8/2003	4/8/2003	4/8/2003		DFW

Lab ID	H3D070127003	**EDD**	H3D070127
Client ID	HLW98-77F	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Typical Spike 2	**Collection Date**	3/31/2003
Composition Space	HLW98-77	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	56.3	180	38.8	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Arsenic	39.5	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	402	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	9.7	15	2.7	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Cadmium	27.3	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	38.2	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	51.1	75	11.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Lead	124	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Nickel	144	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	85.9	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	64.5	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	80	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	72.3	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	562	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/8/2003	4/8/2003	4/8/2003		DFW

Lab ID	H3D070127006	**EDD**	H3D070127
Client ID	HLW99-03E	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 1 Replicate	**Collection Date**	4/1/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	90.8	180	38.8	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Arsenic	76.3	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	8990	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	184	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	649	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	1190	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	874	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1790	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Nickel	4950	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	413	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	1110	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	919	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	133	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	11500	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/8/2003	4/8/2003	4/8/2003		DFW

Lab ID	H3D070127007	**EDD**	H3D070127
Client ID	HLW99-03F	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 2 Replicate	**Collection Date**	4/1/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	181	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	70.4	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	8480	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	164	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	571	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	1040	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	763	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1710	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Nickel	4510	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	307	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	972	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	230	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	113	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	10600	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/8/2003	4/8/2003	4/8/2003		DFW

Lab ID	H3D070127008	**EDD**	H3D070127
Client ID	HLW99-03G	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 3 Replicate	**Collection Date**	4/1/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	408	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	73.8	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	9800	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	190	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	824	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	1140	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	923	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1830	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Nickel	4780	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	420	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	1150	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	138	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	130	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	12200	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/8/2003	4/8/2003	4/8/2003		DFW

Lab ID	H3D070127009	**EDD**	H3D070127
Client ID	HLW99-03H	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 4 Replicate	**Collection Date**	4/1/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	578	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	62	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	7640	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	161	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	526	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	863	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	722	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1600	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	0.000043	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003	B	KD
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Nickel	2990	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	407	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	910	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	42.5	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	101	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	9130	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/8/2003	4/8/2003	4/8/2003		DFW

Lab ID	H3D070127010	**EDD**	H3D070127
Client ID	HLW99-03ER1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 1 Replicate	**Collection Date**	4/2/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	57.1	180	38.8	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Arsenic	83.7	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	9610	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	209	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	680	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	1260	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	917	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1880	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Nickel	5050	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	428	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	1130	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	847	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	117	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	12000	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/8/2003	4/8/2003	4/8/2003		DFW

Lab ID	H3D070127011	**EDD**	H3D070127
Client ID	HLW99-03FR1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 2 Replicate	**Collection Date**	4/2/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	180	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	66.2	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	8840	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	170	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	687	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	1160	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	740	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1770	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Nickel	4710	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	319	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	1070	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	181	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	107	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	11300	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/8/2003	4/8/2003	4/8/2003		DFW

Lab ID	H3D070127012	**EDD**	H3D070127
Client ID	HLW99-03GR1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 3 Replicate	**Collection Date**	4/2/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	305	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	68.8	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	8400	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	177	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	629	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	1190	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	816	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1670	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Nickel	3860	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	438	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	980	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	106	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	93.8	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	10300	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/9/2003	4/9/2003	4/8/2003	N*	DFW

Lab ID	H3D070127013	**EDD**	H3D070127
Client ID	HLW99-03HR1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 4 Replicate	**Collection Date**	4/2/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	682	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	68.6	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	6120	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	134	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	427	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	641	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	583	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1340	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Mercury	0.000036	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003	B	KD
Nickel	2650	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	245	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	734	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	36.3	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	125	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	7340	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/9/2003	4/9/2003	4/8/2003	N*	DFW

Lab ID	H3D070127014	**EDD**	H3D070127
Client ID	HLW99-03ER2	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 1 Replicate	**Collection Date**	4/3/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	60.8	180	38.8	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Arsenic	71.9	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	7170	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	166	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	538	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	931	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	703	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1640	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	0.000035	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003	B	KD
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Nickel	3590	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	259	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	863	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	465	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	105	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	8900	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/9/2003	4/9/2003	4/8/2003	N*	DFW

Lab ID	H3D070127015	**EDD**	H3D070127
Client ID	HLW99-03FR2	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 2 Replicate	**Collection Date**	4/3/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	219	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	83.4	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	8260	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	179	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	611	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	954	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	789	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1810	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Nickel	4310	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	238	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	969	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	219	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	128	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	10200	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/9/2003	4/9/2003	4/8/2003	N*	DFW

Lab ID	H3D070127016	**EDD**	H3D070127
Client ID	HLW99-03GR2	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 3 Replicate	**Collection Date**	4/3/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	290	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	52.4	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	6010	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	132	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	485	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	708	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	627	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1400	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Mercury	0.00003	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003	B	KD
Nickel	2850	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	237	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	687	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	72.2	30	22.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Vanadium	63.6	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	7370	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/9/2003	4/9/2003	4/8/2003	N*	DFW

Lab ID	H3D070127017	**EDD**	H3D070127
Client ID	HLW99-03HR2	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	Bounding Spike 4 Replicate	**Collection Date**	4/3/2003
Composition Space	HLW99-03	**Receipt Date**	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	547	180	38.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Arsenic	67.5	30	14.5	1	4/9/2003	4/10/2003	4/8/2003		KGS
Barium	6690	150	3.1	1	4/9/2003	4/10/2003	4/8/2003		KGS
Beryllium	161	15	2.7	1	4/9/2003	4/10/2003	4/8/2003		KGS
Cadmium	462	15	2.3	1	4/9/2003	4/10/2003	4/8/2003		KGS
Chromium	759	30	7.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Copper	656	75	11.9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Lead	1490	30	9	1	4/9/2003	4/10/2003	4/8/2003		KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/8/2003		KD
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/8/2003		KD
Nickel	2590	120	11	1	4/9/2003	4/10/2003	4/8/2003		KGS
Selenium	302	15	12.2	1	4/9/2003	4/10/2003	4/8/2003		KGS
Silver	821	30	11.8	1	4/9/2003	4/10/2003	4/8/2003		KGS
Thallium	24.3	30	22.7	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Vanadium	96.7	150	16.9	1	4/9/2003	4/10/2003	4/8/2003	B	KGS
Zinc	7890	60	7.7	1	4/9/2003	4/10/2003	4/8/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/9/2003	4/9/2003	4/8/2003	N*	DFW

