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SINGLE-SHELL TANK COMPONENT CLOSURE DATA QUALITY OBJECTIVES

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LIST OF TERMS

CAS	Chemical Abstracts Service
CFR	*Code of Federal Regulations*
CI	confidence interval
CVAA	cold vapor atomic absorption
DOE	U.S. Department of Energy
DQO	Data quality objective
Ecology	State of Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
EDTA	ethylene diamine tetra acetic acid
EQL	estimated quantitation limit
g	grams
GC/MS	gas chromatography/mass spectrometry
GEA	gamma energy analysis
IC	ion chromatography
ICP/AES	inductively coupled plasma/atomic emission spectroscopy
ICP/MS	inductively coupled plasma/mass spectrometry
ISE	ion-specific electrode
LCS	laboratory control sample
M	molarity of moles per liter
MDL	method detection limit
mg/g	milligrams per gram
mg/kg	milligrams per kilograms
mL	milliliters
MTCA	Model Toxics Control Act
N/A	not applicable
NIST	National Institute of Science and Technology
NP	not performed
NPH	Normal Paraffin Hydrocarbons
NRC	U.S. Nuclear Regulatory Commission
PCB	polychlorinated biphenyls
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
QC	quality control
RPD	relative percent difference
SST	single-shell tank
SVOC	semivolatile organic compound
TBP	Tributyl Phosphate
TIC	tentatively identified compound
UCL	upper confidence limit
UHC	underlying hazardous constituent
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
VOA	Volatile organic analysis
VOC	volatile organic compound

LIST OF TERMS, Continued

WAC	*Washington Administrative Code*
%	percent
Ci/m^3	Curies per cubic meter
nCi/g	Nanocuries per gram
μCi/g	microcuries per gram
μg	micrograms
μL	microliters

GLOSSARY

Closure action/activity	Refers to component closure actions and/or activities throughout this document.
Wiemers	List of constituents identified for characterization in Table 4.4 of the *Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project* (Wiemers et al. 1998)
A	Identifies constituents from the Part A Permit.
R	Identifies constituents requested by the risk assessment group.
U	Identifies constituents as Underlying Hazardous Constituents.
W	Identifies constituents in Table 4.4 of the *Regulatory Data Quality Objectives Supporting Tank Waste Remediation System Privatization Project* (Wiemers et al. 1998)

1.0 INTRODUCTION

A key closure activity associated with Hanford Site cleanup is retrieval of as much single-shell tank (SST) waste as technically possible. To accomplish closure of the SST farms, information addressing the residual waste (waste remaining in individual SSTs after completion of waste retrieval) is required. Data are required to address risk assessment as well as performance criteria. Tanks within a tank farm will undergo component closure activities in accordance with the SST Closure Plan, which is the basis for modification of the Dangerous Waste Portion of the Resource Conservation Recovery Act Site-wide Permit. Required information includes but is not limited to the volume of the residual waste left in the tanks, the concentration of certain constituents (see Section 4.0) in the residual waste, and data for risk assessment determinations. The concentration and the volume of the residual waste will provide the inventory of the constituents in the residual waste.

In order to obtain the concentrations of the constituents of concern, samples of the residual waste (liquid and solids) remaining in the SST after retrieval are required. Liquid grab samples (depending on the retrieval method for a particular tank) will be obtained during the final waste retrieval activity and the solids after the final waste retrieval (see Section 8.0). The waste retrieval operations are detailed in the process control plans prepared for each tank. Retrieval actions are a component closure activity; however, retrieval will be complete in some tanks prior to permit issuance in accordance with the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et al.) M-45 milestones.

This document describes the Data Quality Objective (DQO) process undertaken to ensure appropriate data are collected to support the component closure activities for all single shell tanks and will cover all sampling and analytical activities for that purpose. The DQO process was implemented in accordance with *Data Quality Objectives for Sampling and Analyses,* TFC-ENG-CHEM-C-16, Rev. A and the U.S. Environmental Protection Agency (EPA) QA/G-4, *Guidance for the Data Quality Objectives Process*, with some modifications to accommodate project or tank specific requirements and constraints.

The DQO process is iterative. Therefore, changes to this document will be made, as required, during the time the DQO is in effect (component closure of the single-shell tanks). The DQO will be updated when requirements change (e.g., addition or deletion of constituents to be analyzed), changes in available equipment (e.g., off riser sampling), changes in retrieval methods, etc. Changes to the DQO document can be initiated by involved or affected groups (i.e., Ecology, ORP, and CH2M HILL organizations.). In addition, these groups will be informed of all changes that occur prior to the action taking effect.

The State of Washington Department of Ecology (Ecology) will not address information directly related to the strict application of the U.S. Department of Energy/Atomic Energy Agency (DOE/AEA) regulations in this DQO. However, Ecology will address information related to mixed waste and radionuclides as required by regulations, guidance, and the HFFACO (Ecology et al.), as well as retrieval/closure agreements, documents, and plans.

2.0 PROBLEM STATEMENT

The objective of a problem statement is to clearly define the problem (the reason analytical data are required) so the focus of the project (SST component closure actions) will be unambiguous. With the objective of the problem statement in mind, the scope of this DQO can be outlined in the following statements:

- The DQO process will address only the component closure activities for SSTs.
- This DQO will not address soil sampling and analysis or any actions associated with ancillary equipment in the tank farm. Therefore, the component closure action boundary for the SSTs will be the exterior of the tank walls. However, the closure action criteria will be consistent with and support final closure of the tank farms. Because the development of this DQO did not focus on soil and ancillary equipment (pipes, pits, vaults, etc.), this DQO does not adequately serve as a basis for final closure of the tank farms. These issues will be addressed in separate component closure DQOs or in DQOs for the closure of the tank farms.

Considering the purpose and scope of this DQO, a concise statement of the problem can be written as follows:

> Conduct component closure activities for SSTs in a manner that contributes to final closure of the tank farms.

The principal study question (PSQ) identifies key unknown conditions that reveal the solution to the problem. Generally, the PSQ requires data to be resolved. The PSQ that addresses the problem statement above is:

> Does the residual waste in a SST meet the HFFACO M-45-00 milestone volume requirements and support Washington Administrative Code (WAC) 173-303-610 (2) closure performance standards for protection of human health and the environment to allow component closure activities to continue?

3.0 DECISION STATEMENTS

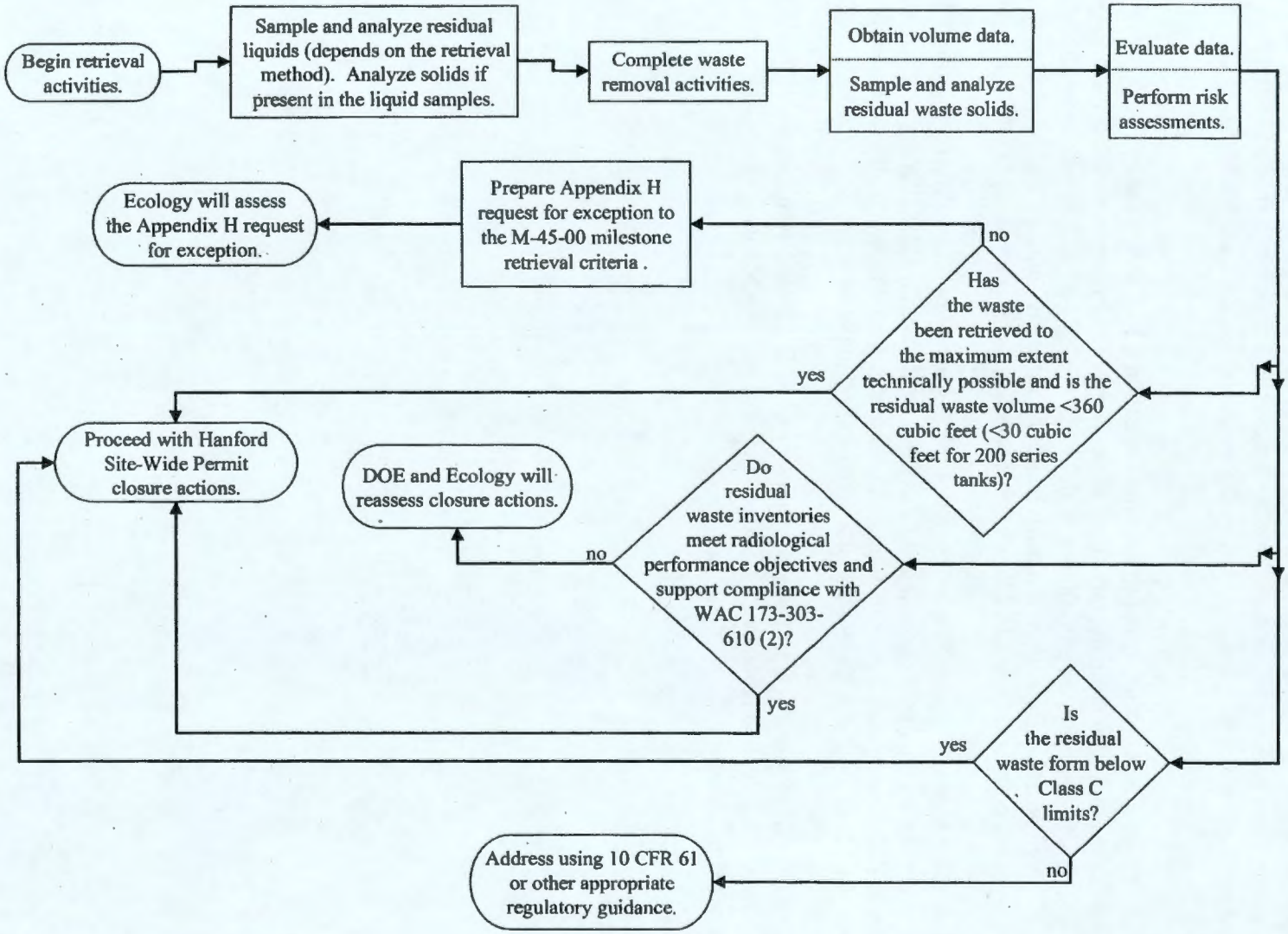
Decision statements link alternative actions with the principal study question and express a choice between alternative actions. Decision statements are created by combining the study questions with alternative actions. Using this formula, the decision statement can be expressed as:

> Determine whether or not the residual waste in a SST meets the HFFACO M-45-00 milestone requirements, radiological performance objectives defined in DOE Order 435.1, and supports compliance with WAC 173-303-610 (2) closure performance standards for protection of human health and the environment and allows the component closure actions to proceed, or requires reassessment of the component closure actions.

Figure 3-1 shows the general logic flowchart for the component closure action of a SST. The flowchart shows the decisions and activities that are covered by this DQO and are needed to address a SST component closure action. The decisions are discussed and expanded in Section 6.0 while the sampling activities are discussed in Section 8.0.

As indicated in Figure 3-1, all three decisions must be addressed to proceed with Hanford Site-Wide Permit closure actions. The decisions are parallel actions. The decision rules are discussed in Section 6.0.

Figure 3-1. SSTs Component Closure Action Logic Flowchart.



4.0 DATA INPUTS

This section describes the information required to address the problem statement and the decision statement shown above. As mentioned above, three types of data are required for the component closure activities for SST component closure action: volume data, chemical and radionuclide constituent concentrations, and release rates of critical constituents for risk assessment determinations. The volume data are required to address one of the decision rules (see Section 6.0) and used with constituent concentrations to determine constituent inventories in the residual waste. The constituent inventories and release rates are needed to support risk assessment calculations. In addition, the concentrations of specific radionuclides are required to address the decision rule concerning Class C limits.

The determination of selected constituent release rate tests, required for risk assessment calculations, will be conducted by Pacific Northwest National Laboratory (PNNL) from samples collected through this DQO (see Section 8.0).

4.1 ANALYTICAL PARAMETERS

An analytical strategy for the component closure action of a SST was developed during DQO process meetings. This strategy is based on analyzing for major constituent categories (volatile organic compounds [VOC], semivolatile organic compounds [SVOC], inorganics, and radionuclides) by a set of specific analytical methods. The strategy identifies specific or "primary" constituents (Single-Shell Tank Part A Permit [Part A] [CH2M HILL 2003], underlying hazardous constituents [UHC], and radionuclides from 10 CFR 61.55) that will be analyzed with the quality control (QC) specified in this DQO. In the event that a constituent identified on the secondary list is determined to affect the risk assessment, it shall be added to the primary list. The secondary constituents (those constituents that can be detected with the analytical methods being used but not on the primary list) will be reported using the QC indicated in the strategy described for each analytical group.

The following sections discuss the major constituent categories: organic, inorganic, and radiochemical. The sections include flowcharts showing the analytical strategy and tables showing the SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* analytical methods and the Part A, UHC, 10 CFR 61.55, and risk assessment (primary constituents) covered by these analytical methods. Some constituents may be measured by more than one method. In these cases, the selection of the method may depend on the action levels required for a decision, method detection limits, or the expectation that the constituent is present.

Waste analyses will be performed utilizing the applicable methods outlined in SW-846. However, SW-846 methods may require modifications to address radiological concerns and some matrix conditions found in the Hanford Site tank waste. All attempts will be made to meet the data quality objectives.

4.1.1 Organics

Other than plant solvents, the amount of organic constituents that may have entered the tank waste is expected to be small in volume and highly variable compared to the inorganic and radionuclide components that make up the largest fraction of the wastes. These organic constituents are subject to hydrolytic and radiolytic chemical reactions that lead to changes in their composition. Because of the large amount of uncertainty in their composition, a strategy for effectively evaluating the primary constituents is needed as well as a way that effectively evaluates the tentatively identified compounds (TIC). Detected organic constituents that are not part of the calibration mix (primary constituents) are TICs. The strategic approach for analyzing VOCs and SVOCs is shown in Figure 4-1.

Based on the strategy (see Figure 4-1) for organic components, the primary constituents would be analyzed with the specified level of QC (see Section 4.2). This means they would be included in the calibration of the gas chromatographs and method detection limits (MDL) would be determined for each constituent for the appropriate sample preparation required.

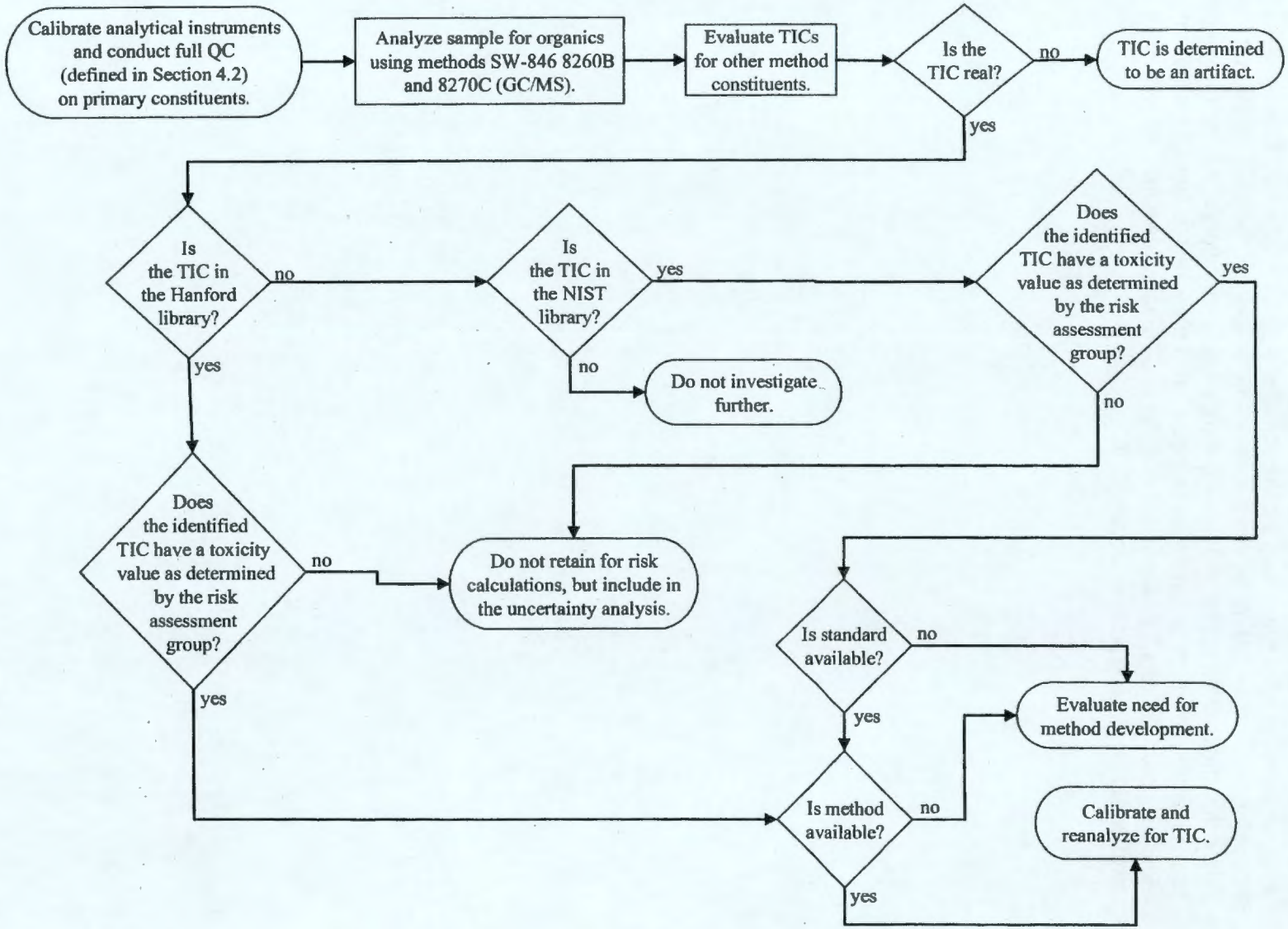
Because the volatile organic analysis (VOA) calibration standards are normally prepared in methanol, this constituent cannot be included as an analyte.

The flowchart (Figure 4-1) shows the process for evaluating these TICs to support component closure action decisions. Some TICs are the result of bleeding from the chromatographic column being used. Other TICs may be caused by reactions of the waste matrices with surrogates added to the sample as part of the analytical process. If the TIC is determined by the responsible chemist to be an artifact of the testing, no further evaluation is needed. These TICs are flagged and discussed in the data package narrative. If the TIC is determined to be real, it will be evaluated against a gas chromatographic library containing the secondary compounds of interest. This library of compounds (called the "Hanford Library") is composed of constituents that have been identified as possibly being present in Hanford Site waste in the Regulatory DQO (PNNL-12040) except those already identified as primary constituents.

The "Hanford Library" was developed by running single standards of the constituents on the laboratory's gas chromatography/mass spectrometry (GC/MS) systems. The results of these analyses provide accurate retention time information and mass response factors for these compounds and permit a better evaluation of the TIC. If a TIC is identified in the "Hanford Library" of compounds, a semi-quantitative estimate (estimated off of an archived one point calibration) of its concentration is made. The risk assessment group receives the analytical reports when the reports are released and determines if the toxicity of any identified TIC is a concern (see Figure 4-1). If the identified TIC does not have a toxicity value in standard databases or scientific literature, it will be reported in the retrieval data report but not retained for the risk assessment. If the TIC does have a toxicity value in standard databases or scientific literature, a further evaluation of the TIC is conducted. This can be as simple as recalibrating and reanalyzing or as complex as developing a new analytical method.