IHLW SURROGATE SAMPLE DATA - INITIAL MATRIX GLASS

Lab ID	H3B110210001	**EDD**	H3B110210
Client ID	HLW02-26	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer25	**Analysis Method**	SW 846 6010B
		Collection Date	1/29/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	147	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	583	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	16.1	30	7.2	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Copper	35.8	75	11.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Lead	117	30	9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Nickel	28	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	ND	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	86.9	30	11.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	750	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210002	**EDD**	H3B110210
Client ID	HLW02-55	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW02-42	**Analysis Method**	SW 846 6010B
		Collection Date	1/29/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	39.4	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	156	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	ND	75	11.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Lead	25.1	30	9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Nickel	74	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	16.7	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	15.4	30	11.8	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	608	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210003	**EDD**	H3B110210
Client ID	HLW02-45	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner18	**Analysis Method**	SW 846 6010B
		Collection Date	1/29/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	43.1	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	181	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	ND	75	11.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Lead	17	30	9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Nickel	44.3	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	14.4	15	12.2	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Silver	14.9	30	11.8	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	360	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210004	**EDD**	H3B110210
Client ID	HLW02-46	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner19	**Analysis Method**	SW 846 6010B
		Collection Date	1/29/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	22.6	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	111	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	ND	75	11.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Lead	19.4	30	9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Nickel	132	120	11	1	2/19/2003	2/25/2003	2/17/2003		KGS
Selenium	21.8	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	14.1	30	11.8	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	439	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210005	**EDD**	H3B110210
Client ID	HLW02-15	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer14	**Analysis Method**	SW 846 6010B
		Collection Date	1/29/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	22.2	30	14.5	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Barium	115	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	19.6	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	13.4	30	7.2	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Copper	31.1	75	11.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Lead	136	30	9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Nickel	19.8	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	26.1	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	63.6	30	11.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Thallium	41.7	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	706	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210006	**EDD**	H3B110210
Client ID	HLW02-03	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer02	**Analysis Method**	SW 846 6010B
		Collection Date	1/29/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	35.7	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	328	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	1240	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	45.3	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	74.7	75	11.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Lead	233	30	9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Nickel	630	120	11	1	2/19/2003	2/25/2003	2/17/2003		KGS
Selenium	92.3	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	140	30	11.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Thallium	62.6	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	18.3	150	16.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Zinc	1600	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210007	**EDD**	H3B110210
Client ID	HLW02-44	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner17	**Analysis Method**	SW 846 6010B
		Collection Date	1/29/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	19.1	30	14.5	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Barium	106	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	386	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	12.9	30	7.2	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Copper	38.1	75	11.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Lead	95	30	9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Nickel	89.2	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	16.6	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	51.4	30	11.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	766	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210008	**EDD**	H3B110210
Client ID	HLW02-41	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner14	**Analysis Method**	SW 846 6010B
		Collection Date	1/29/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	43.9	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	117	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	46.4	75	11.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Lead	23.6	30	9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Nickel	54.8	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	12.4	15	12.2	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Silver	ND	30	11.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Thallium	24.2	30	22.7	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	467	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210010	**EDD**	H3B110210
Client ID	HLW02-01	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Center	**Analysis Method**	SW 846 6010B
		Collection Date	1/30/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	68.4	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	257	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	20	75	11.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Lead	65.6	30	9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Nickel	135	120	11	1	2/19/2003	2/25/2003	2/17/2003		KGS
Selenium	28.1	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	39.2	30	11.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	653	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210012	**EDD**	H3B110210
Client ID	HLW02-10	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer09	**Analysis Method**	SW 846 6010B
		Collection Date	1/30/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	69.5	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	755	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	12.3	75	11.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Lead	31.2	30	9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Nickel	38	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	64.2	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	12.8	30	11.8	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	999	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210013	**EDD**	H3B110210
Client ID	HLW02-33	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner06	**Analysis Method**	SW 846 6010B
		Collection Date	1/30/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	40.7	180	38.8	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	82.5	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	209	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	ND	75	11.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Lead	28.5	30	9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Nickel	263	120	11	1	2/19/2003	2/25/2003	2/17/2003		KGS
Selenium	49.1	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	21.5	30	11.8	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	824	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210019	**EDD**	H3B110210
Client ID	HLW02-31	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner04	**Analysis Method**	SW 846 6010B
		Collection Date	1/30/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	35.1	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	197	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	ND	75	11.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Lead	35.5	30	9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Nickel	92.5	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	41.8	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	23.1	30	11.8	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Thallium	33.3	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	793	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210020	**EDD**	H3B110210
Client ID	HLW02-56	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW02-44	**Analysis Method**	SW 846 6010B
		Collection Date	1/30/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	15.8	30	14.5	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Barium	83.4	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	378	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	11.7	30	7.2	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Copper	25	75	11.9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Lead	88.4	30	9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Nickel	85.2	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	18.8	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	58	30	11.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	741	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110210011	**EDD**	H3B110210
Client ID	HLW02-30	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner03	**Analysis Method**	SW 846 6010B
		Collection Date	1/30/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	81	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	487	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	8.6	30	7.2	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Copper	ND	75	11.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Lead	28.2	30	9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Nickel	113	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	16.7	15	12.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Silver	24.6	30	11.8	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	954	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J	KGS

Lab ID	H3B110213001	**EDD**	H3B110213
Client ID	HLW02-19	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer18	**Analysis Method**	SW 846 6010B
		Collection Date	2/5/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	9.8	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	12.1	15	2.3	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	11.2	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	17.4	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	16.7	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	420	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213002	**EDD**	H3B110213
Client ID	HLW02-05	**Matrix**	WET
Lab Name	STLKNX	**Basis**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer04	**Analysis Method**	SW 846 6010B
		Collection Date	2/4/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	9.9	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	11.3	15	2.3	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	10.8	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	18.2	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	14	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	417	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213003	**EDD**	H3B110213
Client ID	HLW02-53	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW02-17	**Analysis Method**	SW 846 6010B
		Collection Date	2/4/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	7.6	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	204	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	11.4	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	11.6	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	ND	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	279	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213004	**EDD**	H3B110213
Client ID	HLW02-08	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer07	**Analysis Method**	SW 846 6010B
		Collection Date	2/4/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	27.9	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	38.1	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	14.9	75	11.9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Lead	23.9	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	49.7	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	22.5	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	1390	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213005	**EDD**	H3B110213
Client ID	HLW02-42	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner15	**Analysis Method**	SW 846 6010B
		Collection Date	2/4/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	44	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	166	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	27.7	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	79.4	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	15.8	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	17.5	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	654	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213006				**EDD**	H3B110213			
Client ID	HLW02-49				**Basis**	WET			
Lab Name	STLKNX				**Matrix**	WATER			
SampleOrigin	HLW Initial Matrix Glass				**Leach/Prep Method**		SW 846 1311/3010A		
Composition Space	1a.Inner22				**Analysis Method**		SW 846 6010B		
					Collection Date		2/4/2003		
					Receipt Date		2/11/2003		
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	25.7	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	125	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	24.3	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	57.9	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	ND	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	494	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213007				**EDD**	H3B110213			
Client ID	HLW02-16				**Basis**	WET			
Lab Name	STLKNX				**Matrix**	WATER			
SampleOrigin	HLW Initial Matrix Glass				**Leach/Prep Method**		SW 846 1311/3010A		
Composition Space	1a.Outer15				**Analysis Method**		SW 846 6010B		
					Collection Date		2/4/2003		
					Receipt Date		2/11/2003		
Analyte	**Conc ug/L**	**EQL ug/L**	**MDL ug/L**	**Dil**	**Prep Date**	**Analysis Date**	**Leach Date**	**Lab Qual**	**Sample Analysis Analyst**
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	136	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	528	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	11.2	30	7.2	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Copper	34.3	75	11.9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Lead	119	30	9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Nickel	27.3	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	40.1	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	69.2	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	690	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213009	**EDD**	H3B110213
Client ID	HLW02-04	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer03	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	7.8	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	264	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	ND	30	9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Nickel	13.7	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	31	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	ND	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	350	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213010	**EDD**	H3B110213
Client ID	HLW02-06	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer05	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	14.6	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	565	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	14.3	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	287	120	11	1	2/21/2003	2/26/2003	2/19/2003		KGS
Selenium	59.3	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	24.2	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	729	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213011	**EDD**	H3B110213
Client ID	HLW02-28	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner01	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	46.5	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Cadmium	353	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	17.6	75	11.9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Lead	25.6	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	86	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	16.6	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	22.5	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	695	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213012	**EDD**	H3B110213
Client ID	HLW02-39	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner12	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	18.4	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	181	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	18.6	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	119	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	16.3	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	362	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213013	**EDD**	H3B110213
Client ID	HLW02-07	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer06	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	49.5	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	7.8	15	2.3	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Chromium	12	30	7.2	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Copper	23.8	75	11.9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Lead	66.1	30	9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Nickel	13.6	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	42.9	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	323	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213014	**EDD**	H3B110213
Client ID	HLW02-14	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer13	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	21.2	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	229	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	12.8	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	14.9	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	13.5	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	307	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213015	**EDD**	H3B110213
Client ID	HLW02-13	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer12	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	139	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	20.4	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	12.6	30	7.2	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Copper	35.8	75	11.9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Lead	118	30	9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Nickel	28.5	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	30.2	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	83.9	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	706	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213016	**EDD**	H3B110213
Client ID	HLW02-36	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner09	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	57.1	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	247	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	11	30	7.2	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Copper	17.6	75	11.9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Lead	62.4	30	9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Nickel	58.9	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	32.8	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	41.6	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	489	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213017	**EDD**	H3B110213
Client ID	HLW02-52	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW02-01	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	53.4	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	199	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	7.6	30	7.2	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Copper	13.6	75	11.9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Lead	54.3	30	9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Nickel	106	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	24.4	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	36.1	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	504	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213019	**EDD**	H3B110213
Client ID	HLW02-09	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer08	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	59.8	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	25.9	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	18.8	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	392	120	11	1	2/21/2003	2/26/2003	2/19/2003		KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	ND	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	976	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B110213020	**EDD**	H3B110213
Client ID	HLW02-54	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW02-4	**Analysis Method**	SW 846 6010B
		Collection Date	2/6/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	7.3	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	252	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	ND	30	9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Nickel	16.5	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	26.8	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	ND	30	11.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	338	60	7.7	1	2/21/2003	2/26/2003	2/19/2003	J	KGS

Lab ID	H3B270125001	**EDD**	H3B270125
Client ID	HLW02-21R1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer20	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	13.6	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	14	15	2.3	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	16.1	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	23.4	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	ND	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	14.7	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	581	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125002	**EDD**	H3B270125
Client ID	HLW02-24	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer23	**Analysis Method**	SW 846 6010B
		Collection Date	2/24/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	15	30	14.5	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Barium	83.8	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	13.1	15	2.3	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	18.6	75	11.9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Lead	72.3	30	9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Nickel	19.2	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	42.8	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	39.8	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	520	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125003	**EDD**	H3B270125
Client ID	HLW02-43	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner16	**Analysis Method**	SW 846 6010B
		Collection Date	2/12/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	67.3	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	569	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	14.1	75	11.9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Lead	36.8	30	9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Nickel	130	120	11	1	3/10/2003	3/12/2003	3/6/2003		KGS
Selenium	19.5	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	28.9	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	1070	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125004	**EDD**	H3B270125
Client ID	HLW02-35	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner08	**Analysis Method**	SW 846 6010B
		Collection Date	2/12/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	104	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	230	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	28.5	75	11.9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Lead	93.9	30	9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Nickel	263	120	11	1	3/10/2003	3/12/2003	3/6/2003		KGS
Selenium	15.4	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	68.3	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	24	30	22.7	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	884	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125005	**EDD**	H3B270125
Client ID	HLW02-20R1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer19	**Analysis Method**	SW 846 6010B
		Collection Date	2/21/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	25.2	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	12.5	15	2.3	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	14.5	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	15.2	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	ND	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	17.2	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	426	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125006	**EDD**	H3B270125
Client ID	HLW02-25R1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer24	**Analysis Method**	SW 846 6010B
		Collection Date	2/21/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	29.2	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	316	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	13.7	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	15.8	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	12.5	15	12.2	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Silver	15.4	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	34.2	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	429	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125007	**EDD**	H3B270125
Client ID	HLW02-29R1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner02	**Analysis Method**	SW 846 6010B
		Collection Date	2/5/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	89.1	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	165	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	22	75	11.9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Lead	76.8	30	9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Nickel	75.4	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	31.9	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	39.4	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	644	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125008	**EDD**	H3B270125
Client ID	HLW02-51R1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner24	**Analysis Method**	SW 846 6010B
		Collection Date	2/5/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	30.9	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	121	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	21.6	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	ND	120	11	1	3/10/2003	3/12/2003	3/6/2003		KGS
Selenium	29.5	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	14.7	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	476	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125009	**EDD**	H3B270125
Client ID	HLW02-32R1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner05	**Analysis Method**	SW 846 6010B
		Collection Date	2/5/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	30.8	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	233	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	22.3	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	55.6	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	36.3	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	14.4	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	455	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125010	**EDD**	H3B270125
Client ID	HLW02-50	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner23	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	31.7	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	171	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	27	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	76.2	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	17.1	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	22.5	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	41.5	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	663	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125011	**EDD**	H3B270125
Client ID	HLW02-17	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer16	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	8	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	260	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	12.6	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	13	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	ND	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	ND	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	343	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125013	**EDD**	H3B270125
Client ID	HLW02-47	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner20	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	68.9	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	108	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	15.7	75	11.9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Lead	63.1	30	9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Nickel	48.9	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	ND	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	33.7	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	448	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125014	**EDD**	H3B270125
Client ID	HLW02-57	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW02-8	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	32.7	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	40.7	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	23.8	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	55.6	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	ND	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	24.4	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	1640	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125015	**EDD**	H3B270125
Client ID	HLW02-27	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer26	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	49.2	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	18.4	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	17	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	32.4	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	32.8	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	ND	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	49.2	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	764	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125016	**EDD**	H3B270125
Client ID	HLW02-02	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer01	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	60.7	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	288	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	7.5	30	7.2	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Copper	18.6	75	11.9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Lead	74.8	30	9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Nickel	ND	120	11	1	3/10/2003	3/12/2003	3/6/2003		KGS
Selenium	ND	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	36.8	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	377	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125017	**EDD**	H3B270125
Client ID	HLW02-23R1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer22	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	63.9	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	779	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	22.6	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	414	120	11	1	3/10/2003	3/12/2003	3/6/2003		KGS
Selenium	ND	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	16	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	28	30	22.7	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	1000	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125018	**EDD**	H3B270125
Client ID	HLW02-22	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer21	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	12.6	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	8	15	2.3	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	13.5	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	12	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	14.5	15	12.2	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Silver	ND	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	306	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125019	**EDD**	H3B270125
Client ID	HLW02-40	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner13	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	47.5	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	195	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	12.5	75	11.9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Lead	53.4	30	9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Nickel	44.9	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	13.5	15	12.2	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Silver	23.3	30	11.8	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	387	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3B270125020	**EDD**	H3B270125
Client ID	HLW02-11	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Outer10	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	17.4	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	20.5	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	21.3	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	318	120	11	1	3/10/2003	3/12/2003	3/6/2003		KGS
Selenium	44.3	15	12.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Silver	ND	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	32.8	30	22.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	787	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	H3C100111005	**EDD**	H3C100111
Client ID	HLW02-34R1	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1a.Inner07	**Analysis Method**	SW 846 6010B
		Collection Date	2/26/2003
		Receipt Date	3/10/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/13/2003	3/14/2003	3/13/2003		KGS
Arsenic	ND	30	14.5	1	3/13/2003	3/14/2003	3/13/2003		KGS
Barium	118	150	3.1	1	3/13/2003	3/14/2003	3/13/2003	B J	KGS
Beryllium	ND	15	2.7	1	3/13/2003	3/14/2003	3/13/2003		KGS
Cadmium	443	15	2.3	1	3/13/2003	3/14/2003	3/13/2003	J	KGS
Chromium	ND	30	7.2	1	3/13/2003	3/14/2003	3/13/2003		KGS
Copper	23.5	75	11.9	1	3/13/2003	3/14/2003	3/13/2003	B	KGS
Lead	90	30	9	1	3/13/2003	3/14/2003	3/13/2003		KGS
Nickel	281	120	11	1	3/13/2003	3/14/2003	3/13/2003		KGS
Selenium	15.6	15	12.2	1	3/13/2003	3/14/2003	3/13/2003		KGS
Silver	70	30	11.8	1	3/13/2003	3/14/2003	3/13/2003		KGS
Thallium	ND	30	22.7	1	3/13/2003	3/14/2003	3/13/2003		KGS
Vanadium	ND	150	16.9	1	3/13/2003	3/14/2003	3/13/2003		KGS
Zinc	863	60	7.7	1	3/13/2003	3/14/2003	3/13/2003	J	KGS