If the TIC is not found in the "Hanford Library" of compounds, then the TIC will be evaluated against the standard National Institute of Standards and Technology (NIST) library of compounds. This library has over 100,000 compounds. However, because they are collected on different instruments from those used for the actual analysis, the retention times and response factors will be different. Before the analyst can name or identify the TIC, the analyst must be confident that the chromatogram and mass spectra match well enough to name the compound. If the analyst cannot confidently name the compound, it is identified as an unknown and no further action is required. When a TIC is identified in the NIST library, then the TIC will be evaluated in a similar manner as a "Hanford Library" TIC.

Figure 4-1. Strategy for Organic Analyses.



The standard SW-846 methods may not be the best suited for some TIC compounds. If the sensitivity or the quality of the data is not adequate for making confident decisions, then it may be necessary to develop an improved method. The best available analytical technologies and methods shall be used for the residual waste characterization until improved technologies or methods are available. These methods shall be applied to future samples where these TICs may be identified.

The 222-S Laboratory follows the SW-846 approach to identifying and estimating concentrations for TICs. The Reconstructed Ion Chromatogram is evaluated for TICs by identifying any peaks that have not already been identified as target compounds. In addition the laboratory imposes two thresholds on the TICs to make the data more manageable: 1) the TIC peaks must be greater than 10 percent of the nearest internal standard (IS) area free from interferences and 2) only the 30 largest TICs will be evaluated and reported. These thresholds are similar to those used by the *USEPA Contract Laboratory Program* (EPA, 2004). If the sample must be diluted before analyzing on the GC/MS because of high concentrations of some organics (such as NPH and TBP), then the ability to detect and identify lower concentration organics and TICs will be reduced. A Hanford library and NIST library search will be performed and evaluated by the responsible chemist. For a TIC identified in the NIST library, an estimate of the concentration will be made based on the concentration of the IS used and a response factor of 1. For a TIC identified in the "Hanford Library," concentrations will be estimated based on the concentration of the IS used and a response factor determined by a single standard for that constituent measured on that instrument when the "Hanford Library" was developed. All TIC results will be flagged with a "J" to indicate that the result is an estimate.

Table 4-1 shows SW-846 method 8260B VOC considered primary for this DQO. In addition, the table shows the reason for inclusion as a primary constituent (found in the Part A or UHC) and which of these primary constituents are found in the Regulatory DQO (PNNL-12040). Constituents identified with asterisks may be determined by more than one method. All of the method numbers discussed in this section are SW-846 methods.

Table 4-1. Method 8260B VOC Analyses For Primary Constituents. (2 Sheets)

Constituent	CAS	Reason for Inclusion	Comments
1,1,1-Trichloroethane	71-55-6	A, U, W	
1,1,2,2-Tetrachloroethene	127-18-4	A, W	
1,1,2,2-Tetrachloroethane	79-34-5	A, U, W	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	A, W	
1,1,2-Trichloroethane	79-00-5	A, W	
1,1,2-Trichloroethylene	79-01-6	A, U, W	
1,1-Dichloroethene	75-35-4	A, U, W	
1,2-Dichloroethane	107-06-2	A, W	
Chloroethene(vinyl chloride)	75-01-4	A, W	
2-Butanone(MEK)	78-93-3	A, U, W	
2-Nitropropane	79-46-9	A	
2-Propanone (Acetone)	67-64-1	A, U, W	
4-Methyl-2-pentanone (MIBK)	108-10-1	A, U, W	
Benzene	71-43-2	U, W	
Carbon disulfide	75-15-0	A, W	

Table 4-1. Method 8260B VOC Analyses For Primary Constituents. (2 Sheets)

Constituent	CAS	Reason for Inclusion	Comments
Carbon tetrachloride	56-23-5	A, U, W	
Chlorobenzene	108-90-7	A, U, W	
Chloroform	67-66-3	A, W	
Dichloromethane (methylene chloride)	75-09-2	A, U W	
Ethyl Acetate	141-78-6	A, W	
Ethylbenzene	100-41-4	A, W	
Diethyl ether	60-29-7	A	
Isobutanol*	78-83-1	A	
Methanol	67-56-1	A, W	Will not be analyzed. See explanation in text.
n-Butyl alcohol (1-butanol)*	71-36-3	A, U, W	
Toluene	108-88-3	A, U, W	
trans-1,3-dichloropropene	542-75-6	U, W	
Trichlorofluoromethane	75-69-4	A, W	
Xylenes	1330-20-7	A, W	
o-Xylene	95-47-6	A, W	
m-Xylene	108-38-3	A, W	
p-Xylene	106-42-3	A, W	

Notes:

CAS	Chemical Abstracts Service
*	Constituent may be analyzed by the VOC (8260B) method or the SVOC (8270C) method.
A	Part A constituent.
U	UHC constituent.
W	Constituent in PNNL-12040.

Table 4-2 shows method 8270C SVOC considered primary for this DQO. In addition, the table shows the reason for inclusion as a primary constituent (found in the Part A or UHC) and which of these primary constituents are found in the Regulatory DQO (PNNL-12040).

Table 4-2. Method 8270C SVOC Analyses For Primary Constituents. (2 Sheets)

Constituent	CAS	Reason for Inclusion	Comments
1,2,4-Trichlorobenzene*	120-82-1	U, W	
2,4-Dinitrotoluene	121-14-2	A	
2,4,5-Trichlorophenol	95-95-4	A, U	
2,4,6-Trichlorophenol	88-06-2	U	
2,6-Bis (tert-butyl)-4-methylphenol	128-37-0	A, W	
2-Chlorophenol	95-57-8	U	
2-Ethoxyethanol	110-80-5	A	
2-Methylphenol (o-cresol)	95-48-7	A	
4-Methylphenol (p-cresol)	106-44-5	A	
Acenaphthene	83-32-9	U	
Butylbenzylphthalate	85-68-7	U	
Cresylic acid (cresol, mixed isomers)	1319-77-3	A	
Cyclohexanone	108-94-1	A, W	
Di-n-butylphthalate	84-74-2	U	

Table 4-2. Method 8270C SVOC Analyses For Primary Constituents. (2 Sheets)

Constituent	CAS	Reason for Inclusion	Comments
Di-n-octylphthalate	117-84-0	U	
N-nitroso-di-n-propylamine	621-64-7	U	
Fluoranthene	206-44-0	U	
Hexachlorobutadiene*	87-68-3	A, W	
Hexachloroethane*	67-72-1	A	
m-Cresol (3-Methylphenol)	108-39-4	A	
Naphthalene	91-20-3	U	
Nitrobenzene*	98-95-3	A, W	
n-Nitrosomorpholine	59-89-2	U	
o-Dichlorobenzene*	95-50-1	A, W	
o-Nitrophenol	88-75-5	U	
p-Chloro-m-cresol (4-Chloro-3-methylphenol)	59-50-7	U	
Pyrene	129-00-0	U	
Pyridine*	110-86-1	A, W	
Tributyl phosphate	126-73-8	R, W	

Notes:

CAS	Chemical Abstracts Service.
*	Constituent may be analyzed by the SVOC (8270C) method or the VOC (8260B) method.
A	Part A constituent.
R	Risk assessment constituent.
U	UHC constituent.
W	Constituent in PNNL-12040.

In addition to the organic constituents shown in Table 4-1 and Table 4-2, polychlorinated biphenyls (PCBs) will be analyzed as primary constituents. In addition, percent water is required for solids so the PCB concentration can be reported on a dry weight basis. The total PCB concentration is determined using SW-846 method 8082.

Total PCB concentrations are calculated by summing the concentrations of seven Aroclors (1016, 1221, 1232, 1242, 1248, 1254, and 1260) found in a sample. The total PCBs in a sample are calculated by summing only detected Aroclors. If no Aroclors are detected, the total PCB concentration is considered the detection limit for the single most common Aroclor expected in the sample. Tank results indicate Aroclor 1254 is by far the most common Aroclor in Hanford tank waste. The policy of determining total PCB concentrations, as described above, is the policy of the EPA Manchester Laboratory for determining total PCB concentrations in a sample. In addition, this method was specified by agreement in a meeting with representatives from EPA Region 10, EPA Manchester Laboratory, Ecology, DOE, PNNL, and CH2M HILL Hanford Group, Inc. (CH2M HILL).

Table 4-3 shows the "Hanford Library" constituents for VOCs (method 8260B) and SVOCs (method 8270C). All of these constituents are found in the Regulatory DQO (PNNL-12040) and analyzed according to the strategy shown in Figure 4-1.

Table 4-3 includes constituents identified under the polynuclear aromatic hydrocarbon procedure 8310 and pesticide procedure 8081A. These constituents are not expected in Hanford Site waste, and analyses by these methods will not be conducted unless detected by method 8270C and require additional delineation.

One VOC (butane) and four SVOCs (pentachloronaphthalene, hexachloronaphtahlene, tetrachloronaphthalene, and octachloronaphthalene) will not be included in the "Hanford Library." It was not possible to get butane into solution, and the four SVOCs could not be obtained as pure compounds suitable for a standard. The NIST library will be relied on for the identification of these compounds.

Table 4-3. Secondary Organic Constituents "Hanford Library." (2 Sheets)

Method 8260B VOC	CAS	Method 8270C SVOC	CAS
cis-1,3-Dichloropropene	10061-01-5	p-Nitrochlorobenzene	100-00-5
Ethylene dibromide (1,2, Dibromoethane)	106-93-4	1,4-Dinitrobenzene	100-25-4
Butane	106-97-8	1,4-Dichlorobenzene	106-46-7
1,3-Butadiene	106-99-0	Phenol	108-95-2
Acrolein (propenal)	107-02-8	Hexachlorobenzene	118-74-1
3-Chloropropene (Allyl chloride)	107-05-1	N,N-Diphenylamine	122-39-4
Propionitrile (Ethyl cyanide)	107-12-0	Pentachloronaphthalene	1321-64-8
Acrylonitrile	107-13-1	Hexachloronaphtahlene*	1335-87-1
2-Pentanone	107-87-9	Tetrachloronaphthalene	1335-88-2
Methylcyclohexane	108-87-2	Octachloronaphthalene	2234-13-1
n-Pentane	109-66-0	Isodrin*	465-73-6
5-Methyl-2-hexanone	110-12-3	Benzo[a]pyrene*	50-32-8
2-Heptanone	110-43-0	Dibenz[a,h]anthracene*	53-70-3
n-Hexane	110-54-3	1,3-Dichlorobenzene	541-73-1
Cyclohexane	110-82-7	3-Methyl-2-butanone	563-80-4
n-Octane	111-65-9	N-Nitroso-N,N-dimethylamine	62-75-9
4-Heptanone	123-19-3	Hexafluoroacetone	684-16-2
Acetic acid, n-butylester	123-86-4	Pentachloronitrobenzene (PCNB)	82-68-8
1,4-Dioxane	123-91-1	Pentachlorophenol	87-86-5
n-Heptane	142-82-5	2-sec-Butyl-4,6-dinitophenol (Dinoseb)	88-85-7
Cyclopentane	287-92-3	1,1'-Biphenyl	92-52-4
Ethyl alcohol	64-17-5	Acetophenone	98-86-2
2-Propyl alcohol	67-63-0	Toxaphene*	8001-35-2
n-propyl alcohol (1-propanol)	71-23-8	Nitric acid, propyl ester	627-13-4
Bromomethane	74-83-9	Aldrin*	309-00-2
Chloroethane	75-00-3	alpha-BHC*	319-84-6
Acetonitrile	75-05-8	beta-BHC*	319-85-7
1,1 Dichloroethane	75-34-3	gamma-BHC (Lindane)*	58-89-9
Dichlorofluromethane	75-43-4	Dieldrin*	60-57-1
Chlorodifluoromethane	75-45-6	Endrin*	72-20-8
3-Methy-2-butanone*	563-80-4	1,1-Dimethylhydrazine	57-14-7
Hexafluoroacetone*	684-16-2	Methylhydrazine	60-34-4
2-Butenaldehyde (2-Butenal)	4170-30-3		
Methyl isocyanate	624-83-9		
n-Propionaldehyde	123-38-6		
3-Heptanone	106-35-4		
Chloromethane	74-87-3		

Table 4-3. Secondary Organic Constituents "Hanford Library." (2 Sheets)

Method 8260B VOC	CAS	Method 8270C SVOC	CAS
n-Nonane	111-84-2		
Styrene	100-42-5		
Tetrahydrofuran	109-99-9		
Cyclohexene	110-83-8		
2-Methyl-2-propenenitrile	126-98-7		
2-Hexanone	591-78-6		
Triethylamine	121-44-8		
Oxirane	75-21-8		
2-Methyl-2-propanol	75-65-0		
Dichlorodifluoromethane	75-71-8		
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2		
Heptachlor	76-44-8		
1,2-Dichloropropane	78-87-5		
1-Methylpropyl alcohol	78-92-2		
3-Pentanone	96-22-0		

Notes:

CAS Chemical Abstracts Service
* Constituent may be analyzed by an alternate method.

4.1.2 Inorganics

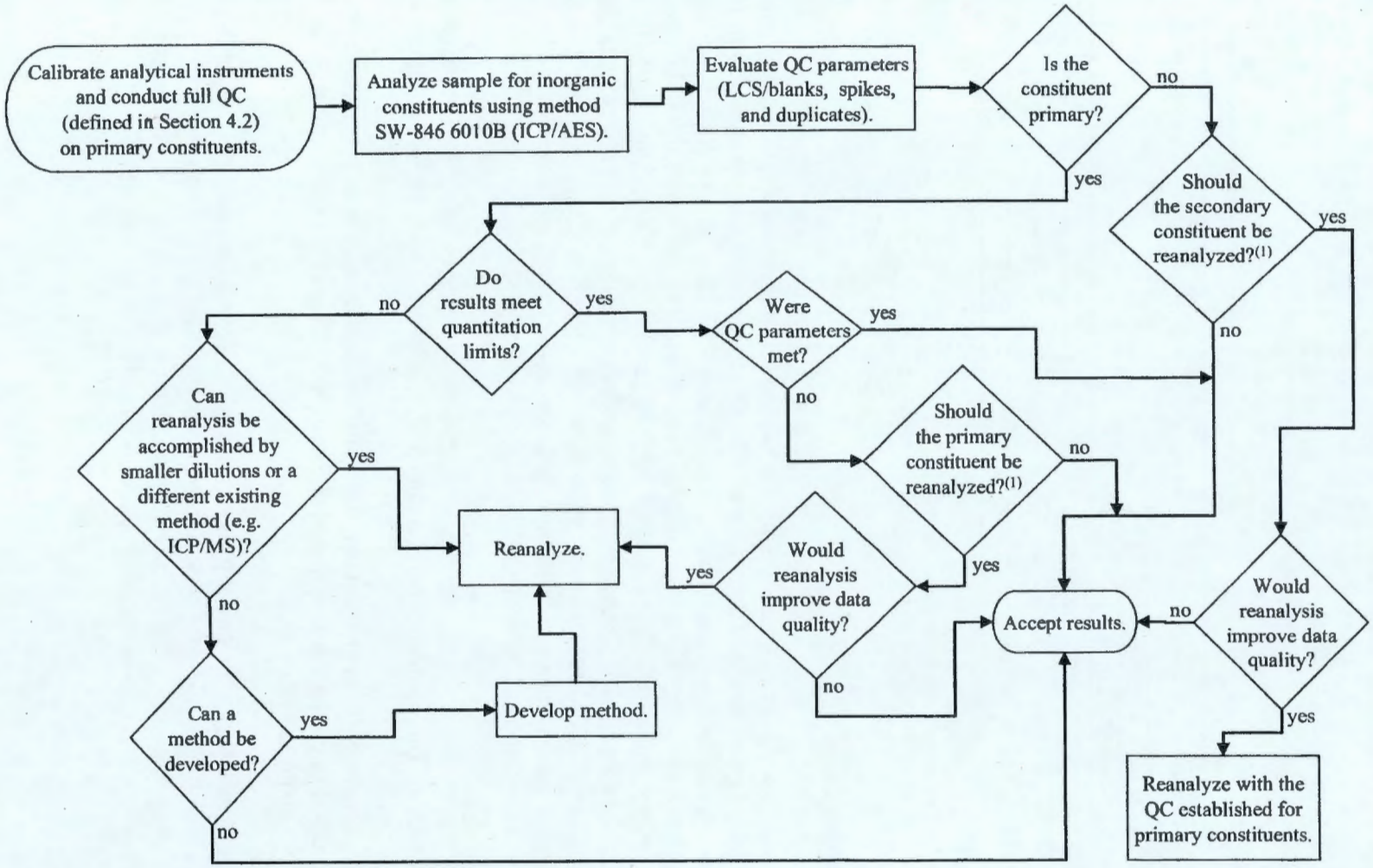
The analytical strategy for inorganics is similar to that of the organics and is shown Figure 4-2. Although the inorganic methods do not have TICs, some inorganic analytical methods are capable of analyzing multiple constituents. This allows additional data to be obtained with minimum effort and costs. When these methods are utilized, all constituents will be reported. The secondary constituents will be analyzed with the same QC as the primary constituents. However, unlike the primary constituents, the secondary constituents will not be reanalyzed if they fall outside of the QC acceptance criteria shown in Table 4-7. Figure 4-2 shows the strategy for the inorganic analytical methods for multiple constituents (e.g., inductively coupled plasma/atomic emission spectroscopy [ICP/AES]).

As with the organic analyses, the primary inorganic constituents are identified as Part A and UHC constituents. The secondary constituents will be addressed as indicated in Figure 4-2.

The analytical strategy for primary constituents that are analyzed by a single constituent analytical method (e.g., mercury) is shown in Figure 4-3. This is the same as the Part A and UHC analytical path in Figure 4-2.