IHLW SURROGATE SAMPLE DATA - AUGMENTATION MATRIX GLASS

Lab ID	H3D100122003	**EDD**	H3D100122
Client ID	HLW03-03	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Analysis Method**	SW 846 6010B
Composition Space	1b.Outer03	**Leach/Prep Method**	SW 846 1311/3010A
		Collection Date	4/3/2003
		Receipt Date	4/10/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	4/16/2003	4/24/2003	4/14/2003		KGS
Arsenic	ND	30	14.5	1	4/16/2003	4/24/2003	4/14/2003		KGS
Barium	114	150	3.1	1	4/16/2003	4/24/2003	4/14/2003	B J	KGS
Beryllium	ND	15	2.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Cadmium	789	15	2.3	1	4/16/2003	4/24/2003	4/14/2003		KGS
Chromium	21.3	30	7.2	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Copper	ND	75	11.9	1	4/16/2003	4/24/2003	4/14/2003		KGS
Lead	24.5	30	9	1	4/16/2003	4/24/2003	4/14/2003	B J	KGS
Nickel	235	120	11	1	4/16/2003	4/24/2003	4/14/2003		KGS
Selenium	28.4	15	12.2	1	4/16/2003	4/24/2003	4/14/2003		KGS
Silver	27.5	30	11.8	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Thallium	36.4	30	22.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Vanadium	ND	150	16.9	1	4/16/2003	4/24/2003	4/14/2003		KGS
Zinc	918	60	7.7	1	4/16/2003	4/24/2003	4/14/2003	J	KGS

Lab ID	H3D100122004	**EDD**	H3D100122
Client ID	HLW03-42	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW02-46	**Analysis Method**	SW 846 6010B
		Collection Date	3/28/2003
		Receipt Date	4/10/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	4/16/2003	4/24/2003	4/14/2003		KGS
Arsenic	15.6	30	14.5	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Barium	162	150	3.1	1	4/16/2003	4/24/2003	4/14/2003	J	KGS
Beryllium	ND	15	2.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Cadmium	168	15	2.3	1	4/16/2003	4/24/2003	4/14/2003		KGS
Chromium	13.1	30	7.2	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Copper	20.6	75	11.9	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Lead	50.5	30	9	1	4/16/2003	4/24/2003	4/14/2003	J	KGS
Nickel	182	120	11	1	4/16/2003	4/24/2003	4/14/2003		KGS
Selenium	20.7	15	12.2	1	4/16/2003	4/24/2003	4/14/2003		KGS
Silver	25.3	30	11.8	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Thallium	ND	30	22.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Vanadium	18.8	150	16.9	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Zinc	524	60	7.7	1	4/16/2003	4/24/2003	4/14/2003	J	KGS

Lab ID	H3D100122005	**EDD**	H3D100122
Client ID	HLW03-02	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer02	**Analysis Method**	SW 846 6010B
		Collection Date	4/4/2003
		Receipt Date	4/10/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	4/16/2003	4/24/2003	4/14/2003		KGS
Arsenic	ND	30	14.5	1	4/16/2003	4/24/2003	4/14/2003		KGS
Barium	58.5	150	3.1	1	4/16/2003	4/24/2003	4/14/2003	B J	KGS
Beryllium	ND	15	2.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Cadmium	695	15	2.3	1	4/16/2003	4/24/2003	4/14/2003		KGS
Chromium	18.7	30	7.2	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Copper	ND	75	11.9	1	4/16/2003	4/24/2003	4/14/2003		KGS
Lead	25.3	30	9	1	4/16/2003	4/24/2003	4/14/2003	B J	KGS
Nickel	254	120	11	1	4/16/2003	4/24/2003	4/14/2003		KGS
Selenium	ND	15	12.2	1	4/16/2003	4/24/2003	4/14/2003		KGS
Silver	19	30	11.8	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Thallium	36	30	22.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Vanadium	ND	150	16.9	1	4/16/2003	4/24/2003	4/14/2003		KGS
Zinc	62	60	7.7	1	4/16/2003	4/24/2003	4/14/2003	J	KGS