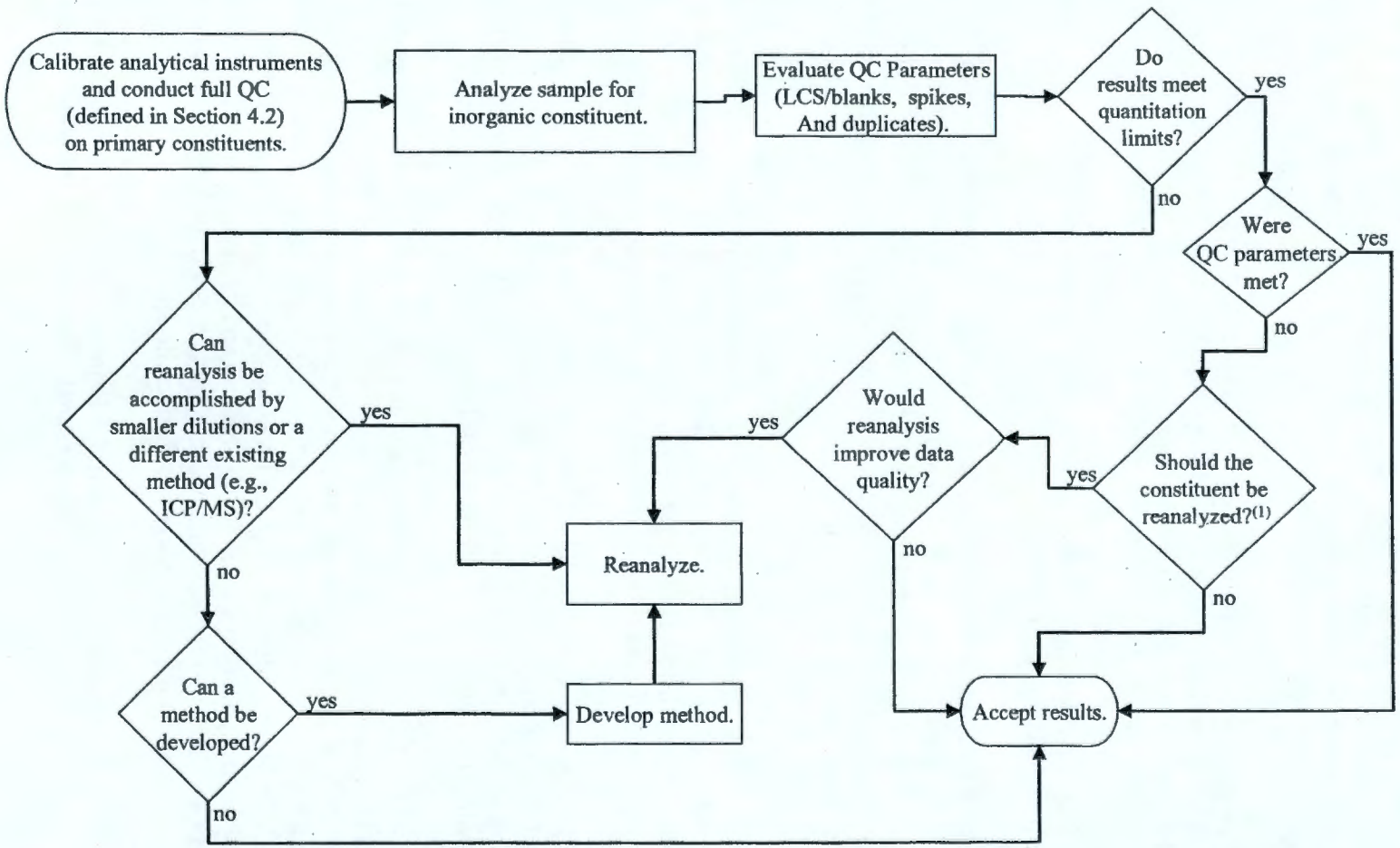
As shown in Figure 4-2, if the primary constituent does not meet the quantitation limits (see Section 4.2) it would be reanalyzed using either a smaller dilution (larger sample size) or a more sensitive existing method, such as inductively coupled plasma/mass spectrometry (ICP/MS). If neither of these options is possible, then a new method may need to be developed.

Figure 4-2. Strategy for Inorganic Analyses Using Methods for Multiple Constituents.



(1) The decision to reanalyze a secondary constituent will be made by the Chemist, Project Coordinator, and Tank Coordinator

Figure 4-3. Strategy for Inorganic Single Constituent Analytical Method.



(1) The decision to reanalyze a secondary constituent will be made by the Chemist, Project Coordinator, and Tank Coordinator

If a secondary constituent is detected, then the result is evaluated against the concentration levels of concern (see Section 4.3). If the concentration level is well below the levels of concern (see Section 4.3), then the data may be accepted. If the concentration of the secondary constituent is near or above the level of concern and the QC is adequate, the data are accepted. However, if the QC or uncertainty in the data does not permit a confident decision, then the sample would be reanalyzed as if it were a primary constituent.

The primary inorganic constituents and analytical methods for these constituents are shown in Table 4-4. As shown in Table 4-4, with the exception of mercury, metals are determined by ICP/AES. Mercury is determined by a cold vapor atomic absorption (CVAA) method [SW-846 7470A (for liquids) and SW-846 7471A (for solids)].

If the ICP/AES sensitivity is inadequate for some of the primary metals, they will be determined by alternative methods such as ICP/MS.

Five anions (nitrate, nitrite, fluoride, sulfide and cyanide) are identified as primary constituents. Fluoride, nitrate, and nitrite are measured by ion chromatography (IC). This method can also provide secondary constituent information for other common anions. The IC analyses are normally performed on a water digestion of solids; however, this will not provide information on insoluble fluorides or chlorides.

The cyanide procedure uses a microdistillation and spectrophotometric measurement of the distilled cyanide. Solid samples are dissolved in ethylenediaminetetraacetic acid (EDTA) before distillation. This distillation has been demonstrated to be effective for the insoluble nickel ferrocyanides generated in some Hanford Site processes. There are no specific methods for ferrocyanide but the total cyanide measurement provides a conservative estimate.

Ammonia will be determined by the IC method. Because of the highly soluble nature of ammonia compounds, removal is expected during waste retrieval. Ammonia is normally measured using a microdistillation of the solids. Because of the volatile nature of ammonia in alkaline solutions, it is important to stabilize by acidifying as soon as possible.

For liquid waste samples, free hydroxide concentration is normally determined by an approved 222-S Laboratory analytical titration method. However, titration results at low OH^- concentrations (< 0.03 M) pose accuracy problems. As a general guideline, when the waste samples have a pH < 12.5, the free OH^- concentration is calculated from the analytical pH measurement. For waste samples with pH > 12.5, the free hydroxide concentration is normally determined by the analytical titration method. Sodium and buffer (aluminum, phosphate, total organic carbon, and carbonate) concentrations and the shape and quality of the potentiometric titration curve are used in the evaluation of the hydroxide and pH data.

The pH of solids is determined according to SW-846 method 9045C. This method uses a 1:1 mix of solids with water and then the pH is measured. The titration method for hydroxide is not applied to solids.

Table 4-4. Primary Inorganic Constituents and Analytical Methods.

Constituent	Reason For Inclusion	Analytical Method	Alternate Method
Aluminum Al	R, W	6010B (ICP/AES)	6020 (ICP/MS)
Antimony Sb	R, W	6010B (ICP/AES)	6020 (ICP/MS)
Arsenic As	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Barium Ba	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Beryllium Be	U, W	6010B (ICP/AES)	6020 (ICP/MS)
Cadmium Cd	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Chromium Cr	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Cobalt Co	R, W	6010B (ICP/AES)	6020 (ICP/MS)
Copper Cu	R, W	6010B (ICP/AES)	6020 (ICP/MS)
Iron Fe	R, W	6010B (ICP/AES)	6020 (ICP/MS)
Lead Pb	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Manganese Mn	R, W	6010B (ICP/AES)	6020 (ICP/MS)
Nickel Ni	U, W	6010B (ICP/AES)	6020 (ICP/MS)
Selenium Se	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Silver Ag	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Strontium Sr	R	6010B (ICP/AES)	6020 (ICP/MS)
Thallium Tl	U, W	6010B (ICP/AES)	6020 (ICP/MS)
Uranium U	R, W	6010B (ICP/AES)	6020 (ICP/MS)
Vanadium V	U, W	6010B (ICP/AES)	
Zinc Zn	U, W	6010B (ICP/AES)	6020 (ICP/MS)
Mercury Hg	A, U, W	7470A (CVAA)	
Fluoride F^-	U, W	9056 (IC)	
Nitrite NO_2^-	R, W	9056 (IC)	
Nitrate NO_3^-	R, W	9056 (IC)	
Cyanide CN^-	A, U, W	9014 (Spectrophotometric)	
Ferrocyanide $Fe(CN)^{3-}$	A, U, W	Considered total cyanide.	
Sulfide S^{2-}	U, W	9215 (Ion Selective Electrode)	9034 (Titration)
Ammonium NH_4^{+} [a]	W	EPA 300.7 (IC)	
Hydroxide OH^- [a]	W	Titration or pH (see text)	

Notes:

A	Part A constituent.
R	Risk assessment constituent.
U	UHC constituent.
W	Constituent in PNNL-12040.
CVAA	Cold vapor atomic absorption
IC	Ion chromatograpy.
ICP/AES	Inductively coupled plasma/atomic emissions spectroscopy.
ICP/MS	Inductively coupled plasma/mass spectrometry

[a] Constituents added during DQO process meetings.

Sulfides were not routinely used in Hanford Site processes. Limited use of sulfide may have occurred during the ferrocyanide processing of ^{137}Cs in the tanks. The other possible source of sulfides would be from the reduction of sulfates. However, this is unlikely in the high nitrate tank waste matrices. Soluble sulfide is not very stable and is easily oxidized by air. Any sulfide remaining in the waste is most likely present as insoluble metal sulfide. The 222-S Laboratory uses microdistillation and measurement by ion selective electrode to determine sulfide concentrations.

The secondary inorganic constituents are identified in Table 4-5. Most of these constituents are identified in the Regulatory DQO (PNNL-12040, Table 4.7). However, constituents cerium through titanium (see Table 4-5) are determined by the ICP/AES method but not identified in the Regulatory DQO. Although some of the constituents in Table 4-5 are considered secondary because of their minimum risk, they are expected to be major components of the residual sludge and important to material balance calculations.

The ICP/MS method can be used as an alternative method for most of the constituents identified for ICP/AES. However, ICP/MS will not be run for these constituents unless results are generated as part of another analysis such as uranium isotopic or it becomes required as indicated in Figure 4-2.

Table 4-5. Secondary Inorganic Constituents. (2 Sheets)

Constituent	Constituent
Method 6010B (ICP/AES)	**Method 9056 (IC)**
Boron B	Bromide Br^-
Bismuth Bi	Chloride Cl^-
Calcium Ca	Phosphate PO_4^{3-}
Lithium Li	Sulfate SO_4^{2-}
Molybdenum Mo	Acetate $C_2H_3O_2^-$
Magnesium Mg	Formate CHO_2^-
Sodium Na	Glycolate $C_2H_3O_3^-$
Phosphorus P	Oxalate $C_2O_4^{2-}$
Potassium K	
Rhodium Rh	
Sulfur S	
Silicon Si	
Tin Sn	
Tantalum Ta	
Tungsten W	
Yttrium Y	
Zirconium Zr	
Cerium Ce	
Europium Eu	
Lanthanum La	
Niobium Nb	
Neodymium Nd	
Palladium Pd	
Praseodymium Pr	
Rubidium Rb	
Ruthenium Ru	
Samarium Sm	
Tellurium Te	
Thorium Th	
Titanium Ti	

Notes:

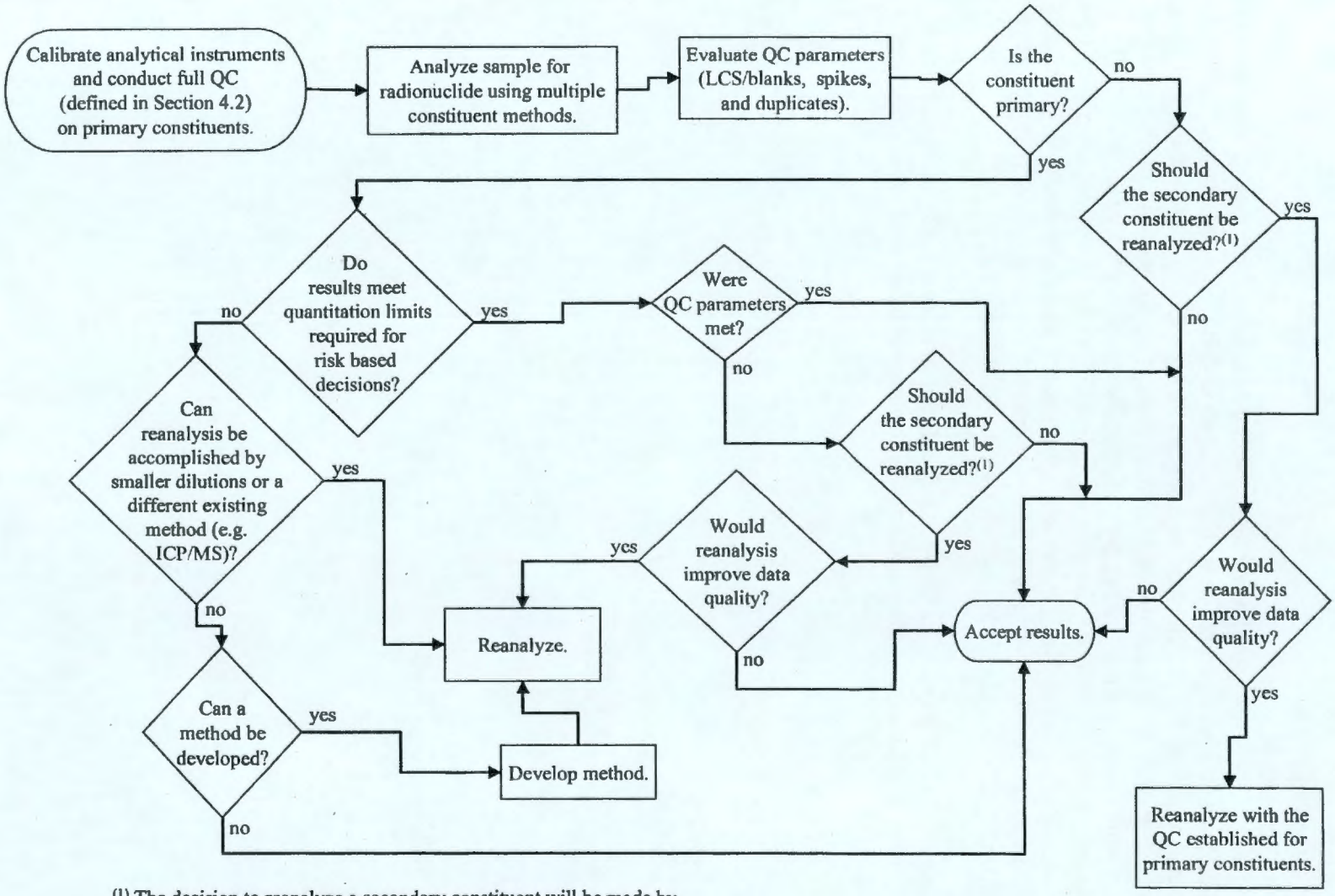
IC	ion chromatography
ICP/AES	inductively coupled plasma/atomic emission spectroscopy

4.1.3 Radionuclides

The strategy for analyzing radionuclides is similar to the inorganic analytical strategy but the radionuclides have more single constituent analytical methods. The strategy for determining the analytical requirements for the radionuclides can be seen in Figures 4-4 and 4-5. Figure 4-4 shows the strategy for the radionuclide analytical methods for multiple constituents (e.g., GEA), while Figure 4-5 shows the strategy for radionuclide constituents that are analyzed by a single constituent analytical method. The primary radionuclides are those identified in 10 CFR 61.55, constituents (e.g., ^{79}Se) added for risk assessment needs, and those that could be major activity contributors. Table 4-6 shows the primary constituents required by this DQO, the reason the constituent is a primary, and the methods used for analysis.

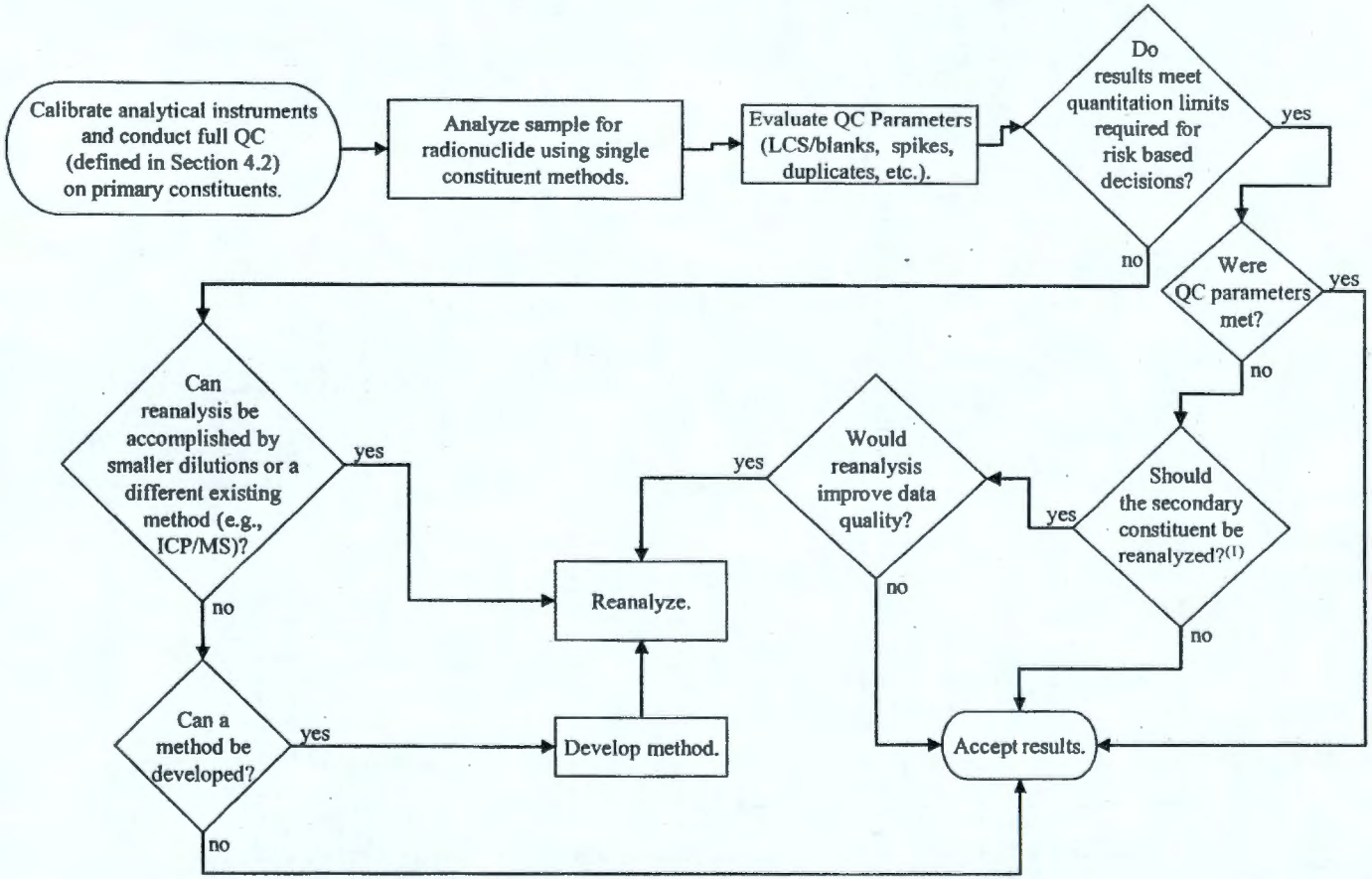
As can be seen in Figures 4-4 and 4-5, the development of analytical methods to lower the quantitation limits will take place after risk evaluations indicate method development is necessary.

Figure 4-4. Strategy for Radionuclide Analyses Using Methods for Multiple Constituents.



(1) The decision to reanalyze a secondary constituent will be made by the Chemist, Project Coordinator, and Tank Coordinator

Figure 4-5. Strategy for Radionuclide Single Constituent Analytical Method.



(1) The decision to reanalyze a secondary constituent will be made by the Chemist, Project Coordinator, and Tank Coordinator.

Table 4-6. Primary Radiochemistry Constituents.

Constituent	Reason for Inclusion	Analytical Method	Alternate Method
^{137}Cs	10 CFR 61.55	GEA	
^{60}Co	10 CFR 61.55	GEA	
^{152}Eu	Potential major activity contributor	GEA	
^{154}Eu	Potential major activity contributor	GEA	
^{155}Eu	Potential major activity contributor	GEA	
^{14}C	10 CFR 61.55	Liquid Scintillation Counting	
^{3}H	10 CFR 61.55	Liquid Scintillation Counting	
^{129}I	10 CFR 61.55	Low Energy Gamma Counting	
^{63}Ni	10 CFR 61.55	Liquid Scintillation Counting	
^{90}Sr	10 CFR 61.55	Beta Proportional Counting	
^{99}Tc	10 CFR 61.55	ICP/MS	Liquid Scintillation Counting
^{125}Sb	Risk assessment	GEA	
^{79}Se	Risk assessment	Liquid Scintillation Counting	
^{233}U	Potential major activity contributor	ICP/MS	
^{234}U	Potential major activity contributor	ICP/MS	
^{235}U	Potential major activity contributor	ICP/MS	
^{236}U	Potential major activity contributor	ICP/MS	
^{238}U	Potential major activity contributor	ICP/MS	
^{237}Np	10 CFR 61.55	ICP/MS	Alpha Counting
^{238}Pu	10 CFR 61.55	Alpha Counting	ICP/MS
$^{239/240}Pu$	10 CFR 61.55	Alpha Counting	ICP/MS as ^{239}Pu and ^{240}Pu
^{241}Pu	10 CFR 61.55	Calculate from ^{238}Pu & $^{239/240}Pu$	Liquid Scintillation Counting
^{241}Am	10 CFR 61.55	Alpha Counting	ICP/MS
^{242}Cm	10 CFR 61.55	Alpha Counting	
^{243}Cm	10 CFR 61.55	Alpha Counting	
^{244}Cm	10 CFR 61.55	Alpha Counting	
^{228}Th	Possibly significant in some tanks.	Calculation	GEA
^{230}Th	Possibly significant in some tanks.	ICP/MS	
^{232}Th	Possibly significant in some tanks.	ICP/MS	

Notes:

GEA Gamma energy analysis
ICP/MS Inductively coupled plasma/mass spectrometry

The only truly multiple constituent analytical method for radiochemistry is gamma energy analysis (GEA). Therefore, the secondary constituents are those found in the GEA library. If a constituent in the GEA library is detected, the concentration will be reported.

Additional isotopes other than those requested are not normally reported for ICP/MS because measurements are made by peak hopping rather than scanning. ICP/MS may identify other isotopes but is limited to the mass range scanned.

Only two gamma emitting isotopes, ^{137}Cs and ^{60}Co are identified in 10CFR 61.55. The other gamma emitting isotopes are added for other reasons (see Table 4-6). In most Hanford Site tank waste, ^{137}Cs is the dominant gamma-emitting isotope. Other isotopes may not be detected or will be reported at a high less than level by GEA because of the ^{137}Cs background.

^{129}I is measured by a chemical separation and low energy gamma counting.

^{79}Se is determined by liquid scintillation counting. There are no standards or tracers for ^{79}Se because these isotopes are not commercially available. Nonradioactive selenium is used to correct for chemical yields in the procedures.

The ^{230}Th and ^{232}Th can be determined by alpha analysis but are normally measured by ICP/MS because of their long half-life. ^{228}Th must be determined by calculation from ^{232}Th and ^{232}U estimates or from alpha counting. Determination of ^{228}Th by GEA may be impacted by high ^{137}Cs levels.

In addition to the constituents discussed above, a bulk density or solids specific gravity depending on the solids consistency is required. Bulk density is needed to determine waste inventories.

4.2 QUALITY CONTROL

Laboratories performing analyses specified in this DQO shall maintain a quality assurance (QA) plan. The plan shall meet the *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL-96-68) baseline requirements for laboratory quality systems.

All sampling events will be conducted using controlled procedures. At a minimum, two field blanks and two trip blanks will be collected for the liquid sampling event. One field blank and one trip blank are needed for the VOC analyses and the other field blank and trip blank will be used for the SVOC analyses. The grab sampling field blanks shall be lowered into the tank headspace, the stopper removed, and the blank retrieved. Field blanks and trip blanks will be analyzed using the same methods as the waste samples.

Field and trip blanks are not required for the solid sampling activity because the sampling and shipping conditions of the blanks would not be representative of the solid sample sampling and shipping conditions.

At a minimum, a duplicate analysis, a matrix spike, a laboratory blank, and a laboratory control sample are required for each batch of samples. Instances where this requirement is not applicable are shown in Table 4-7. Evaluation criteria for these QC analyses are shown in Table 4-7. Laboratory blanks will be evaluated according to HNF-SD-CP-QAPP-016, *222-S Laboratory Quality Assurance Plan.*

The QC criteria in Table 4-7 are goals for demonstrating reliable method performance. The laboratory's internal QA system will be used to evaluate the analytical data and processes whenever a criterion is exceeded. The laboratory may reanalyze based on the internal evaluation. Otherwise, the data will be further evaluated in accordance with the strategies in Figures 4-2 through 4-5. All data not meeting the QC requirements will be noted accordingly and discussed in the narrative of the laboratory data report.

Table 4-7. Quality Control Parameters for Primary Constituents. (2 Sheets)

Constituents	Method	QC Acceptance Criteria			
		LCS % Recovery[a]	Spike% Recovery[b]	Liquid RPD[c]	Solid RPD[c]
Al, Ag, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Pb, Mn, Ni, Sb, Se, Sr, Tl, U, V, Zn	ICP/AES	80 – 120%	75 – 125%	≤20%	≤30%
Hg	CVAA	80 – 120%	75 – 125%	≤20%	≤30%
F^-, NH_4^+, NO_2^-, NO_3^-	IC	80 – 120%	75 – 125%	≤20%	≤30%
CN^-	9014 (Spectrophotometric)	80 – 120%	75 – 125%	≤20%	≤30%
S^{2-}	9215	80 – 120%	75 – 125%	≤20%	≤30%
OH^-	Titration	80 – 120%	N/A	≤20%	≤30%
	pH (see text)	± 0.1 pH Units	N/A	N/A	N/A
PCB	GC/ECD	70 – 130%	70 – 130%	≤30%	≤30%
VOC	GC/MS	70 – 130%	70 – 130%	≤30%	≤30%
SVOC	GC/MS	70 – 130%	70 – 130%	≤30%	≤30%
% H_2O	TGA	80 – 120%	N/A	≤20%	≤30%
Bulk Density	Gravimetric	N/A	N/A	≤20%	≤30%
^{235}U, ^{238}U, ^{237}Np, ^{232}Th	ICP/MS	80 – 120%	75 – 125%	≤20%	≤30%
^{233}U, ^{234}U, ^{236}U, ^{230}Th,	ICP/MS	N/A	N/A	≤20%	≤30%
^{228}Th	Calculation	N/A	N/A	N/A	N/A
^{60}Co, ^{137}Cs, ^{125}Sb	GEA	80 – 120%	N/A[e]	≤20%	≤30%
^{152}Eu, ^{154}Eu, ^{155}Eu	GEA	80 – 120%	N/A[e]	≤20%	≤30%
^{129}I	GEA	80 – 120%	N/A[d]	≤20%	≤30%
^{14}C, ^{3}H	Liquid scintillation counting	80 – 120%	75 – 125	≤20%	≤30%
^{63}Ni	Liquid scintillation counting	80 – 120%	N/A[d]	≤20%	≤30%
^{90}Sr	Beta counting	75 – 125%	N/A[d]	≤20%	≤30%
^{99}Tc	Liquid scintillation counting	80 – 120%	75 – 125	≤20%	≤30%
^{79}Se	Liquid scintillation counting	NP	N/A[d]	≤20%	≤30%
^{238}Pu, $^{239/240}Pu$	Alpha counting	80 – 120%	N/A[d]	≤20%	≤30%
^{241}Pu	Calculation from ^{238}Pu & $^{239/240}Pu$	N/A	N/A	N/A	N/A

Table 4-7. Quality Control Parameters for Primary Constituents. (2 Sheets)

Constituents	Method	QC Acceptance Criteria			
		LCS % Recovery[a]	Spike% Recovery[b]	Liquid RPD[c]	Solid RPD[c]
^{241}Am, ^{242}Cm, $^{243/244}Cm$	Alpha counting	80 – 120%	N/A[d]	≤20%	≤30%

Notes:

CVAA	Cold Vapor Atomic Absorption
GEA	Gamma Energy Analysis
GC/ECD	Gas Chromatography/Electron Capture Detector
GC/MS	Gas Chromatography/Mass Spectrometry
IC	Ion Chromatography
ICP/AES	Inductively Coupled Plasma / Atomic Emission Spectroscopy
ICP/MS	Inductively Coupled Plasma / Mass Spectroscopy
TGA	Themogravimetric Analysis
N/A	Not applicable
NP	Not performed

(a) LCS = Laboratory Control Sample. This sample is carried through the entire analytical method. The accuracy of a method is usually expressed as the percent recovery of the LCS. The LCS is a matrix with known concentration of constituents processed with each preparation and analyses batch. It is expressed as percent recovery; i.e., the amount measured, divided by the known concentration, times 100.

(b) For some methods, the sample accuracy is expressed as the percent recovery of a matrix spike sample. It is expressed as percent recovery; i.e., the amount measured, less the amount in the sample, divided by the spike added, times 100. One matrix spike is performed per analytical batch. Samples are batched with similar matrices. For other constituents, the accuracy is determined based on use of serial dilutions.

(c) RPD = Relative Percent Difference between the samples. Sample precision is estimated by analyzing duplicates taken separately through preparation and analysis. Acceptable sample precision is usually ≤20% RPD for liquids or ≤ 30% for solids if the sample result is at least 10 times the instrument detection limit.

RPD = ((absolute difference between primary and duplicate)/mean) x 100

(d) Matrix spike analyses are not required for this method because a carrier or tracer is used to correct for constituent loss during sample preparation and analysis. The result generated using the carrier or tracer accounts for any inaccuracy of the method on the matrix. The reported results reflect this correction.

(e) The measurement is a direct reading of the energy and the analysis is not affected by the sample matrix; therefore, a matrix spike is not required.

Recommendations for ensuring sample integrity prior to analysis are provided in SW-846. The recommendations include type of sample container, holding time, preservation, and zero headspace in samples (for volatile components). These requirements are generally based on sampling of environmental samples (e.g., soil, ground or river water). The requirements are difficult to meet for Hanford Site tank waste samples. Because of their highly radioactive nature, extra precautions are used in the sample collection, shipping, and preparation for analysis to minimize radiation exposure to the workers. The SW-846 recommendations are addressed below.

- Type of sample container – In general, liquid samples will be obtained using glass bottles with Teflon[1]-lined lids or Teflon-lined septum caps as needed. The appropriate bottle size and color is determined by the specific needs of the sampling event. For example, for extremely radioactive samples, smaller sample bottles may be required to minimize the radiation source. On the other hand, if a sampling event requires a large amount of sample material for a variety of analyses and tests, larger bottles may be used to minimize the number of samples and, therefore, the exposure time to the samplers. In other words, appropriate bottle size is determined by radioactivity of the waste to be sampled and the specific needs of the sampling events.

  Solids samples are commonly obtained by core, clam shell, or finger-trap sampling methods. New sampling methods (e.g., off riser sampling) are being evaluated. In general, solids are much more radioactive than liquid waste. To minimize exposure to workers in the field, solids samples are shipped to the laboratory in the sampling device. That is, the solids are not transferred from the sampling device into sample bottles in the field. The samples are broken down in shielded hot-cells at the laboratory and solids are placed into bottles at that time. If a solids sample is taken using a clamshell and the sample is low in radioactivity, the waste material may be removed from the clamshell and placed in a sample bottle within a glovebox in the field. This approach minimizes spread of contamination because the sample can be removed from the clamshell without removing the clamshell from the holder. Presently, if a clamshell is removed from the holder, it must be done by force causing splashing of waste material inside the glovebox. Removing the sample from the clamshell and placing it in a jar in the field also allows the operators to determine when the required volume of material has been collected. In all cases, the finger-trap sampler will be shipped to the laboratory in the sampling device. The finger-trap relies on dropping the sampler into the waste to collect the sample. Solids enter the sampler and are trapped within the stainless steel pipe of the sampler by thin, flexible, overlapping steel blades or "fingers" at the open end. The sample is removed in the laboratory hotcell.

- Holding time – The extra precautions required to sample Hanford Site tank waste either lengthens the time required for each sampling, shipping, and analysis step or creates additional steps. For example: personnel must wear protective clothing and shielded gloves when collecting samples; samples must be stored and transported in shielded casks; samples are removed from the casks and transferred into shielded hot cells at the laboratory; samples are broken down and subsampled for analysis using remote manipulators; and samples are stored and analyzed in a manner consistent with fissile material requirements and personnel exposure control. Therefore, the recommended holding times for some analyses may not be met. However, efforts shall be made to minimize the duration between sampling and analysis of samples.

- Sample Preservation – Sample preservation could be temperature control, chemical preservation, or both. Controlling sample temperature during transport is difficult because samples are shipped in large, heavy, shielded casks. The cost of providing refrigeration capable of handling these casks would be prohibitive. Therefore, cooling of samples during

[1] Teflon® is a registered trademark of I. E. DuPont De Nemours and Company, Inc., Wilmington, Delaware.

transport is not required by this DQO. Efforts shall be made to maintain temperature of samples within the range of normal temperatures for the time of the year when the samples are collected. Hot cell space is limited and cannot accommodate large refrigeration units. However, limited (i.e., small) refrigeration capability shall be provided in the laboratory for samples for which cooling is critical (e.g., VOA).

Chemical preservations are not recommended for the Hanford Site tank waste. Hanford Site tank wastes commonly contain high levels of salt and will precipitate metals when preserved by adding acid. In addition, the waste is maintained at high pH (generally >12). Preserving the samples by adding acid may require a large amount of acid and may alter the chemical and physical characteristics of the waste. This would adversely affect the goal of assessing concentrations and physical properties of the waste, as it exists in the tank.

- Zero headspace in sample bottles – To minimize loss of volatile components, SW-846 recommends that the sample bottles contain zero headspace. This recommendation is generally not achievable because of personnel exposure concerns. Upon removing a liquid sample from a tank, the sample bottle is quickly capped and placed in a shielded cask to minimize radiation exposure to the workers. Sampling personnel are not allowed to "top off" the samples. Therefore, a zero headspace is commonly not obtained. As discussed earlier (except in certain cases using the clamshell), solids samples are shipped to the laboratory in the sample device to minimize radiation exposure to the workers.

While not all of the above recommendations can be met for every sample, efforts shall be made to minimize the potential impacts and the duration between sampling and analysis of the samples. For analyses with required holding times, the time between sampling the waste and the analytical time will be reported in the data package.

The data report from the 222-S Laboratory will be a format IV data package. A format IV data package, as defined in HNF-SD-CP-QAPP-016, *222-S Laboratory Quality Assurance Plan*, is necessary because the data are expected to receive extensive review from outside individuals and organizations. The format IV data package is subject to internal laboratory QA verification and review including peer review prior to release. However, a third party validation of the data package is not required. The data package will include the data for all samples, including composites, segments, subsegments, drainable liquids, and associated blanks taken and analyzed during a single sampling activity. The data package shall be issued as a document approved for public release via an Engineering Data Transmittal form.

The data package is organized into two major parts: (1) a summary report section, and (2) a raw data compilation. Both data package sections will be organized according to the type of analyses or activity where the data were generated. The summary report section is comprised of two subsections: (1) a narrative that identifies the methods used and discusses any unusual sample or QC results from each analysis or activity; and (2) summary tables of the sample and QC results. Each raw data activity is organized by analysis type and batch or by the time the activity occurred. For most analytical measurements, the batch arrangement requires the least duplication.

Examples of raw data included in the format IV data package are:

- GC chromatograms,
- GC/MS reconstructed ion chromatograms and quantitation reports,
- ICP integration data by constituent,
- Documentation of the amount of spiked material,
- Documentation of the amount of spiked surrogate,
- LABCORE completed work list reports,
- LABCORE data entry templates,
- Results of tracers and carriers,
- Results of internal standards.

Prior to issuing the format IV data package, preliminary data will be available after the data are reviewed and approved by appropriate laboratory personnel. Complete QA/QC review will not be available until the format IV data package is released.

4.3 REQUIRED QUANTITATION LIMITS

Detection limits are commonly set an order of magnitude below the action levels required by the DQO. However, the action levels for the second decision rule (see Figure 3-1 and Section 6.0) are under development, therefore, it was determined the initial quantitation limits for this DQO will be Washington Administrative Code Chapter 173-340 (WAC 173-340) Method B soil limits for protection of groundwater. However, as the performance assessment requirements mature, the required quantitation limits will be revised to meet the risk assessment requirements. The DQO document will be revised to reflect these changes.

Tables 4-8 through 4-11 show comparisons of the WAC 173-340 limits and the MDLs from the 222-S Laboratory. The source of the WAC 173-340 limits is shown in Appendix A. Where physical-chemical parameter values (the distribution coefficient, Kd value, and Henry's Law Constant) are not available in the CLARC 3.1 tables, parameter values were obtained from EPA Region 9 or default values of zero were used, as noted in Appendix A. The EPA Region 9 parameters are available at http://www.epa.gov/region09/waste/sfund /prg/index.htm.

Table 4-12 show comparisons of industrial and residential Residual Radioactivity Modeling (RESRAD) values with the MDLs from the 222-S Laboratory.

The MDLs in Tables 4-8 through 4-12 are based on the assumption that the radiation levels remaining in the liquids and solids after retrieval of the waste will still be sufficiently high to require the use of sample sizes and analytical procedures that are routinely used for characterization of high level waste samples. If the radiation levels are significantly lower the MDLs may be lowered by as much as a factor of 5 to 10 for many of the existing methods by using larger sample sizes. The MDLs will be reported with the analytical results and will be based on the actual sample size.

Use of MTCA Method B and RESRAD values in the tables below does not imply that the associated SST component closure will be sufficient for tank farm closure performance

standards. Analytical data generated according to this DQO will be used to quantify the risk contribution of the SST component closure to the overall risk of the tank farm. This data will be assessed when the risk assessment is established.