Lab ID	F4D070174001	**EDD**	F4D070174
Client ID	HLW03-12-2	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer12	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2003
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	174	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Arsenic	18.4	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Barium	215	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	43.2	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	129	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Copper	ND	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004		JG
Lead	49.1	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	94.8	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Selenium	6.1	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Silver	30	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	2.6	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	3120	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174002	**EDD**	F4D070174
Client ID	HLW03-07-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer07	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	16.8	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Arsenic	18.4	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Barium	51	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	46.5	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	199	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Copper	ND	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004		JG
Lead	104	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	60.8	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Selenium	95.9	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	27.3	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	6.4	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	2750	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174003	**EDD**	F4D070174
Client ID	HLW03-29-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner09	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	49.1	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Arsenic	39.7	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Barium	129	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	313	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	152	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Copper	14.7	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004	B	JG
Lead	106	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	295	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Selenium	33	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	74.5	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	13	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	2990	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174004	**EDD**	F4D070174
Client ID	HLW03-26-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner06	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	94	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Arsenic	82.7	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Barium	234	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	75.6	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	70.7	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Copper	42.7	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004	B	JG
Lead	228	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	358	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Selenium	106	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	119	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	30.7	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	2080	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174005	**EDD**	F4D070174
Client ID	HLW03-38-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner18	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2003
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	5.3	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Arsenic	19.8	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Barium	91.2	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	68.8	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	17.6	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Copper	10.5	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004	B	JG
Lead	74.5	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	52.3	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Selenium	22.8	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	34.7	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	7.8	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	217	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174010	**EDD**	F4D070174
Client ID	HLW03-27-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner07	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	17	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Arsenic	9.6	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Barium	72.8	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	24.8	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	13.3	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Copper	8.4	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004	B	JG
Lead	89.4	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	101	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Selenium	29	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	32.8	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	5.5	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	675	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174011	**EDD**	F4D070174
Client ID	HLW03-36-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner16	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	12.4	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Arsenic	11.2	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Barium	48.3	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	43	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	6.7	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Copper	ND	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004		JG
Lead	79.1	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	48.6	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Selenium	12.8	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Silver	19.8	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	4.1	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	154	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174012	**EDD**	F4D070174
Client ID	HLW03-28-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner08	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	18.7	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Arsenic	ND	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Barium	35.5	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	29.9	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	7.5	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Copper	ND	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004		JG
Lead	43.6	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	128	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Selenium	16.2	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	8.2	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	1.5	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	232	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174013	**EDD**	F4D070174
Client ID	HLW03-25-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner05	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2003
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	8.2	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Arsenic	21.7	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Barium	107	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Cadmium	33	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Chromium	9.4	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Copper	15.2	62.5	3	2.5	4/15/2004	4/15/2004	4/12/2004	B	JG
Lead	98.7	12.5	4.5	2.5	4/15/2004	4/15/2004	4/12/2004	J	JG
Nickel	138	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Selenium	37.9	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	44.6	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	9	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Zinc	923	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG

Lab ID	F4D070174019	**EDD**	F4D070174
Client ID	HLW03-33-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner13	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	20.8	25	5.15	2.5	4/13/2004	4/14/2004	4/13/2004	B	JG
Arsenic	9.2	30	3.725	2.5	4/13/2004	4/14/2004	4/13/2004	B	JG
Barium	33	500	17	2.5	4/13/2004	4/14/2004	4/13/2004	BE	JG
Cadmium	19.7	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/13/2004		JG
Chromium	6.1	30	1.5025	2.5	4/13/2004	4/14/2004	4/13/2004	B	JG
Copper	ND	62.5	3	2.5	4/15/2004	4/15/2004	4/13/2004		JG
Lead	26.4	12.5	4.5	2.5	4/15/2004	4/15/2004	4/13/2004	B	JG
Nickel	65.2	120	3.05	2.5	4/13/2004	4/14/2004	4/13/2004	B	JG
Selenium	13.7	15	3.25	2.5	4/13/2004	4/14/2004	4/13/2004	B	JG
Silver	7.3	25	1.04	2.5	4/13/2004	4/14/2004	4/13/2004	BN	JG
Thallium	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/13/2004		JG
Vanadium	1.7	125	1.4675	2.5	4/13/2004	4/14/2004	4/13/2004	B	JG
Zinc	545	50	8.5	2.5	4/13/2004	4/14/2004	4/13/2004	E	JG

Lab ID	F4D070183001	**EDD**	F4D070183
Client ID	HLW03-44-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW03-11	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	4.9	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	ND	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Barium	21.4	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	6.7	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Chromium	ND	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	18.6	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Nickel	11	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	24.3	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	1.7	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	BN	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	ND	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Zinc	12.1	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT

Lab ID	F4D070183002	**EDD**	F4D070183
Client ID	HLW03-16-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer16	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	4.9	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Arsenic	ND	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Barium	21.4	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	6.7	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	ND	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	18.6	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	11	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Selenium	24.3	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	1.7	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	ND	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	12.1	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183003	**EDD**	F4D070183
Client ID	HLW03-37-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner17	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2003
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	8.1	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	10.5	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	58.4	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	21.5	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	6.6	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	12.6	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	70.5	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	98	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	20.2	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	29.8	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	10.2	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Vanadium	6.8	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	602	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183004	**EDD**	F4D070183
Client ID	HLW03-17-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer17	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	14.1	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	44	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Barium	131	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	27.3	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	4.8	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	42.5	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	184	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	153	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Selenium	4.6	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Silver	69.1	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	18.7	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	1740	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D07018300	**EDD**	F4D070183
Client ID	HLW03-32-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner12	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	17.2	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	12.9	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	66.9	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	26.2	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	7.1	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	14.6	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	82.3	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	108	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	16.1	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	36.5	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	5.8	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	704	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183006	**EDD**	F4D070183
Client ID	HLW03-22-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner02	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	13.2	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	19.7	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	94.6	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	85.3	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	11.5	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	15.5	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	78.8	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	78.5	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	42.7	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	40.5	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	7.8	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	267	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183007	**EDD**	F4D070183
Client ID	HLW03-30-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner10	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2003
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	38.9	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Arsenic	13.1	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	51.8	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	36.8	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	20.5	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	43.6	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	106	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	26.1	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	24.7	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	BN	TT
Thallium	17	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Vanadium	3.3	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	346	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183008	**EDD**	F4D070183
Client ID	HLW03-34-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner14	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	10.5	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	17	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	57	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	17.3	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	17.6	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	7.3	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	57.3	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	85.6	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	20.3	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	42	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	6.4	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	156	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183009	**EDD**	F4D070183
Client ID	HLW03-24-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner04	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	17.2	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	14.6	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	46.2	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	116	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	23.6	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	40.9	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	179	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Selenium	17.6	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	26.6	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	3.4	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	1060	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D07018300	**EDD**	F4D070183
Client ID	HLW03-31-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner11	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	46.8	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Arsenic	14.7	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	61.1	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	41.3	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	45.6	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	50.5	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	193	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Selenium	46.8	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	28.5	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	30.8	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	4.6	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	389	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183011	**EDD**	F4D070183
Client ID	HLW03-10R1-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer10	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2003
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	12.6	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	67	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Barium	209	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B J	TT
Cadmium	32.2	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	7.1	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	62.4	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	266	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004	J	TT
Nickel	326	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Selenium	16.4	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004	J	TT
Silver	178	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	23.7	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	9.6	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004	B J	TT