Table 4-8. Comparison of WAC 173-340 Limits to MDLs for Primary Organic Constituents (3 Sheets)

CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8260B[a] (VOC) Estimated MDLs mg/kg	Method 8260B[a] (VOC) Estimated MDLs mg/L	CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8270C[b] (SVOC) Estimated MDLs mg/kg	Method 8270C[b] (SVOC) Estimated MDLs mg/L
67-64-1	Acetone (2-Propanone)	3.21E+00	4.38E-02	1.72E-03	83-32-9	Acenaphthene	9.79E+01	1.54E+00	6.6E-01
71-43-2	Benzene	4.48E-03	6.26E-03	2.7E-04	117-84-0	Bis-2-ethylhexyl phthalate (Dioctylphthalate)	5.32E+05	1.52E+00	8.4E-01
75-15-0	Carbon disulfide	5.65E+00	9.25E-03	4.8E-04	71-36-3	Butanol; n- (n-butyl alcohol)	6.62E+00	1.38E+00	2.31E+00
56-23-5	Carbon tetrachloride	3.10E-03	1.19E-02	4.4E-04	85-68-7	Butylbenzylphthalate	8.93E+02	1.63E+00	3.2E-01
108-90-7	Chlorobenzene	8.74E-01	7.73E-03	2.7E-04	95-57-8	Chlorophenol; 2-	9.43E-01	1.36E+00	1.08E+00
67-66-3	Chloroform	3.81E-02	9.46E-03	3.3E-04	108-39-4	Cresol; m- (3-Methylphenol)	3.20E+00	5.95E+00	2.46E+00
107-06-2	Dichloroethane; 1,2-	2.32E-03	6.43E-03	3.5E-04	95-48-7	Cresol; o- (2-Methylphenol)	4.66E+00	2.61E+00	1.14E+00
75-35-4	Dichloroethylene; 1,1- (Dichloroethene)	5.22E-04	1.03E-02	3.9E-04	106-44-5	Cresol; p- (4-Methylphenol)	3.20E-01	5.95E+00	unknown
75-09-2	Dichloromethane (methylene chloride)	2.54E-02	7.66E-03	4.5E-04	1319-77-3	Cresylic acid (cresol, mixed isomers)	Note (e)	3.73E+00	3.67E+00
542-75-6	Dichloropropene; 1,3,- (trans-)	1.41E-03[f]	6.38E-03	3.2E-04	108-94-1	Cyclohexanone	3.20E+02	2.24E+00	3.1E-01
141-78-6	Ethyl acetate	1.61E+02	9.72E-03	2.9E-04	84-74-2	Dibutylphthalate (Di-n-butylphthalate)	1.14E+01	2.02E+00	5.4E-01
60-29-7	Ethyl ether (Diethyl ether)	9.09E+00	8.85E-03	3.9E-04	95-50-1	Dichlorobenzene; 1,2- (ortho-)	7.03E+00	1.38E+00	5.0E-01
100-41-4	Ethylbenzene	6.05E+00	1.55E-02	8.1E-04	121-14-2	Dinitrotoluene; 2,4-	1.89E-01	9.7E-01	5.1E-01
67-72-1	Hexachloroethane	2.49E-01	5.9E-03	5.3E-04	110-80-5	Ethoxyethanol; 2-	2.56E+01	7.3E-01	5.1E-01
78-93-3	Methyl ethyl ketone (2-Butanone)	2.18E+01	2.42E-02	7.9E-04	206-44-0	Fluoranthene	6.31E+02	9.2E-01	8.5E-01
108-10-1	Methyl isobutyl ketone (4-methyl-2-pentanone)	1.28E+01	1.33E-02	3.4E-04	87-68-3	Hexachlorobutadiene	6.05E+00	3.4E-01	4.6E-01
79-46-9	Nitropropane; 2-	1.84E-05	1.58E-02	1.03E-03	78-83-1	Isobutyl alcohol (Isobutanol)	5.47E+01	1.84E+00	2.63E+00
79-34-5	Tetrachloroethane; 1,1,2,2-	1.23E-03	6.53E-03	4.3E-04	128-37-0	methylphenol; 2,6-Bis(tert-butyl)-4-	None	9.4E-01	6.8E-01
127-18-4	Tetrachloroethene; 1,1,2,2-	9.10E-03	8.19E-03	3.1E-04	59-50-7	methylphenol; 4-Chloro-3- (p-Chloro-m-cresol)	None	4.9E-01	1.28E+00
108-88-3	Toluene	7.27E+00	7.32E-03	4.3E-04	91-20-3	Naphthalene	4.46E+00	6.2E-01	4.7E-01
76-13-1	trichloro-1,2,2-trifluoroethane; 1,1,2-	1.92E+03	1.01E-02	8.4E-04	98-95-3	Nitrobenzene	5.11E-02	6.5E-01	3.9E-01
71-55-6	Trichloroethane; 1,1,1-	1.58E+00	8.94E-03	3.0E-04	88-75-5	Nitrophenol; o-	None	1.58E+00	1.03E+00
79-00-5	Trichloroethane; 1,1,2-	4.27E-03	6.53E-03	2.7E-04	621-64-7	Nitroso-di-n-propylamine; N-	5.60E-05	8.7E-01	1.03E+00
79-01-6	Trichloroethylene; 1,1,2-	2.60E-02	1.18E-03	4.3E-04	59-89-2	Nitrosomorpholine; N-	None	7.7E-01	1.01E+00
75-69-4	Trichlorofluoromethane	7.23E+01	9.33E-04	3.8E-04	129-00-0	Pyrene	6.55E+02	1.50E+00	6.4E-01

Table 4-8. Comparison of WAC 173-340 Limits to MDLs for Primary Organic Constituents (3 Sheets)

CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8260B[a] (VOC) Estimated MDLs mg/kg	Method 8260B[a] (VOC) Estimated MDLs mg/L	CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8270C[b] (SVOC) Estimated MDLs mg/kg	Method 8270C[b] (SVOC) Estimated MDLs mg/L
75-01-4	Vinyl chloride (1-Chloroethene)	1.84E-04	4.45E-03	4.4E-04	110-86-1	Pyridine	3.87E-01	9.3E-01	5.5E-01
1330-20-7	Xylenes	9.14E+01	1.43E-02	1.28E-03	120-82-1	Trichlorobenzene; 1,2,4-	2.98E+00	3.8E-01	4.9E-01
108-38-3	Xylene; m-	8.44E+01	8.81E-03	1.02E-03	95-95-4	Trichlorophenol; 2,4,5-	5.75E+01	7.1E-01	1.21E+00
95-47-6	Xylene; o-	9.19E+01	5.53E-03	4.4E-04	88-06-2	Trichlorophenol; 2,4,6-	9.24E-02	7.5E-01	1.18E+00
106-42-3	Xylene; p-	1.72E+02	8.81E-03	1.02E-03	126-73-8	Tributyl phosphate	7.0E-01	0.4	5
120-82-1	1,2,4 - Trichlorobenzene	3.0E+00	1.02E-03	6.7E-04					
		Constituent Limits 0.05[c] mg/kg	Method 8082[d] PCBs MDL mg/kg	Method 8082[d] PCBs MDL mg/L					
11104-26-2	Aroclor 1221	Note c	0.026	7.1E-03					
11141-16-5	Aroclor 1232	Note c	0.46	4.6E-02					
2674-11-2	Aroclor 1016	Note c	0.081	3.78E-02					
53969-21-9	Aroclor 1242	Note c	0.084	2.6E-02					
126572-29-6	Aroclor 1248	Note c	0.027	1.3E-02					
11097-6999-1	Aroclor 1254	Note c	0.016	4.03E-3					
11096-82-5	Aroclor 1260	Note c	0.113	2.86E-02					

Table 4-8. Comparison of WAC 173-340 Limits to MDLs for Primary Organic Constituents (3 Sheets)

CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8260B[a] (VOC) Estimated MDLs mg/kg	Method 8260B[a] (VOC) Estimated MDLs mg/L	CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8270C[b] (SVOC) Estimated MDLs mg/kg	Method 8270C[b] (SVOC) Estimated MDLs mg/L

Notes:

CAS	Chemical Abstracts Service
VOC	Volatile Organic Compound
SVOC	Semivolatile Organic Compound
MDL	Method Detection Limits
Shaded MDLs	Constituents where the MDLs are above WAC 173-340 limits.
unknown	MDL estimate is unknown.
None	Regulatory limits for these constituents are not available in CLARC 3.1 tables. In addition, tables of toxicity information from EPA do not provide a basis for calculating limits.

[a] For solids, 8260B MDL assumes a 0.5 g sample size. If the sample has a high dose rate, a smaller samples size and larger MDL may result. For liquid, 8260B and 8082 MDL basis for liquids – assumes a 10mL sample size. If the liquid is too radioactive, the sample size may be reduced to 1 mL and the MDLs would be 10 times higher.

[b] For solids, 8270C MDL assumes a 2 g sample size. SW-846 30g sample, 222-S Laboratory 1g sample. The ratio of dilution factor is 30g/1g x 2mL/1mL = 60. Example: SW-846 EQL = 5mg/g, 222-S Laboratory EQL = 5mg/g x 60 = 300mg/g. For liquid, 8270C MDL basis assumes a 10 mL sample size. If the liquid is too radioactive or foams, the sample size may be reduced by a factor of 10 or more resulting in corresponding higher MDLs.

[c] 0.05 mg/kg is for total PCBs.

[d] For solids, 8082 MDL assumes a 1g sample size.

[e] Constituent limits are presented for the individual isomers, m-Cresol (CAS 108-39-4), p-Cresol (CAS 106-44-4), o-Cresol (CAS No. 95-48-7) instead of for the mixed isomers of cresol (also called cresylic acid (CAS 1319-77-3)

[f] Constituent limit is for 1,3-Dichloropropene (CAS 542-75-6) instead of the isomer trans-1,3-Dichloropropene.

Table 4-9. Comparison of WAC 173-340 Limits to MDLs for Secondary Organic Constituents. (2 Sheets)

CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8260B (VOC) Estimated MDLs mg/kg	Method 8260B (VOC) Estimated MDLs mg/L	CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8270C (SVOC) Estimated MDLs mg/kg	Method 8270C (SVOC) Estimated MDLs mg/L
123-86-4	Acetic acid, n-butylester	None	0.1	0.5	98-86-2	Acetophenone	6.40E+00	0.4	5
75-05-8	Acetonitrile	2.82E-01	0.1	0.5	309-00-2	Aldrin	5.04E-03	28	unknown
107-02-8	Acrolein (propenal)	6.5E-01	0.1	1.0	50-32-8	Benzo[a]pyrene	1.37E-01	40	3
107-13-1	Acrylonitrile	3.33E-04	0.1	0.5	92-52-4	Biphenyl; 1,1'-	7.55E+02	0.4	5
107-05-1	Allyl chloride (3-Chloropropene)	3.20E+00	0.1	unknown	4170-30-3	Butenaldehyde; 2- (2-Butenal)	None	0.4	unknown
74-83-9	Bromomethane	5.18E-03	0.1	0.5	100-00-5	Chloronitrobenzene (p-Nitrochlorobenzene)	6.56E-02	0.4	5
106-99-0	Butadiene; 1,3-	3.55E-04	0.1	0.5	541-73-1	Dichlorobenzene; 1,3-	None	40	3
75-45-6	Chlorodifluoromethane	None	0.1	0.5	106-46-7	Dichlorobenzene; 1,4- (para-)	3.00E-02	40	3
74-87-3	Chloromethane	3.34E-02	0.1	0.1	53-70-3	Diebenzo[a,h]anthracene	1.37-01	40	3
110-82-7	Cyclohexane	1.30E+03	0.1	0.5	60-57-1	Dieldrin	2.82E-03	28	unknown
110-83-8	Cyclohexene	None	0.1	unknown	57-14-7	Dimethylhydrazine; 1,1-	1.35E-04	0.4	unknown
287-92-3	Cyclopentane	None	0.1	0.5	100-25-4	Dinitrobenzene; 1,4- (para-)	4.5E-02	0.4	1.2
76-14-2	Dichloro-1,1,2,2-tetrafluoroethane; 1,2-	None	0.1	0.5	88-85-1	Dinoseb (2-sec-Butyl-4,6-dinitophenol)	2.80E-02	0.4	6
75-71-8	Dichlorodifluoromethane	2.90E+01	0.1	0.1	122-39-4	Diphenylamine; N,N-	1.60E+00	0.4	5
75-34-3	Dichloroethane; 1,1-	4.37E+00	0.1	0.5	72-20-8	Endrin	4.40E-01	34	unknown
75-43-4	Dichlorofluoromethane	None	0.1	0.5	118-74-1	Hexachlorobenzene	1.50E-02	40	3
78-87-5	Dichloropropane; 1,2-	3.30E-03	0.1	0.5	319-84-6	Hexachlorocyclohexane; alpha- (alpha-BHC)	5.45E-04	18	unknown
10061-01-5	Dichloropropene; 1,3- (cis-)	1.41E-03[a]	0.1	0.4	319-85-7	Hexachlorocyclohexane; beta- (beta-BHC)	2.27E-03	18	unknown
123-91-1	Dioxane; 1,4-	3.18E-02	0.1	0.5	1335-87-1	Hexachloronaphtahlene	None	0.4	5
64-17-5	Ethyl alcohol	None	0.1	0.5	684-16-2	Hexafluoroacetone	None	0.4	5
75-00-3	Ethyl chloride (Chloroethane)	3.03E-02	0.1	0.5	591-78-6	Hexanone; 2-	None	0.4	5
106-93-4	Ethylene dibromide (1,2-Dibromoethane)	2.83E-06	0.1	0.5	465-73-6	Isodrin	None	0.4	6
75-21-8	Ethylene oxide (Oxirane)	1.83E-04	0.1	0.5	58-89-9	Lindane (gamma-BHC)	2.09E-03	28	unknown
76-44-8	Heptachlor	3.78E-03	26	unknown	563-80-4	Methy-2-butanone; 3-	None	0.4	5
142-82-5	Heptane; n-	None	0.1	0.5	126-98-7	Methyl-2-propenenitrile; 2-	6.57E-03	0.4	unknown
110-43-0	Heptanone; 2-	None	0.1	0.5	60-34-4	Methylhydrazine	3.18E-04	0.4	unknown
106-35-4	Heptanone; 3-	None	0.1	1.0	627-13-4	Nitric acid, propyl ester	None	0.1	unknown
123-19-3	Heptanone; 4-	None	0.1	0.5	62-75-9	Nitrosodimethylamine; N-	6.86E-06	0.4	5

Table 4-9. Comparison of WAC 173-340 Limits to MDLs for Secondary Organic Constituents. (2 Sheets)

CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8260B (VOC) Estimated MDLs mg/kg	Method 8260B (VOC) Estimated MDLs mg/L	CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8270C (SVOC) Estimated MDLs mg/kg	Method 8270C (SVOC) Estimated MDLs mg/L
110-54-3	Hexane; n-	9.62E+01	0.1	0.5	2234-13-1	Octachloronaphthalene	None	0.4	5
624-83-9	Methyl isocyanate	None	0.1	unknown	1321-64-8	Pentachloronaphthalene	None	0.4	5
110-12-3	Methyl-2-hexanone; 5-	None	0.1	0.5	82-68-8	Pentachloronitrobenzene (PCNB)	1.35E-03	unknown	6
75-65-0	Methyl-2-Propanol; 2-	None	0.1	0.5	87-86-5	Pentachlorophenol	1.15E-02	133	15
107-87-2	Methylcyclohexane	1.54E+03	0.1	0.5	109-66-0	Pentane; n-	None	0.4	9
78-92-2	Methylpropyl alcohol; 1-(2-butanol)	None	0.1	0.5	108-95-2	Phenol	4.39E+01	40	3
111-84-2	Nonane; n-	None	0.1	0.5	123-38-6	Propionaldehyde; n-	None	0.4	unknown
111-65-9	Octane; n-	None	0.1	0.5	1335-88-2	Tetrachloronaphthalene	None	0.4	5
107-87-9	Pentanone; 2-	None	0.1	0.5	8001-35-2	Toxaphene	1.53E-01	unknown	unknown
96-22-0	Pentanone; 3-	None	0.1	0.5					
107-12-0	Propionitrile (Ethyl cyanide)	None	0.1	0.5	121-44-8	Triethylamine	5.19E-02	0.4	unknown
67-63-0	Propyl alcohol; 2-	None	0.1	0.5					
71-23-8	Propyl alcohol; n- (1-propanol)	None	0.1	0.5					
100-42-5	Styrene	3.28E-02	0.1	0.3					
109-99-9	Tetrahydrofuran	None	0.1	0.5					

Notes:

CAS	Chemical Abstracts Service
VOC	Volatile Organic Compound
SVOC	Semivolatile Organic Compound
MDL	Method Detection Limits
Shaded MDLs	Constituents where the MDLs are above the WAC 173-340 limits.
unknown	MDL estimate unknown. MDLs for secondary components are not measured but estimated from literature. Data are not available for these compounds and methods.
None	Regulatory limits for these constituents are not available in CLARC 3.1 tables. In addition, tables of toxicity information from EPA do not provide a basis for calculating lmits.

[a] Constituent limit is for 1,3-Dichloropropene (CAS 542-75-6) instead of the isomer cis-1,3-Dichloropropene.

Table 4-10. Comparison of WAC 173-340 Limits to MDLs for Primary Inorganic Constituents (2 Sheets)

Metals	WAC 173-340 Limits mg/kg	Primary Method 6010B (ICP/AES)[a] MDLs mg/kg	Alternate Method 6020 (ICP/MS)[b] MDLs mg/kg		Primary Method 6010B (ICP/AES)[a] MDLs mg/L	Alternate Method 6020 (ICP/MS)[b] MDLs mg/L
Antimony Sb	5.42E+00	10.6			10.6	
Aluminum Al	4.52E+01	2.75			26.6	
Arsenic As	3.40E-02	25.7	0.2		25.7	5.0E-01
Barium Ba	9.23E+02	10.5	2.00E-03		10.5	5.0E-03
Beryllium Be	6.32E+01	0.65	2.00E-03		0.7	5.0E-03
Cadmium Cd	5.00E+00 (in soil)	1.05	2.02E-02		1.1	5.0E-02
Cobalt Co	None	2.55			2.6	
Copper Cu	2.63E+02	6.1			6.1	
Iron Fe	1.32E+03	10.05			10.1	
Lead Pb	2.50E+02	11.75	2.00E-01		11.8	5.0E-01
Manganese Mn	5.02E+01	0.55			0.6	
Nickel Ni	1.30E+02	5.5			5.5	
Seleniun Se	5.20E+00	25.9	2.00E-01		25.9	5.0E-01
Silver Ag	1.36E+01	2.75	6.00E-04		2.8	1.5E-03
Strontium Sr	2.92E+03	0.55			0.6	
Thallium Tl	1.59E+00	75.6	4.00E-04		75.6	1.0E-03
Uranium U	1.32E+00	25.75			25.8	
Chromium Cr	2.00E+00 (Total Cr)	2.6	8.00E-02		2.6	2.0E-01
Vanadium V	5.60E+02	2.6	6.00E-03		2.6	1.5E-02
Zinc Zn	5.97E+03	1.05	6.00E-03		1.1	6.00E-02
	Constituent Limits mg/kg	**Primary Method 7470/71 (CVAA) MDLs mg/kg**			**Primary Method 7470/71 (CVAA) MDLs mg/L**	
Mercury Hg[d]	2.09E+00	0.05			0.005	
Anions	**Constituent Limits mg/kg**	**Primary Method 9056 (IC)[e] MDLs mg/kg**			**Primary Method 9056 (IC)[e] MDLs mg/L**	
Fluoride F^-	1.60E+01	20			100	
Nitrate NO_3^-	4.00E+01 (as nitrogen)	280			1400	
Nitrite NO_2^-	4.00E+00 (as nitrogen)	200			1000	
	Constituent Limits mg/kg	**Primary Method 9010B/9014 (Spec.) MDLs mg/kg**			**Primary Method 9010B/9014 (Spec.) MDLs mg/L**	
Cyanide CN^- [f]	8.00E-01	2.5			2.5	
Ferrocyanide $FE(CN)^{3-}$	Analyzed as cyanide					

Table 4-10. Comparison of WAC 173-340 Limits to MDLs for Primary Inorganic Constituents (2 Sheets)

Metals	WAC 173-340 Limits mg/kg	Primary Method 6010B (ICP/AES)[a] MDLs mg/kg	Alternate Method 6020 (ICP/MS)[b] MDLs mg/kg		Primary Method 6010B (ICP/AES)[a] MDLs mg/L	Alternate Method 6020 (ICP/MS)[b] MDLs mg/L
	Constituent Limits mg/kg	Primary Method 9030B/9215 (ISE) MDLs mg/kg			Primary Method 9030B/9215 (ISE) MDLs mg/L	
Sulfide S^{2-} [g]	None	50			50	
Cation	Constituent Limits mg/kg	Primary Method EPA 300.7 MDLs mg/kg			Primary Method EPA 300.7 MDLs mg/L	
NH_4^+	Not regulated	120			1.2	

Notes:

Shaded MDLs	Constituents where the MDLs are above the WAC 173-340 limits.
MDL	Method Detection Limits
CVAA	Cold Vapor Atomic Absorption.
GEA	Gamma Energy Analysis.
IC	Ion Chromatography.
ICP/AES	Inductively Coupled Plasma / Atomic Emission Spectroscopy.
ICP/MS	Inductively Coupled Plasma / Mass Spectroscopy
ISE	Ion Selective Electrode.
Spec.	Spectrophotometric
None	Regulatory limits for these constituents are not available in CLARC 3.1 tables. In addition, tables of toxicity information from EPA do not provide a basis for calculating limits.

[a] ICP/AES for solids assumes dilution factor = 500, 0.5g-50 mL-2mL-10. For liquid, it assumes high salt dilution factor and an acid digest, DF = 500, 1.0mL-50 mL-1mL-10mL. ICP MDLs based on 3050 digest.

[b] Solids ICP/MS based on dilution factor = 2000. Liquid ICP/MS assumes high salt dilution factor and an acid digest, DF = 5000, 1.0mL-50 mL-0.1mL-10mL. ICP/MS MDLs may be based on IDLs and could be 10 times larger.

[c] Footnote (C) no longer used.

[d] Hg assumes a 0.005 μg detection limit and a 0.1g sample size.

[e] For solids, IC assumes a dilution factor = 2000 for water digest and a 50 μL loop. For liquid, IC assumes high salt dilution factor and an water digest DF= 10000, 0.1mL-10mL-0.1mL-10mL and a 50 μL loop.

[f] For solids, CN^- assumes a 0.1g solid with EDTA solution. For liquid, CN^- high salt dilution factor assumes 0.1 mL sample is distilled.

Table 4-11. Comparison of WAC 173-340 Limits to MDLs for Secondary Inorganic Analytes.

Metals	WAC 173-340 Limits mg/kg	Method 6010B (ICP/AES) MDLs mg/kg	Method 6010B (ICP/AES) MDLs mg/L	Anions	WAC 173-340 Limits mg/kg	Method 9056 (IC) MDLs mg/kg	Method 9056 (IC) MDLs mg/L
Boron B	1.12E+01	10.75	10.8	Bromide Br^-	None	240	1200
Bismuth Bi	None	25.8	25.8	Chloride Cl^-	1.00E+03	30	150
Calcium Ca	None	6.25	6.3	Phosphate PO_4^{3-}	None	240	1200
Potassium K	None	157	157	Sulfate SO_4^{2-}	1.00E+03	280	1400
Lithium Li	None	0.9	0.9	Acetate $C_2H_3O_2^-$	None	400	2000
Molybdenum Mo	1.63E+01	2.7	2.7	Formate CO^-	None	400	2000
Magnesium Mg	None	26.25	26.3	Glycolate $C_2H_3O_3^-$	None	400	2000
Sodium Na	None	22.4	22.4	Oxalate $C_2O_4^{2-}$	None	200	1000
Phosphorus P	None	9.8	9.8				
Rhodium Rh	None	25.75	25.8				
Sulfur S	None	11.4	11.4				
Silicon Si	None	5.05	5.1				
Tin Sn	2.50E+04	25.65	25.7				
Tantalum Ta	None	25.45	25.5				
Tungsten W	None	42.85	42.9				
Yttrium Y	None	0.6	0.6				
Zirconium Zr	None	1.2	1.2				
Cerium Ce	None	10.5	10.5				
Europium Eu	None	5.55	5.6				
Lanthanum La	None	2.75	2.8				
Niobium Nb	None	5.0	5.0				
Neodymium Nd	None	5.05	5.1				
Palladium Pd	None	75.75	75.8				
Praeseodynium Pr	None	26.05	26.1				
Rubidium Rb	None	254	254				
Ruthenium Ru	None	25.65	25.7				
Samarium Sm	None	5.35	5.4				
Tellurium Te	None	25.55	25.6				
Thorium Th	None	4.85	4.9				
Titanium Ti	None	0.65	0.7				

Notes:

Shaded MDLs Constituents where the MDLs are above the WAC 173-340 limits.
Constituents where the limits are close to or below MDLs.
ICP/AES Inductively Coupled Plasma / Atomic Emission Spectroscopy
IC Ion Chromatography
None Regulatory limits for these constituents are not available in CLARC 3.1 tables. In addition, tables of toxicity information from EPA do not provide a basis for calculating limits.

Table 4-12. Dose Limits and MDL Comparisons for Primary Radionuclides (2 sheets)

Analyte	Analytical Method	Alternate Analytical Method	Limits For Comparison To MDLs				MDLs pCi/g	MDLs pCi/mL
			Source Industrial RESRAD-15 pCi/g	Source Industrial RESRAD-GW pCi/g	Source Residential RESRAD-GW pCi/g	Source 10 CFR 61.55 Class C Waste pCi/g		
^{241}Am	Alpha Counting		3.35E+02			9.00E+03	5.50E+03	1.10E+02
^{14}C	Liquid Scintillation Counting		3.31E+04	2.91E+02	4.65E+00	5.33E+06	4.00E+02	4.00E+01
^{242}Cm	Alpha Counting					9.00E+03	5.50E+03	1.10E+02
^{243}Cm	Alpha Counting		1.10E+02			9.00E+03	5.50E+03 (as $^{243/244}Cm$)	1.10E+02 (as $^{243/244}Cm$)
^{244}Cm	Alpha Counting		7.44E+02			9.00E+03	5.50E+03 (as $^{243/244}Cm$)	1.10E+02 (as $^{243/244}Cm$)
^{60}Co	GEA		4.90E+00				9.00E+03	2.50E+03
^{137}Cs	GEA		2.34E+01			3.07E+09	1.25E+04	2.50E+02
^{152}Eu	GEA		1.14E+01				1.80E+04	6.50E+04
^{154}Eu	GEA		1.03E+01				1.25E+04	4.60E+04
^{155}Eu	GEA		4.26E+02				2.20E+04	8.10E+04
^{3}H	Liquid Scintillation Counting		6.69E+04	4.10E+03	4.82E+01		4.60E+02	4.60E+01
^{129}I	Low Energy Gamma Counting		3.08E+03	2.02E+00	1.20E-01	5.33E+04	2.00+04	1.00E+03
^{63}Ni	Liquid Scintillation Counting		4.03E+03			4.67E+08	5.00E+3	1.00E+02
^{237}Np	ICP/MS	Alpha Counting	5.92E+01			9.00E+03	3.80E-02 1.05E+04[a]	9.52E-02 2.10E+02[a]
^{238}Pu	Alpha Counting	ICP/MS	4.70E+02			9.00E+03	1.70E+03 6.84E+02[a]	3.40E+01 1.71E+03[a]
^{239}Pu	Alpha Counting	ICP/MS	4.25E+02			9.00E+03 (as $^{239/240}Pu$)	1.70E+03 (as $^{239/240}Pu$) 7.44E+00[a]	3.40E+01 (as $^{239/240}Pu$) 1.86E+01[a]
^{240}Pu	Alpha Counting	ICP/MS	4.26E+02			9.00E+03 (as $^{239/240}Pu$)	1.70E+03 (as $^{239/240}Pu$) 2.27E-00[a]	3.40E+01 (as $^{239/240}Pu$) 5.86E+00[a]
^{241}Pu	Calculate from ^{238}Pu & $^{239/240}Pu$	ICP/MS	1.11E+04			3.50E+09	1.65E+04[a]	1.80E+04[a]
^{125}Sb	GEA						5.5E+06	2.0E+04
^{79}Se	Liquid Scintillation Counting		1.97E+05				1.00E+03	1.00E+02

Table 4-12. Dose Limits and MDL Comparisons for Primary Radionuclides (2 sheets)

Analyte	Analytical Method	Alternate Analytical Method	Limits For Comparison To MDLs				MDLs pCi/g	MDLs pCi/mL
			Source Industrial RESRAD-15 pCi/g	Source Industrial RESRAD-GW pCi/g	Source Residential RESRAD-GW pCi/g	Source 10 CFR 61.55 Class C Waste pCi/g		
^{90}Sr	Beta Proportional Counting		2.41E+03		3.29E+01	4.67E+09	1.65E+03	3.30E+01
^{99}Tc	Liquid Scintillation Counting	ICP/MS	4.12E+05	1.71E+02	1.93E+00	2.00E+06	5.00E+03 3.40E+01[a]	1.00E+02 2.55E+01[a]
^{228}Th	Calculation	GEA	7.73E+00		2.86E+02		6.00E+05[a]	2.70E+06 (for GEA)
^{230}Th	ICP/MS		2.01E+01				2.88E-01	7.21E-01
^{232}Th	ICP/MS		4.80E+00				4.40E-05	6.60E-05
^{233}U	ICP/MS					9.00E+03	1.74E-01	4.34E-01
^{234}U	ICP/MS		2.66E+03 (as $^{233/234}U$)	3.95E+01 (as $^{233/234}U$)	6.70E-01 (as $^{233/234}U$)	9.00E+03	3.75E-02	9.38E-02
^{235}U	ICP/MS		1.01E+02 (as $^{235/236}U$)	3.92E+00 (as $^{235/236}U$)	6.70E-02 (as $^{235/236}U$)	9.00E+03	4.32E-05	1.19E-04
^{236}U	ICP/MS						5.18E-04	1.29E-03
^{238}U	ICP/MS		5.04E+02	3.81E+01	6.50E-01	9.00E+03	4.37E-04	9.24E-04

Notes:

GEA Gamma Energy Analysis.
ICP/MS Inductively Coupled Plasma / Mass Spectroscopy
RESRAD-15 Single radionuclide concentration corresponding to a dose of 15 mrem per year above background calculated by RESRAD for 200 Area industrial soil
RESRAD-GW Single radionuclide concentration calculated by RESRAD to be protective of groundwater for 200 Area industrial soil.

Most radiochemical methods are based on a fusion with a DF= 500.
GEA MDLs for liquids are based on high concentrations of ^{137}Cs in samples. For solids a low ^{137}Cs level was assumed.
ICP/MS MDLs for solids may be based on IDLs. MDLs may be 10 times higher depending on matrix and analyte.
MDLs for liquid assume a high salt/high dose liquid and a sample size of 0.1mL.
The ICP/MS MDL estimates for liquid assume a high salt and a DF of 5000. Larger sample sizes may be possible if the salt and dose concentrations of the liquids are lower.

[a] Method detection limits for alternate methods.

Action levels are available for decision rule 3 (see Tables 6-1 and 6-2). These action levels are shown in Table 4-12 and were taken from 10 CFR 61.55.

Detection limits are dependent on such things as sample size (caused by sample activity and sample availability), methods, and matrix effects. Therefore, when no action limit is established the laboratory will provide the lowest practical detection limit, which depends on the circumstances noted above.

5.0 STUDY BOUNDARIES

This step in the DQO process defines the spatial and temporal boundaries for the required sampling and analyses needed to make the necessary decisions. The spatial boundaries define the physical area to which the decisions will apply and where the samples should be taken. The temporal boundaries describe the timeframe that the data will represent and when the samples should be taken. In addition, this portion of the DQO addresses any sampling constraints.

5.1 SPATIAL AND TEMPORAL BOUNDARIES

As stated in the DQO scope statements, the spatial boundary for the sampling and analyses covered by this DQO is only the SSTs. Therefore, the boundary will be the exterior of the tank walls. The soil and ancillary equipment (pipes, pits, vaults, etc.) in the tank farm will be addressed in separate component closure DQOs or in DQOs for the closure of the tank farms.

The data collected will be used to support SST component closure actions. The temporal boundary for the data collected per this DQO will be the final closure of the SST farms. Because the data will represent the condition of the residual waste in the SSTs, the timing of the sample collection must reflect these conditions. Section 8.0 describes the sampling plan including the timing of the samples. This DQO will be in effect until the sampling and analysis for the component closure activities are complete.

5.2 SAMPLING CONSTRAINTS

Sampling events for SSTs contend with the usual sampling constraints encountered in sampling Hanford Site tank waste. These constraints include operational constraints such as the type of sampling devices available, riser location and availability, and waste activity concerns (radiation exposure to the workers). Other considerations for sampling and analysis are resource limitations on the number of samples and sample handling considerations (see Section 4.2). The sampling plan is discussed in Section 8.0.

6.0 DECISION RULES

The DQO process includes development of decision rules, which define the actions to be taken as a result of exceeding an action level. Decision rules require action levels and alternative actions that will be taken if the action levels are exceeded and are expressed as "if then" statements that incorporates the parameter of interest, the scale of decision making, the action level, and the actions that would result from resolution of the decision rule. For this DQO, three decision rules were developed to address the decision statement in Section 3.0 and shown in Figure 3-1. As can be seen in Figure 3-1, the three decision rules are not sequential but are applied in parallel. All of the decision rules must be met before component closure actions can proceed.

The first decision statement addresses the residual waste volume remaining in a SST after completion of waste retrieval to the maximum extent possible. This decision rule is:

> If the residual waste volume within a SST has been retrieved to the maximum extent possible and is <360 cubic feet (<30 cubic feet for 200 series tanks), then component closure actions for that SST, as specified in the Hanford Site-Wide Permit, can proceed; otherwise, prepare an Appendix H request for an exception to the HFFACO (Ecology et al.) milestone M-45-00 retrieval criteria.

Commonly, an action level is a concentration at which point a predetermined action is taken depending on whether the results of the analyses are above or below the specified action level. To account for uncertainty in the data, analytical results are compared to the action level at a previously agreed to confidence interval. While this decision rule is addressing volume and not concentration, it is still possible to determine a statistically derived confidence interval. For this decision rule the 95% upper confidence limit (UCL) will be determined based upon the estimated residual waste volume. The methodology used to determine the uncertainty in the measurements for this decision rule is discussed in RPP-22891, *Revised Methodology to Calculating Residual Waste Volume at 95% Confidence Interval*, and summarized in Section 7.0.

The second decision rule addresses the concentration of constituents of concern within the residual waste in the SSTs and addresses risk assessment. The second decision rule is:

> If the residual radiological and non-radiological inventories, following evaluation in a performance assessment, are below radiological performance objectives and support compliance with WAC 173-303-610(2), and the performance assessment is approved by Ecology through incorporation of the closure plan into the RCRA Site-Wide Permit, then component closure actions for the SST can proceed; otherwise, the component closure actions will be reassessed.

The third decision rule addresses Class C radiological waste concentrations in the residual waste in its final waste form. The residual final waste form will be evaluated against the U.S. Nuclear Regulatory Commission (NRC) waste classification criteria as defined in 10 CFR 61.55. The evaluation will determine if the residual waste is greater than the NRC Class C waste definition.

If the final waste form is greater than Class C, then the waste will be addressed using 10 CFR 61 or other appropriate regulatory guidance (see Figure 3-1).

The evaluation process and decisions to be made are shown in Figure 3-1. The process follows the requirements for determining if the final waste form exceeds the greater than Class C criteria for mixtures of radionuclides as defined in 10 CFR 61.55 (5) and (7). Tables 6-1 and 6-2 show the upper limits for Class C waste. These tables are used in conjunction with Figure 6-1 to determine if the final waste form is greater than Class C.

Figure 6-1. Class C Waste Evaluation.

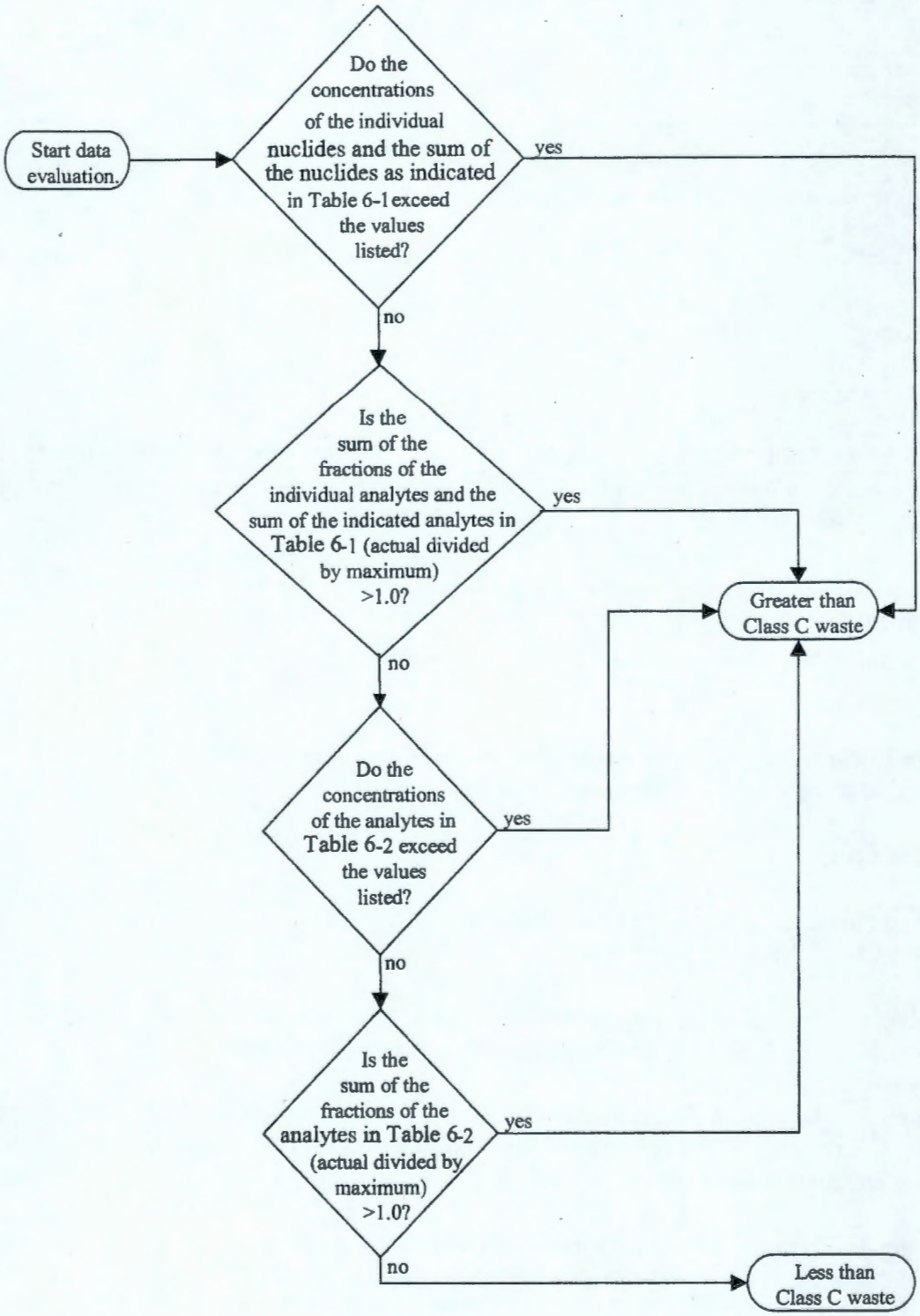


Table 6-1. Upper Limits of Class C Waste (10 CFR 61.55 Table 1).