Lab ID	F4D070183012	**EDD**	F4D07083
Client ID	HLW03-08-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer08	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	12.6	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	43.7	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Barium	125	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	17.5	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	5.2	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	48	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	161	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	25.8	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	16.4	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	99.5	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	24.2	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Vanadium	15.3	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	938	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183013	**EDD**	F4D070183
Client ID	HLW03-01-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer01	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	144	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Arsenic	89.5	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Barium	280	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	1420	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	228	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Copper	87.2	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	327	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	77.8	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	16.5	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	203	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	35.9	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	3010	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183014	**EDD**	F4D070183
Client ID	HLW03-06-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer06	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	9.9	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	5.5	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	38.8	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	251	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	20.3	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	48.9	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	130	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Selenium	7.2	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Silver	4.6	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	BN	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	1.8	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	63.1	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183015	**EDD**	F4D070183
Client ID	HLW03-14-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer14	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2003
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	8.8	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	14.5	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	182	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	42.3	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Chromium	21	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	47.6	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	529	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Selenium	16	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	31.1	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Thallium	61.8	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	3.1	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	2790	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT

Lab ID	F4D070183016	**EDD**	F4D070183
Client ID	HLW03-09-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer09	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	30.7	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Arsenic	6.1	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	17.8	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	10	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Chromium	3.1	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	17.9	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Nickel	17.6	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	28.1	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Silver	3.1	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	BN	TT
Thallium	30.2	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	2.4	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	9.6	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT

Lab ID	F4D070183017	**EDD**	F4D070183
Client ID	HLW03-18-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer18	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	10.3	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	4	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	16.8	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	8.1	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Chromium	32.6	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Copper	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Lead	278	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Nickel	114	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	9.5	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Silver	4.4	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	BN	TT
Thallium	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	2.5	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Zinc	42	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT

Lab ID	F4D070189001	**EDD**	F4D070189
Client ID	HLW03-11-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer11	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	ND	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Barium	21.1	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	7.4	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Chromium	1.6	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	ND	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Lead	16.2	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	11.2	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	21.6	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	2.5	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	25.9	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG

Lab ID	F4D070189002	**EDD**	F4D070189
Client ID	HLW03-13-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer13	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	6.8	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	93.3	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	18.5	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	13.2	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	5.3	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	23	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	145	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Selenium	19.2	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	8.7	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	411	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189003	**EDD**	F4D070189
Client ID	HLW03-04-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer04	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	4.8	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Arsenic	21.8	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	110	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	9.8	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Chromium	26.5	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	20.1	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	82.9	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Nickel	14	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	31.3	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	99.4	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	9.3	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Zinc	21.2	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG

Lab ID	F4D070189004	**EDD**	F4D070189
Client ID	HLW03-40-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner20	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	14.8	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Arsenic	6.9	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	34.3	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	48.6	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	4.5	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	4.2	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	21	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	67.9	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	17.9	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	6.3	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	196	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189005	**EDD**	F4D070189
Client ID	HLW03-45-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW03-26	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	19	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Arsenic	17.5	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	92.6	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	34.4	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	18.3	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	21	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	87.2	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Nickel	123	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Selenium	35.9	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	42.3	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	7.8	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Zinc	1020	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189006	**EDD**	F4D070189
Client ID	HLW03-23-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner03	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	7.5	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	33	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	23.7	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	13.1	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	5.5	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	32.1	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Nickel	59.6	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	22.2	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	9.4	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	280	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189007	**EDD**	F4D070189
Client ID	HLW03-41-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Center	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	10.6	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Arsenic	8.6	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	47.6	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	36.6	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	8.4	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	7.9	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	40.2	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Nickel	61.5	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	12.3	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Silver	16.7	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	3.3	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Zinc	418	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189008	**EDD**	F4D070189
Client ID	HLW03-39-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner19	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	7.5	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Arsenic	10.2	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	50.4	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	35.7	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	8.3	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	7.2	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	45.6	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Nickel	28.4	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	13.3	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Silver	20.3	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	3.1	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Zinc	148	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189009	**EDD**	F4D070189
Client ID	HLW03-35-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner15	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	ND	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Barium	26.7	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	14.2	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	5	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	ND	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Lead	21.4	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	59.2	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	9.9	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Silver	6.8	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	184	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189010	**EDD**	F4D070189
Client ID	HLW03-21-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Inner01	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	20.2	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Arsenic	28.5	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	79	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	176	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	35.9	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Copper	13.5	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	58.1	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Nickel	163	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Selenium	23.8	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	38.3	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	7.2	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Zinc	663	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189011	**EDD**	F4D070189
Client ID	HLW03-20-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer20	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	40.1	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	31.8	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Barium	90.5	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	345	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	5.1	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	36.9	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	104	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Nickel	182	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Selenium	33.7	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	38.5	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Thallium	15.7	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Vanadium	10.4	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Zinc	17.6	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG

Lab ID	F4D070189012	**EDD**	F4D070189
Client ID	HLW03-05-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer05	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	71.5	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	70.8	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Barium	136	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	642	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	102	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Copper	51.9	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	191	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Nickel	43.3	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	61.9	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	90.1	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Thallium	70.7	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	22.7	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Zinc	1760	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189013	**EDD**	F4D070189
Client ID	HLW03-15-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer15	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	32.5	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	3.9	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	27.2	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	290	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	1.6	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	ND	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Lead	26.2	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	11.8	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	6.7	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Silver	5.5	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	37.2	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	685	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189014	**EDD**	F4D070189
Client ID	HLW03-43-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	RepHLW03-06	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	10.5	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Arsenic	10.8	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	61.9	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	536	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	77.1	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Copper	3.8	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	26.8	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	296	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Selenium	9	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Silver	13.8	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	2.1	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Zinc	35.9	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG

Lab ID	F4D070189019	**EDD**	F4D070189
Client ID	HLW03-19-02	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	1b.Outer19	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	6.4	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	22.2	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Cadmium	12.7	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Chromium	2.1	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Copper	ND	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Lead	28.8	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	48.2	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	15	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Silver	ND	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Thallium	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	360	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG

IHLW SURROGATE SAMPLE DATA - CONTROL SAMPLE GLASS

Lab ID	H3B110210009	**EDD**	H3B110210
Client ID	HLW02-M12	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Standard	**Analysis Method**	SW 846 6010B
		Collection Date	1/30/2003
		Receipt Date	1/31/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Arsenic	ND	30	14.5	1	2/19/2003	2/25/2003	2/17/2003		KGS
Barium	27.2	150	3.1	1	2/19/2003	2/25/2003	2/17/2003	B J	KGS
Beryllium	ND	15	2.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Cadmium	17.3	15	2.3	1	2/19/2003	2/25/2003	2/17/2003		KGS
Chromium	ND	30	7.2	1	2/19/2003	2/25/2003	2/17/2003		KGS
Copper	ND	75	11.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Lead	16.9	30	9	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Nickel	65.1	120	11	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Selenium	13.6	15	12.2	1	2/19/2003	2/25/2003	2/17/2003	B	KGS
Silver	ND	30	11.8	1	2/19/2003	2/25/2003	2/17/2003		KGS
Thallium	ND	30	22.7	1	2/19/2003	2/25/2003	2/17/2003		KGS
Vanadium	ND	150	16.9	1	2/19/2003	2/25/2003	2/17/2003		KGS
Zinc	430	60	7.7	1	2/19/2003	2/25/2003	2/17/2003	J .	KGS