Table to be used in conjunction with Figure 3-1 and cannot be used independently.		
Constituents	**Concentration**	**Units**
^{14}C	8	Ci/m^3
^{99}Tc	3	Ci/m^3
^{129}I	0.08	Ci/m^3
^{241}Pu	3,500	nCi/g
^{242}Cm	20,000	nCi/g
Sum of the concentrations of the following alpha emitting nuclides: ^{241}Am, ^{243}Cm, ^{244}Cm, ^{237}Np, ^{238}Pu, $^{239/240}Pu$	100	nCi/g

Notes:

Ci/m^3 Curies per cubic meter
nCi/g Nanocuries per gram

Table 6-2. Upper Limits of Class C Waste.(10 CFR 61.55 Table 2)

Table to be used in conjunction with Figure 3-1 and cannot be used independently		
Constituents	**Concentration**	**Units**
^{63}Ni	700	Ci/m^3
^{90}Sr	7,000	Ci/m^3
^{137}Cs	4,600	Ci/m^3

Notes:

Ci/m^3 Curies per cubic meter

The following example illustrates the process used with Figure 6-1 and Tables 6-1 and 6-2 to determine if the final waste form is greater than Class C.

Example:

Hypothetical waste analysis concentrations: $^{14}C = 4\ Ci/m^3$, $^{241}Am = 20$ nCi/g, $^{243}Cm = 10$ nCi/g, $^{63}Ni = 350\ Ci/m^3$, and $^{90}Sr = 5{,}250\ Ci/m^3$.

Step 1: The ^{14}C concentration ($4\ Ci/m^3$) is less than the maximum value for ^{14}C ($8\ Ci/m^3$) shown in Table 6-1. Indicates the waste is less than Class C.

Step 2: The sum of the alpha-emitting transuranic radionuclides (^{241}Am at 20 nCi/g and ^{243}Cm at 10 nCi/g) is less than the maximum value (100 nCi/g) shown in Table 6-1. Indicates waste is less than Class C.

Step 3: The sum of the fractions (actual concentrations divided by maximum concentrations) for ^{14}C and the alpha-emitting transuranic radionuclides (^{241}Am and ^{243}Cm) is: $4\ Ci/m^3 / 8\ Ci/m^3 + (20\ nCi/g + 10\ nCi/g) / 100\ nCi/g = 0.5 + 0.3 = 0.8$. Indicates waste is less Class C.

Step 4: The ^{63}Ni (350 Ci/m^3) and ^{90}Sr (5,250 Ci/m^3) individual concentrations are less than the maximum values shown in Table 6-2. Indicates waste is less than Class C.

Step 5: The sum of the fractions (actual concentrations divided by maximum concentrations) for ^{63}Ni and ^{90}Sr is: 350 Ci/m^3 / 700 Ci/m^3 + 5,250 Ci/m^3 / 7,000 Ci/m^3 = 0.5 + 0.75 = 1.25. Indicates waste is greater than Class C.

Conclusion: For this example, the waste would be greater than Class C because the sum of the fractions for ^{63}Ni and ^{90}Sr is greater than 1.

As the result of the United States District Court, District of Idaho, issuing a judgement in *Natural Resources Defense Council, et al.*, Civ. No. 01-0413-S-BLW (July 3, 2003) (appealed to the 9th Circuit Court of Appeals) holding invalid certain portions of "Radioactive Waste Management" (DOE O 435.1), the classification process for the final residual waste form cannot be specifically defined at this time. However, it is believed that the information required for final classification will be supported by the ability to meet the performance objectives defined in Subpart C as defined in 10 CFR 61.40. These also include the capability to meet Class C calculations in 10 CFR 61.55 and estimate the transuranic levels as defined by the Atomic Energy Act and TRU classification defined in 40 CFR 191, (alpha emitting radionuclides with half lives greater than 20 years of the tank waste residual).

The third decision rule can be stated as:

> If the average of the radiological activity in the final waste form does not exceed the greater than Class C waste definition, then component closure actions for that SST, as specified in the Hanford Site-Wide Permit, can proceed; otherwise, the waste will be addressed using 10 CFR 61 or other appropriate regulatory guidance.

In addition to the decision rules discussed above, two SSTs (241-S-102 and 241-S-112) have additional HFFACO requirements for component closure. The HFFACO milestone requirements addressing the removal of long lived radioisotopes (^{99}Tc, ^{79}Se, ^{14}C, ^{129}I, ^{232}U, ^{233}U, ^{234}U, ^{235}U, ^{236}U, and ^{238}U) from tank 241-S-102 (milestone M-45-05A) and tank 241-S-112 (milestone M-45-03C) were considered in the preparation of this DQO. Milestone M-45-05A requires removing "...approximately 490 Ci..." from tank 241-S-102 while milestone M-45-03C requires removing "...approximately 550 Ci..." from tank 241-S-112 based on the best basis inventory as of August 1, 2000. According to the best basis inventory as of August 1, 2000, tank 241-S-102 contained 487 Ci and tank 241-S-112 contained 555 Ci of the long lived radioisotopes.

A DQO process meeting (February 3, 2004) was held to discuss the DQO approach to the HFFACO issue outlined in the previous paragraph. The meeting attendees were composed of representatives from ORP, Ecology, and CH2MHILL. With the above information in mind, the DQO process team agreed that if the TPA volume requirement (360 cubic feet) is achieved the requirement to remove approximately 490 Ci of long lived radioisotopes from tank 241-S-102 and approximately 550 Ci from tank 241-S-112 would also be achieved. No separate decision rule would be necessary to address this requirement.

If the data do not meet the requirements for proceeding with component closure actions, as indicated by the decision rules listed above, the component closure actions may be accomplished depending on the decisions made from the alternative requirements. However, this DQO does not address those decisions.

7.0 ERROR TOLERANCE

As mentioned in Section 6.0, an action level is a concentration at which point a predetermined action is taken depending on whether the results of the analyses are above or below the specified action level. To account for uncertainty in the data, analytical results are compared to the action level at an established statistical confidence interval.

The uncertainty in determining the volume of residual waste in a SST can be established for the waste on the bottom of the tank, residual waste in equipment void spaces, residual waste on stiffener rings, and residual waste on the tank walls. These four areas for waste to remain in a SST contribute to the total residual waste volume. The video-camera/CAD modeling system (CCMS) provides the basis for estimating the residual waste on the bottom of the tank. The potential sources of error in estimating residual waste volume using the CCMS are as follows:

- As-built deviation of tank geometry from construction drawings,
- Creep or warping due to thermal effects,
- Error in creating waste surface topography in the CAD program and
- The error in the algorythm used in the CAD modeling.

Two tests to determine the uncertainty in the results of the CCMS were conducted at the Cold Test Facility and are described in RPP-18744, *Results of the Video Camera/CAD Modeling System Test.*

The Bootstrap method was selected to determine the upper limit of a 95% confidence interval from the results of the CCMS Cold Test Facility test is described in RPP-RPT-22891, *Revised Methodology to Calculating Residual Waste Volume at 95% Confidence Interval.* Bootstrap is a robust statistical method used to construct the confidence interval for the population mean. This method is a distribution-free approach that does not make specific assumptions about the shape of the underlying distribution. It assumes that the samples are representative of the underlying distribution but requires no assumption about the shape of that distribution. Bootstrap estimates are calculated following a procedure given in *An Introduction to the Bootstrap* (Efron and Tibshirani 1993, Chapters 7 and 9). This method involves the selection of a number (in this application the number 1024 was used) of new 19 point data sets. These new data sets are formed by randomly selecting 19 data points, with replacement, from the original data set. Therefore, in the new data sets, the usual situation will be for a new data set to have one or more of the original data points appearing two or more times and one or more of the original data points not appearing at all. Regression lines are calculated for each of the new data sets, the resulting slopes are rank ordered and the 95% lower limit slope is used to determine a 95% lower limit regression line.

$$X = \text{lower limit slope} * Y + \text{intercept.}$$

This equation is then solved for Y to obtain the 95% upper limit regression line

$$Y = (X - \text{intercept})/\text{lower bound slope.}$$

Using this process, the best-fit slope is 1/0.959 = 1.043. The 95% UCL for the residual waste volume on the bottom of the tank is determined with the following regression equation:

$$\text{Actual Waste Volume @95\%UCIft}^3 = 1.043 \times \text{CCMS In-Tank Volume Est.ft}^3 + 0.852$$

In addition, based upon the review of the videos an evaluation of the residual waste on the stiffener rings and walls is made using a best estimate value using a visual estimate of thickness of the waste on the ring and how much of the ring had waste. Equipment in the tank is also evaluated to determine the existence of void spaces that could contain waste. In these cases, the voids spaces are conservatively assumed to be filled with waste. The assumptions concerning residual waste on the stiffener rings, in the void space of equipment, and on the tank walls are best estimate values and do not require the determination of a confidence interval. The waste calculated to be on the stiffener rings, in equipment void spaces, and on the tank walls are added to the amount in the bottom of the tank to determine the total residual waste left in the tank.

The actual action levels for the second decision rule depend on the risk assessment process and the modeling and are not available at this time. Therefore, the uncertainties associated with this decision rule cannot be compared to an action level. If actual action levels are established, as the risk assessment process matures, they can be incorporated into the decision rule.

The third decision rule contains action levels. Therefore, the analytical results can be compared to an action level.

The concentrations of the Class C constituents are averaged over final waste form for comparison to Class C action limits (10 CFR 61.55). Therefore, the mean concentration of each constituent is compared to the action limit to determine if the final waste form is Class C or less.

8.0 SAMPLING DESIGN

Random sampling cannot be accomplished because of the operational constraints (e.g., sample location restrictions due to riser availability, locations, the lack of off riser sampling capability, etc.) Therefore, a subjective sampling plan will be conducted as discussed in Section 8.2.

In addition to supplying waste samples to address this DQO, tank waste will be obtained to conduct risk assessment tests. As stated in Section 4.0, the waste sample material collected for constituent release rate tests (used for risk assessment calculations) will be shipped to PNNL. The testing will be governed by an approved test plan. Sample quantities of 120 g of solids and

150 mL of liquid were established for these tests. The optimum quantity of sample needed for the specified analyses governed by this DQO is approximately 222 g of solids and 2,650 mL of liquid. This amount of sample material will allow the lowest MDLs with existing equipment capacity, allow for any required reruns, and allow for any sample loss during handling. However, the final amount of sample material used for the analyses depends on the radioactivity of the material as well as existing equipment capacity. Therefore, the total amount of sample material needed (including PNNL sample volume requirements) to perform all required testing and analyses are approximately 342 g of solids and 2,800 mL of liquid.

While the optimum amount of material needed for the analyses is 169 g of solids and 2,650 mL of liquid, the actual amount obtained during a sampling event will depend on such things as worker exposure and the number and size of bottles required to satisfy analytical requirements and any contingency requirements.

The only requirement for the sample sent to PNNL is the quantity of material and material from each riser if more than one riser is sampled. Requirements in Section 8.2 only pertain to the sample material sent to the 222-S Laboratory.

8.1 VOLUME MEASUREMENTS

The method for estimating residual waste volume following waste retrieval actions is visual assessment of waste against known tank geometry using the CCMS and by determining the void space in any equipment in the tank which was in contact with waste. The CCMS represents the best currently available technology for developing the post-retrieval waste volume estimates. This system was tested in the Cold Test Facility for application to both 100 series and 200 series SSTs (RPP-18744).

At the completion of waste retrieval operations, in-tank videos are taken. Residual waste volume measurements are obtained by inserting a video camera into a tank riser and obtaining a videotape of the tank interior. Based upon the visual analysis of the video a 3-dimension model of the surface topography of the residual waste on the bottom of the tank is generated taking into account the configuration and dimensions of the tank. The 3-D CAD system algorithms then generate an estimate of the residual waste volume remaining on the bottom of the SST. Once this volume is determined, the 95% UCL is determined using the previously described equation (see Section 7.0). This equation calculates the residual waste volume on the bottom of the tank at the 95% UCL.

In addition, based on the review of the in tank video, an evaluation of the residual waste on the stiffener rings is made using a conservative assumption that the residual waste is uniformly distributed on a ring when observed on a ring. Equipment in the tank is also evaluated to determine the existence of void spaces which could be filled with waste. It is conservatively assumed that all void spaces are filled completely with waste. The total residual waste volume is the sum of:

- The residual waste on the tank bottom (volume at the 95% UCL in ft^3)
- The residual waste on the stiffener rings (ft^3)

- The residual waste in the equipment void spaces (ft^3)
- The residual waste on the tank walls when appropriate (ft^3)

During the DQO process meetings, the potential for waste on the tank walls was discussed and it was determined the amount of waste on the tank walls would be minimal for tanks retrieved using modified sluicing (MS) method. In instances where a visually detectable quantity of residual waste adheres to the tank walls, an estimate of the amount of residual waste on the tank walls will be added to the residual waste volume.

8.2 WASTE SAMPLING

Waste retrieval from SSTs will employ one of three retrieval methods [the MS, the mobile retrieval system (MRS) (in-tank vehicle plus vacuum system), or the articulating mast system (AMS), (a vacuum system)]. The selected method for a specific tank will be based on characteristics of the waste and the characteristics of the tank to be retrieved.

The planned sampling strategy will depend on the retrieval method and the amount of liquid used during retrieval. Some retrieval methods (MRS and AMS) may not use or leave sufficient liquid to sample. However, the general sampling plan is three samples will be obtained for each sample matrix (solids and liquids); one sample from one riser and two samples from a second riser (a sample and duplicate sample). Available risers that are as far apart as possible should be selected. Two risers may not always be available due to use by retrieval or other equipment, the availability of waste under the risers, riser configuration, etc. In cases where only one riser is available, a minimum of two samples (sample and duplicate) will be obtained. In addition, a minimum of one duplicate analysis is required for one of the samples. Therefore, sufficient sample material must be obtained in one of the samples for this purpose. In some cases, solid waste may be mobilized and placed under a specific riser in a tank to facilitate sampling. Moving solid waste under a riser to promote sampling access may be possible with all three retrieval methods. The ability to move the residual solid waste will depend on waste characteristics (consistency, particle size, etc.), waste location in the tank, retrieval method, etc.

A sample may be composed of more than one grab. A grab is defined as the deployment of the sampling device (one clam shell, finger-trap, or bottle). Multiple grabs may be required for one sample to obtain enough material to complete all analyses.

8.2.1 Liquid Samples

When liquid samples are obtained, the quantity of liquid in one of the samples must be sufficient to perform a duplicate analysis. In addition, two bottles are required per sample to conduct the VOC analyses (two bottles for the sample and two additional bottles for the duplicate sample) and another two are required to conduct the SVOC analyses (two bottles for the sample and two additional bottles for the duplicate sample). If insufficient sample material is available for the rest of the required analyses, the contents from each pair of bottles may be combined after the VOC and SVOC subsamples are taken.

All liquid samples containing solids will be centrifuged and the centrifuged solids will be analyzed (see Figure 8-1). It is unlikely sufficient centrifuged solids will be available for a complete set of solid analyses. Therefore, the types of solid analyses may require prioritization. The analytical priorities in order of preference are radiochemistry (particularly for long half-life radionuclides), inorganic metals, inorganic anions, SVOCs, PCBs, and VOCs.

8.2.2 Solids Samples

Two sampling devices (finger trap and clamshell) are currently available for obtaining solids. The clamshell sampling device was developed so small waste depths could be sampled. Currently, off riser sampling is not available, but the capability is being developed. When off riser sampling becomes available, the sampling design for solids for all retrieval methods will be re-evaluated.

The optimum amount of solid sample material to accomplish the analytical requirements in this DQO is approximately 222 g (116 g for the sample with the duplicate analysis and 53 g each for the sample without duplicate analyses). This would allow enough material to optimize detection limits. If possible, additional material should be collected to allow for handling loss.

While approximately 222 g is the optimum amount of sample, the analyses required by this DQO could be accomplished with a minimum of approximately 37 g. However, a 37 g sample could reduce detection limits and may be insufficient if sample material is lost during analytical operations. The amount of material listed in other places in this DQO is for the optimum amount.

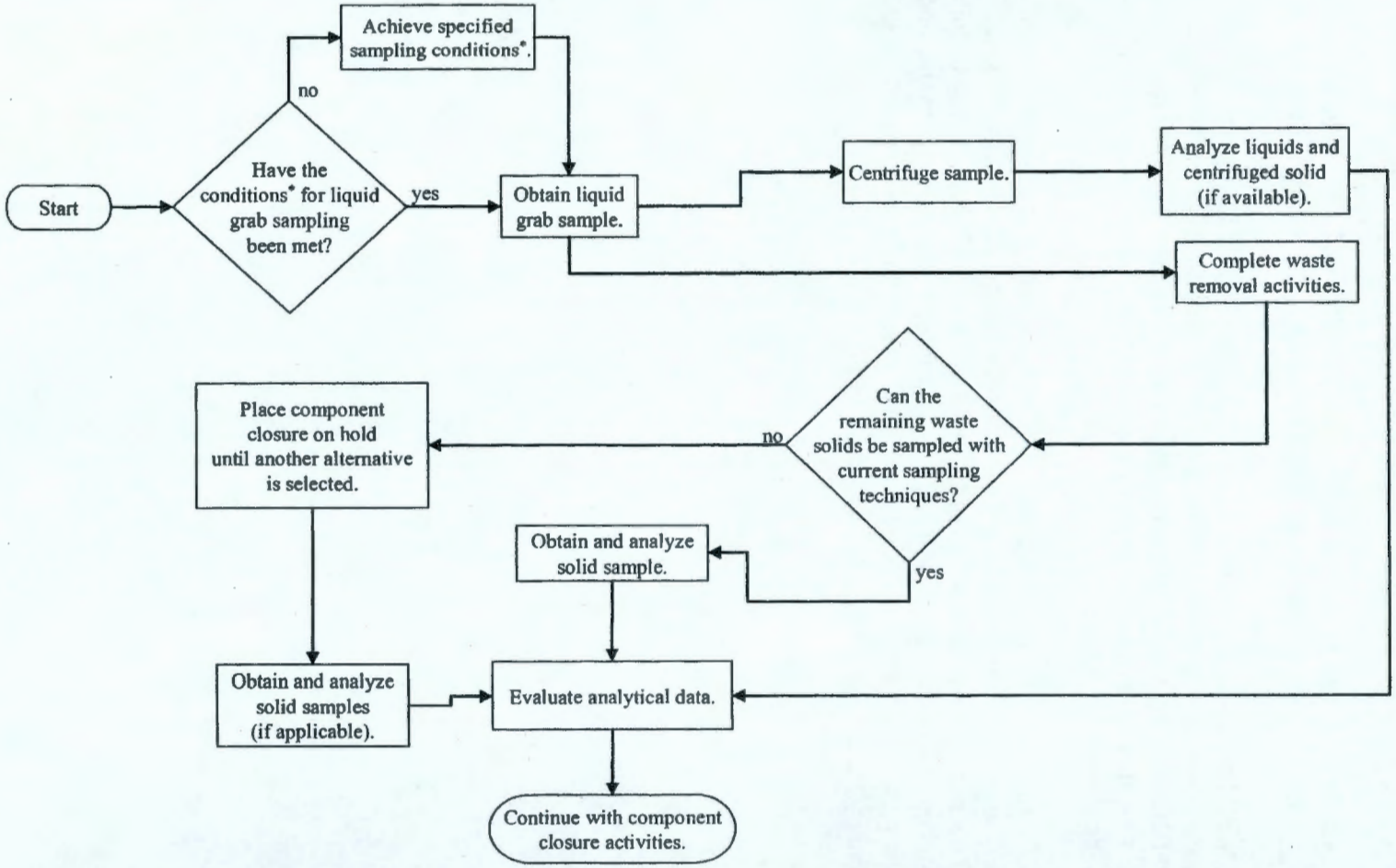
8.2.3 MS Retrieval Method Sampling

When the MS retrieval method is used, liquid samples will be collected after completion of the final washing activity and prior to pumping the remaining liquid out of the tank. These samples are expected to be representative of any liquid remaining in the tank (after final pumping) because no additional liquid will be added and the retrieval process will leave the liquid well mixed. In addition, the timing of the sampling activity (before rather then after final pumping) will increase the likelihood of obtaining sufficient liquid samples with current grab sampling techniques.