Lab ID	H3D100122001	**EDD**	H3D100122
Client ID	HLW03-19A	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	4/9/2003
		Receipt Date	4/10/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	4/16/2003	4/24/2003	4/14/2003		KGS
Arsenic	ND	30	14.5	1	4/16/2003	4/24/2003	4/14/2003		KGS
Barium	41.6	150	3.1	1	4/16/2003	4/24/2003	4/14/2003	B J	KGS
Beryllium	ND	15	2.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Cadmium	16.4	15	2.3	1	4/16/2003	4/24/2003	4/14/2003		KGS
Chromium	11.5	30	7.2	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Copper	ND	75	11.9	1	4/16/2003	4/24/2003	4/14/2003		KGS
Lead	38.9	30	9	1	4/16/2003	4/24/2003	4/14/2003	J	KGS
Nickel	69.2	120	11	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Selenium	ND	15	12.2	1	4/16/2003	4/24/2003	4/14/2003		KGS
Silver	20.6	30	11.8	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Thallium	ND	30	22.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Vanadium	ND	150	16.9	1	4/16/2003	4/24/2003	4/14/2003		KGS
Zinc	382	60	7.7	1	4/16/2003	4/24/2003	4/14/2003	J	KGS

Lab ID	H3D100122002	**EDD**	H3D100122
Client ID	HLW03-19M	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	4/9/2003
		Receipt Date	4/10/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	4/16/2003	4/24/2003	4/14/2003		KGS
Arsenic	ND	30	14.5	1	4/16/2003	4/24/2003	4/14/2003		KGS
Barium	11.9	150	3.1	1	4/16/2003	4/24/2003	4/14/2003	B J	KGS
Beryllium	ND	15	2.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Cadmium	15.6	15	2.3	1	4/16/2003	4/24/2003	4/14/2003		KGS
Chromium	13.4	30	7.2	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Copper	ND	75	11.9	1	4/16/2003	4/24/2003	4/14/2003		KGS
Lead	26.8	30	9	1	4/16/2003	4/24/2003	4/14/2003	B J	KGS
Nickel	57.7	120	11	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Selenium	ND	15	12.2	1	4/16/2003	4/24/2003	4/14/2003		KGS
Silver	17.4	30	11.8	1	4/16/2003	4/24/2003	4/14/2003	B	KGS
Thallium	ND	30	22.7	1	4/16/2003	4/24/2003	4/14/2003		KGS
Vanadium	ND	150	16.9	1	4/16/2003	4/24/2003	4/14/2003		KGS
Zinc	669	60	7.7	1	4/16/2003	4/24/2003	4/14/2003	J	KGS

Lab ID	H3D070127001	**EDD**	H3D070127
Client ID	HLW99-03M12	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Spike Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Standard	**Analysis Method**	SW 846 6010B
		Collection Date	4/3/2003
		Receipt Date	4/4/2003

Analyte	Conc	EQL	MDL	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	4/9/2003	4/10/2003	4/3/2003		KGS
Arsenic	ND	30	14.5	1	4/9/2003	4/10/2003	4/3/2003		KGS
Barium	11.4	150	3.1	1	4/9/2003	4/10/2003	4/3/2003	B	KGS
Beryllium	ND	15	2.7	1	4/9/2003	4/10/2003	4/3/2003		KGS
Cadmium	21.9	15	2.3	1	4/9/2003	4/10/2003	4/3/2003		KGS
Chromium	8.0	30	7.2	1	4/9/2003	4/10/2003	4/3/2003	B	KGS
Copper	15.9	75	11.9	1	4/9/2003	4/10/2003	4/3/2003	B	KGS
Lead	28.6	30	9	1	4/9/2003	4/10/2003	4/3/2003	B	KGS
Mercury	ND	0.03	0.005	1	4/9/2003	4/9/2003	4/3/2003		KD
Mercury	ND	0	3E-05	1	4/10/2003	4/10/2003	4/3/2003		KD
Nickel	82	120	11	1	4/9/2003	4/10/2003	4/3/2003	B	KGS
Selenium	12.4	15	12.2	1	4/9/2003	4/10/2003	4/3/2003	B	KGS
Silver	32	30	11.8	1	4/9/2003	4/10/2003	4/3/2003		KGS
Thallium	ND	30	22.7	1	4/9/2003	4/10/2003	4/3/2003		KGS
Vanadium	ND	150	16.9	1	4/9/2003	4/10/2003	4/3/2003		KGS
Zinc	615	60	7.7	1	4/9/2003	4/10/2003	4/3/2003	J	KGS
Cyanide, Total	ND	0.5	0.27	1	4/9/2003	4/10/2003	4/3/2003	N*	DFW

Lab ID	H3B110213008	**EDD**	H3B110213
Client ID	HLW02-M12A	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	2/4/2003
		Receipt Date	2/11/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	2/21/2003	2/26/2003	2/19/2003		KGS
Arsenic	ND	30	14.5	1	2/21/2003	2/26/2003	2/19/2003		KGS
Barium	5.6	150	3.1	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Beryllium	ND	15	2.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Cadmium	16.6	15	2.3	1	2/21/2003	2/26/2003	2/19/2003		KGS
Chromium	ND	30	7.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Copper	ND	75	11.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Lead	18.7	30	9	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Nickel	58.5	120	11	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Selenium	ND	15	12.2	1	2/21/2003	2/26/2003	2/19/2003		KGS
Silver	16.1	30	11.8	1	2/21/2003	2/26/2003	2/19/2003	B	KGS
Thallium	ND	30	22.7	1	2/21/2003	2/26/2003	2/19/2003		KGS
Vanadium	ND	150	16.9	1	2/21/2003	2/26/2003	2/19/2003		KGS
Zinc	398	60	7.7	1	2/21/2003	2/26/2003	2/19/2003		KGS

Lab ID	H3C100111020	**EDD**	H3C100111
Client ID	HLW02-M12B	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	2/26/2003
		Receipt Date	3/10/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/13/2003	3/14/2003	3/13/2003		KGS
Arsenic	ND	30	14.5	1	3/13/2003	3/14/2003	3/13/2003		KGS
Barium	4.8	150	3.1	1	3/13/2003	3/14/2003	3/13/2003	B J	KGS
Beryllium	ND	15	2.7	1	3/13/2003	3/14/2003	3/13/2003		KGS
Cadmium	18.3	15	2.3	1	3/13/2003	3/14/2003	3/13/2003	J	KGS
Chromium	ND	30	7.2	1	3/13/2003	3/14/2003	3/13/2003		KGS
Copper	ND	75	11.9	1	3/13/2003	3/14/2003	3/13/2003		KGS
Lead	15.1	30	9	1	3/13/2003	3/14/2003	3/13/2003	B	KGS
Nickel	70.4	120	11	1	3/13/2003	3/14/2003	3/13/2003	B	KGS
Selenium	14	15	12.2	1	3/13/2003	3/14/2003	3/13/2003	B	KGS
Silver	ND	30	11.8	1	3/13/2003	3/14/2003	3/13/2003		KGS
Thallium	ND	30	22.7	1	3/13/2003	3/14/2003	3/13/2003		KGS
Vanadium	ND	150	16.9	1	3/13/2003	3/14/2003	3/13/2003		KGS
Zinc	411	60	7.7	1	3/13/2003	3/14/2003	3/13/2003	J	KGS

Lab ID	H3B270125012	**EDD**	H3B270125
Client ID	HLW02-M12GA91	**Basis**	WET
Lab Name	STLKNX	**Matrix**	WATER
SampleOrigin	HLW Initial Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	2/19/2003
		Receipt Date	2/27/2003

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	180	38.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Arsenic	ND	30	14.5	1	3/10/2003	3/12/2003	3/6/2003		KGS
Barium	7.7	150	3.1	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Beryllium	ND	15	2.7	1	3/10/2003	3/12/2003	3/6/2003		KGS
Cadmium	16.6	15	2.3	1	3/10/2003	3/12/2003	3/6/2003		KGS
Chromium	ND	30	7.2	1	3/10/2003	3/12/2003	3/6/2003		KGS
Copper	ND	75	11.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Lead	23.6	30	9	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Nickel	61.1	120	11	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Selenium	12.8	15	12.2	1	3/10/2003	3/12/2003	3/6/2003	B	KGS
Silver	ND	30	11.8	1	3/10/2003	3/12/2003	3/6/2003		KGS
Thallium	ND	30	22.7	1	3/10/2003	3/12/2003	3/6/20Q3		KGS
Vanadium	ND	150	16.9	1	3/10/2003	3/12/2003	3/6/2003		KGS
Zinc	394	60	7.7	1	3/10/2003	3/12/2003	3/6/2003	J	KGS

Lab ID	F4D070174014	**EDD**	F4D070174
Client ID	HLW03-G45	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	6.9	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Arsenic	ND	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Barium	10.7	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Beryllium	12.6	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Cadmium	1.7	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Chromium	ND	62.5	3	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Copper	24.3	12.5	4.5	2.5	4/13/2004	4/14/2004	4/12/2004	J	JG
Lead	50.9	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Nickel	13.2	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Selenium	ND	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	294	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG
Zinc	6.9	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG

Lab ID	F4D070174015	**EDD**	F4D070174
Client ID	HLW03-107M	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	7.5	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Arsenic	ND	30	3.725	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Barium	12.4	500	17	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Beryllium	12.9	12.5	0.7125	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Cadmium	1.7	30	1.5025	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Chromium	ND	62.5	3	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Copper	24.5	12.5	4.5	2.5	4/13/2004	4/14/2004	4/12/2004	J	JG
Lead	51.4	120	3.05	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG
Nickel	16.2	15	3.25	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Selenium	ND	25	1.04	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Silver	ND	30	9.1	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Thallium	ND	125	1.4675	2.5	4/13/2004	4/14/2004	4/12/2004		JG
Vanadium	304	50	8.5	2.5	4/13/2004	4/14/2004	4/12/2004	N	JG
Zinc	7.5	25	5.15	2.5	4/13/2004	4/14/2004	4/12/2004	B	JG

Lab ID	F4D070183018	**EDD**	F4D070183
Client ID	HLW03-G42	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	11	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	5.2	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	13.1	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Beryllium	12.2	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Cadmium	2.5	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Chromium	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Copper	20.1	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	48.1	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Nickel	14.1	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	1.2	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	BN	TT
Silver	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Thallium	ND	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	287	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Zinc	11	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT

Lab ID	F4D070183019	**EDD**	F4D070183
Client ID	HLW03-M42	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	3/23/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	7.4	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Arsenic	7.7	30	3.725	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Barium	13.2	500	17	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Beryllium	13.1	12.5	0.7125	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Cadmium	3	30	1.5025	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Chromium	ND	62.5	3	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Copper	22.8	12.5	4.5	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Lead	52	120	3.05	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Nickel	13.8	15	3.25	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT
Selenium	ND	25	1.04	2.5	4/14/2004	4/15/2004	4/13/2004	N	TT
Silver	ND	30	9.1	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Thallium	ND	125	1.4675	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Vanadium	290	50	8.5	2.5	4/14/2004	4/15/2004	4/13/2004		TT
Zinc	7.4	25	5.15	2.5	4/14/2004	4/15/2004	4/13/2004	B	TT

Lab ID	F4D070189015	**EDD**	F4D070189
Client ID	HLW03-106	**Basis**	WET
Lab Name	STLSTL	**Matrix**	WATER
SampleOrigin	HLW Augmentation Matrix Glass	**Leach/Prep Method**	SW 846 1311/3010A
Composition Space	VSL Control Sample	**Analysis Method**	SW 846 6010B
		Collection Date	3/22/2004
		Receipt Date	4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	ND	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Arsenic	6.4	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	22.2	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Beryllium	12.7	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Cadmium	2.1	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Chromium	ND	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Copper	28.8	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	48.2	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	15	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	ND	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Thallium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	360	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	ND	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004		JG

Lab ID	F4D070189016		**EDD**	F4D070189	
Client ID	HLW03-M41	**Basis**	WET		
Lab Name	STLSTL	**Matrix**	WATER		
SampleOrigin	HLW Augmentation Matrix Glass		**Leach/Prep Method**		SW 846 1311/3010A
Composition Space	VSL Control Sample		**Analysis Method**		SW 846 6010B
			Collection Date		3/23/2004
			Receipt Date		4/7/2004

Analyte	Conc ug/L	EQL ug/L	MDL ug/L	Dil	Prep Date	Analysis Date	Leach Date	Lab Qual	Sample Analysis Analyst
Antimony	6.8	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Arsenic	7	30	3.725	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Barium	17.2	500	17	2.5	4/15/2004	4/16/2004	4/14/2004	BE	JG
Beryllium	13.6	12.5	0.7125	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Cadmium	2.8	30	1.5025	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Chromium	ND	62.5	3	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Copper	26.4	12.5	4.5	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Lead	55.5	120	3.05	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Nickel	8.6	15	3.25	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG
Selenium	ND	25	1.04	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Silver	ND	30	9.1	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Thallium	ND	125	1.4675	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Vanadium	387	50	8.5	2.5	4/15/2004	4/16/2004	4/14/2004		JG
Zinc	6.8	25	5.15	2.5	4/15/2004	4/16/2004	4/14/2004	B	JG

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