After completion of the retrieval activities, a determination of how to obtain samples of any residual solids will be made. If solid samples cannot be obtained due to the configuration of the waste (e.g., not under available risers), the component closure will be placed on hold until another alternative is selected (see Figure 8-1).

Figure 8-1 shows the sampling strategy for sampling liquids and solids when the MS method of retrieval is used. This sampling strategy was developed in the DQO process meetings for tank 241-C-106.

Figure 8-1. Sampling Strategy for MS Retrieved SSTs



*Conditions for Liquid Waste Sampling

1. No additional liquid will be added to the tank
2. Remaining liquid waste is well mixed
3. Sample just prior to final liquid waste removal

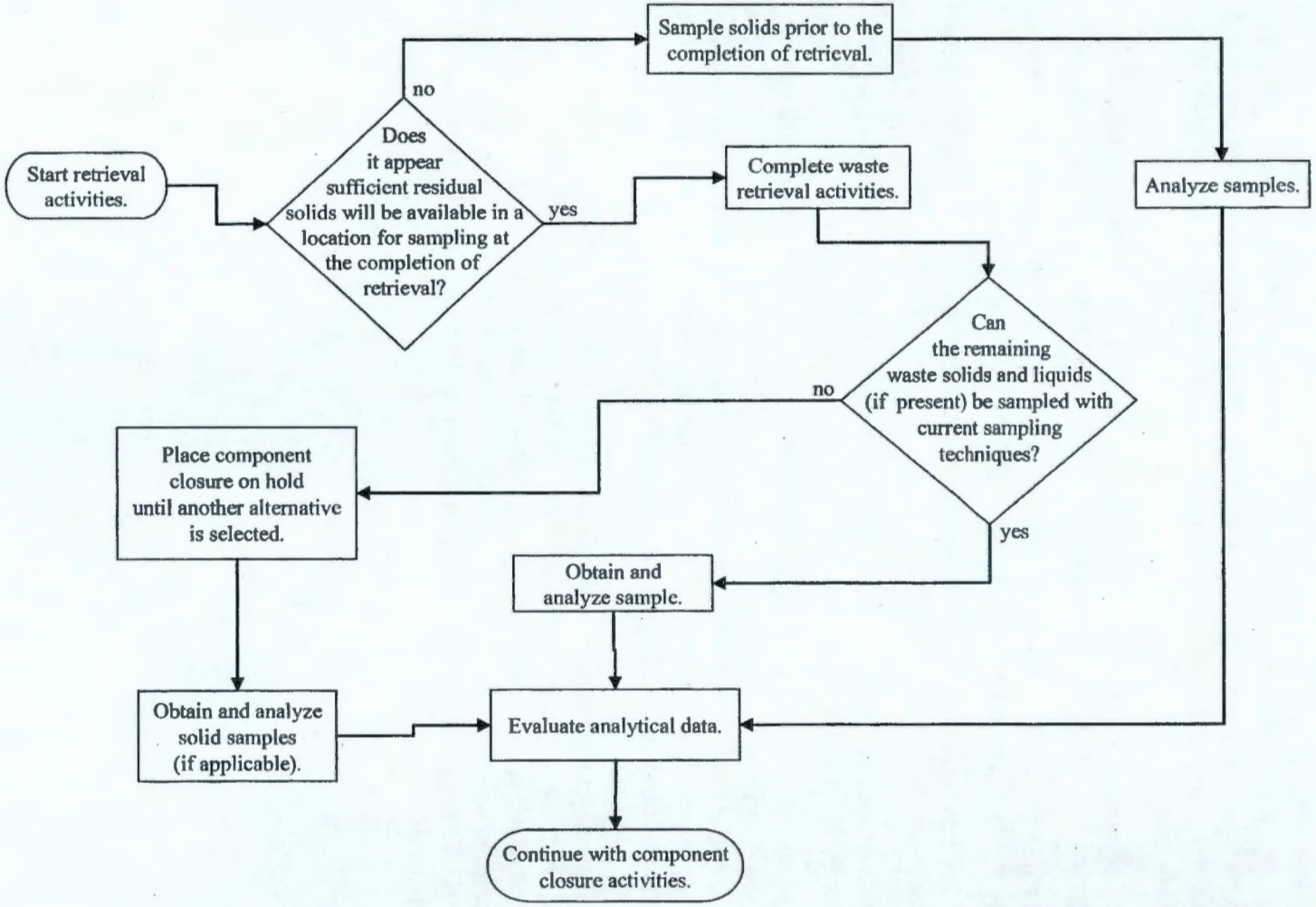
8.2.4 MRS and AMS Retrieval

The MRS and AMS retrieval methods will introduce little liquid into the tank during retrieval and most of the liquid introduced to promote retrieval would be removed by the vacuum systems. Therefore, the sampling strategy for the tanks where the MRS and AMS retrieval methods are used is different from the sampling strategy used for tanks using the MS retrieval method.

Because the MRS and AMS retrieval methods use minimal liquid during retrieval and the liquid is removed as it is used, component closure samples of residual liquid are not expected when these retrieval methods are used. However, a small amount of residual liquids (e.g., flush water) may remain in the tank after retrieval activities are completed. Any residual liquid existing after retrieval will be sampled if possible.

If it appears, during retrieval, that sufficient solids will not remain when retrieval is complete or solids will not be in a location so sampling can take place (e.g., under an available riser), solid samples will be collected near the end of retrieval to allow the best opportunity to collect solid samples. Until experience is gained with these retrieval methods, the exact timing and sampling activity will depend on the waste configuration toward the end of waste retrieval activity. The sampling strategy for the MRS and AMS is shown in Figure 8-2.

Figure 8-2. Sampling Strategy for MRS and AMS Retrieved SSTs



The C-200 series tanks (241-C-201, 241-C-202, 241-C-203, and 241-C-204) are being retrieved using the AMS retrieval method.

The sampling strategy, developed specifically for the C-200 series tanks, includes pre-retrieval sampling. Pre-retrieval sampling was conducted to ensure information was obtained on any residual waste left in the tanks. It is believed that, for the C-200 series tanks, pre-retrieval samples would provide a reasonable estimate of residual waste composition and provide the best opportunity of obtaining data on any residual waste left in the tank. Pre-retrieval samples were considered because:

- The amount of waste in each tank is small, ranging from approximately from approximately 80 cubic feet in tank C-201 to approximately 350 cubic feet in tank C-203.
- The tanks contain primarily a single waste (Hot Semiworks) source minimizing the variability likely to be found in tanks with multiple waste types.
- The retrieval method is not expected to remove preferentially solids with certain characteristics (e.g., light solids).
- Post retrieval sampling may not be possible due to the configuration (location and quantity) of any residual waste.

While it is expected that any residual waste will be represented by the samples taken prior to retrieval (see justification above), post retrieval sampling is not ruled out. Post retrieval samples will be obtained if the residual waste in the tank is > 30 cubic feet and the configuration (i.e., present under the risers and confirmed by video) of the residual waste permits sampling to occur. Pre-retrieval sampling is not planned for any other tanks.

All sampling ultimately depends on the final configuration of the residual waste. As mentioned above, the sampling design assumes two risers per tank will be available for sampling and residual waste will be accessible through the risers. When off riser capability is available, the sampling design will be re-evaluated and the DQO updated accordingly. If the configuration of the residual waste is different than anticipated, sample alternatives will be evaluated in all retrieval methods.

9.0 REFERENCES

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40 CFR 141, 2002, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

40 CFR 143, 2002, "National Secondary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

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WAC 173-340,"Model Toxics Control Act," *Washington Administrative Code*, as amended.

APPENDIX A

Table A-1. WAC 173-340 Method B Cleanup Levels for Chemicals in Order by Chemical Abstract Number[a].

		Soil Direct Contact		Groundwater Cleanup Levels		Drinking Water MCL[b] mg/L	Overall GW Cleanup Level		3-Phase Partitioning Model Equation for Soil Protection of GW				
CAS No.	Chemical Name	Carcinogen mg/kg	Non-carcinogen mg/kg	Carcinogen mg/L	Non-carcinogen mgL		mg/L	Source	Kd uL/g	Source	Henry's Law Constant	Source	Soil Conc. for GW Protection mg/kg
50-32-8	benzo[a]pyrene	1.37E-01		1.20E-02		2.00E-01	1.20E-02	MTCA B	9.69E+02	CLARC 3.1	4.63E-05	CLARC 3.1	2.33E-01
53-70-3	dibenzo[a,h]anthracene	1.37E-01		1.20E-02			1.20E-02	MTCA B	1.79E+03	CLARC 3.1	6.03E-07	CLARC 3.1	4.29E-01
56-23-5	carbon tetrachloride	7.69E+00	5.60E+01	3.37E-01	5.60E+00	5.00E+00	3.37E-01	MTCA B	1.52E-01	CLARC 3.1	1.25E+00	CLARC 3.1	3.10E-03
57-12-5	cyanide		1.60E+03		3.20E+02	2.00E+02	2.00E+02	MCL	0.00E+00	Default	0.00E+00	Default	8.00E-01
57-14-7	dimethylhydrazine;1,1-	3.85E-01		3.37E-02			3.37E-02	MTCA B	0.00E+00	Default	0.00E+00	Default	1.35E-04
58-89-9	lindane [gamma-BHC]	7.69E-01	2.40E+01	6.73E-02	4.80E+00	2.00E-01	6.73E-02	MTCA B	1.35E+00	CLARC 3.1	5.74E-04	CLARC 3.1	2.09E-03
60-29-7	ethyl ether (diethyl ether)		1.60E+04		1.60E+03		1.60E+03	MTCA B	8.40E-02	Region 9	5.30E-04	Region 9	9.09E+00
60-34-4	methylhydrazine	9.09E-01		7.95E-02			7.95E-02	MTCA B	0.00E+00	Default	0.00E+00	Default	3.18E-04
60-57-1	dieldrin	6.25E-02	4.00E+00	5.47E-03	8.00E-01		5.47E-03	MTCA B	2.56E+01	CLARC 3.1	6.19E-04	CLARC 3.1	2.82E-03
62-75-9	nitrosodimethylamine;N-	1.96E-02		1.72E-03			1.72E-03	MTCA B	0.00E+00	Default	0.00E+00	Default	6.86E-06
67-64-1	acetone (2-Propanone)		8.00E+03		8.00E+02		8.00E+02	MTCA B	5.75E-04	CLARC 3.1	1.59E-03	CLARC 3.1	3.21E+00
67-66-3	chloroform (trichloromethane)	1.64E+02	8.00E+02	7.17E+00	8.00E+01		7.17E+00	MTCA B	5.30E-02	CLARC 3.1	1.50E-01	CLARC 3.1	3.81E-02
67-72-1	hexachloroethane	7.14E+01	8.00E+01	6.25E+00	1.60E+01		6.25E+00	MTCA B	1.78E+00	CLARC 3.1	1.59E-01	CLARC 3.1	2.49E-01
71-36-3	butanol;n- (n-butyl alcohol)		8.00E+03		1.60E+03		1.60E+03	MTCA B	6.92E-03	CLARC 3.1	3.61E-04	CLARC 3.1	6.62E+00
71-43-2	benzene	1.82E+02	2.40E+02	7.95E-01	2.40E+01	5.00E+00	7.95E-01	MTCA B	6.20E-02	CLARC 3.1	2.28E-01	CLARC 3.1	4.48E-03
71-55-6	trichloroethane;1,1,1-		7.20E+04		7.20E+03	2.00E+02	2.00E+02	MCL	1.35E-01	CLARC 3.1	7.05E-01	CLARC 3.1	1.58E+00
72-20-8	endrin		2.40E+01		4.80E+00	2.00E+00	2.00E+00	MCL	1.08E+01	CLARC 3.1	3.08E-04	CLARC 3.1	4.40E-01
74-83-9	bromomethane [methyl bromide]		1.12E+02		1.12E+01		1.12E+01	MTCA B	9.00E-03	CLARC 3.1	2.56E-01	CLARC 3.1	5.18E-03
74-87-3	chloromethane	7.69E+01		3.37E+00			3.37E+00	MTCA B	2.10E-01	Region 9	9.80E-01	Region 9	3.34E-02
75-00-3	ethyl chloride [chloroethane]					4.64E+00	4.64E+00	Region 9	8.80E-02	Region 9	4.50E-01	Region 9	3.03E-02
75-01-4	vinyl chloride [chloroethene; 1-]	6.67E-01	2.40E+02	2.92E-02	2.40E+01	2.00E+00	2.92E-02	MTCA B	1.86E-02	CLARC 3.1	1.11E+00	CLARC 3.1	1.84E-04
75-05-8	acetonitrile		4.80E+02		4.80E+01		4.80E+01	MTCA B	9.40E-02	Region 9	8.20E-04	Region 9	2.82E-01
75-09-2	dichloromethane (methylene chloride)	1.33E+02	4.80E+03	5.83E+00	4.80E+02	5.00E+00	5.00E+00	MCL	1.00E-02	CLARC 3.1	8.98E-02	CLARC 3.1	2.54E-02
75-15-0	carbon disulfide		8.00E+03		8.00E+02		8.00E+02	MTCA B	4.57E-02	CLARC 3.1	1.24E+00	CLARC 3.1	5.65E+00
75-21-8	ethylene oxide	9.80E-01		4.29E-02			4.29E-02	MTCA B	1.30E-02	Region 9	3.10E-03	Region 9	1.83E-04
75-35-4	dichloroethylene;1,1-	1.67E+00	7.20E+02	7.29E-02	7.20E+01	7.00E+00	7.29E-02	MTCA B	6.50E-02	CLARC 3.1	1.07E+00	CLARC 3.1	5.22E-04
75-69-4	trichlorofluoromethane		2.40E+04		2.40E+03		2.40E+03	MTCA B	9.60E-01	Region 9	4.00E+00	Region 9	7.23E+01
75-71-8	dichlorodifluoromethane		1.60E+04		1.60E+03		1.60E+03	MTCA B	3.50E-01	Region 9	4.10E+00	Region 9	2.90E+01
76-13-1	trichloro-1,2,2-		2.40E+06		4.80E+05		4.80E+05	MTCA B	0.00E+00	Default	0.00E+00	Default	1.92E+03

Table A-1. WAC 173-340 Method B Cleanup Levels for Chemicals in Order by Chemical Abstract Number[a].

		Soil Direct Contact		Groundwater Cleanup Levels		Drinking Water MCL[b] mg/L	Overall GW Cleanup Level		3-Phase Partitioning Model Equation for Soil Protection of GW				
CAS No.	Chemical Name	Carcinogen mg/kg	Non-carcinogen mg/kg	Carcinogen mg/L	Non-carcinogen mgL		mg/L	Source	Kd uL/g	Source	Henry's Law Constant	Source	Soil Conc. for GW Protection mg/kg
	trifluoroethane;1,1,2-												
76-44-8	heptachlor	2.22E-01	4.00E+01	1.94E-02	8.00E+00	4.00E-01	1.94E-02	MTCA B	9.53E+00	CLARC 3.1	4.47E-02	CLARC 3.1	3.78E-03
78-87-5	dichloropropane;1,2-	1.47E+01		6.43E-01		5.00E+00	6.43E-01	MTCA B	4.70E-02	CLARC 3.1	1.15E-01	CLARC 3.1	3.30E-03
79-00-5	trichloroethane;1,1,2-	1.75E+01	3.20E+02	7.68E-01	3.20E+01	5.00E+00	7.68E-01	MTCA B	7.50E-02	CLARC 3.1	3.74E-02	CLARC 3.1	4.27E-03
79-01-6	trichloroethylene (TCE; trichloroethene)	9.09E+01		3.98E+00		5.00E+00	3.98E+00	MTCA B	9.40E-02	CLARC 3.1	4.22E-01	CLARC 3.1	2.63E-02
79-34-5	tetrachloroethane;1,1,2,2-	5.00E+00		2.19E-01			2.19E-01	MTCA B	7.90E-02	CLARC 3.1	1.41E-02	CLARC 3.1	1.23E-03
79-46-9	nitropropane; 2-	1.05E-01		4.61E-03			4.61E-03	MTCA B	0.00E+00	Default	0.00E+00	Default	1.84E-05
82-68-8	pentachloronitrobenzene	3.85E+00	2.40E+02	3.37E-01	4.80E+01		3.37E-01	MTCA B	0.00E+00	Default	0.00E+00	Default	1.35E-03
83-32-9	acenaphthene		4.80E+03		9.60E+02		9.60E+02	MTCA B	4.90E+00	CLARC 3.1	6.36E-03	CLARC 3.1	9.79E+01
84-74-2	di-butyl phthalate		8.00E+03		1.60E+03		1.60E+03	MTCA B	1.57E-01	CLARC 3.1	3.85E-08	CLARC 3.1	1.14E+01
85-68-7	butyl benzyl phthalate		1.60E+04		3.20E+03		3.20E+03	MTCA B	1.38E+01	CLARC 3.1	5.17E-05	CLARC 3.1	8.93E+02
87-68-3	hexachlorobutadiene	1.28E+01	1.60E+01	5.61E-01	1.60E+00		5.61E-01	MTCA B	5.37E+01	CLARC 3.1	3.34E-01	CLARC 3.1	6.05E-01
87-86-5	pentachlorophenol	8.33E+00	2.40E+03	7.29E-01	4.80E+02	1.00E+00	7.29E-01	MTCA B	5.92E-01	CLARC 3.1	1.00E-06	CLARC 3.1	1.15E-02
88-06-2	trichlorophenol;2,4,6-	9.09E+01		7.95E+00			7.95E+00	MTCA B	3.81E-01	CLARC 3.1	3.19E-04	CLARC 3.1	9.24E-02
88-85-1	dinoseb (2-sec-butyl-4,6-dinitophenol)		8.00E+01		1.60E+01	7.00E+00	7.00E+00	MCL	0.00E+00	Default	0.00E+00	Default	2.80E-02
91-20-3	naphthalene		1.60E+03		1.60E+02		1.60E+02	MTCA B	1.19E+00	CLARC 3.1	1.98E-02	CLARC 3.1	4.46E+00
92-52-4	biphenyl;1,1-		4.00E+03		8.00E+02		8.00E+02	MTCA B	4.70E+01	Region 9	2.10E-02	Region 9	7.55E+02
95-47-6	xylene;o-		1.60E+05		1.60E+04	1.00E+04	1.00E+04	MCL	2.41E-01	CLARC 3.1	2.13E-01	CLARC 3.1	9.19E+01
95-48-7	cresol; o- (2-methylphenol)		4.00E+03		8.00E+02		8.00E+02	MTCA B	9.12E-02	CLARC 3.1	4.92E-05	CLARC 3.1	4.66E+00
95-50-1	dichlorobenzene;1,2-[ortho]		7.20E+03		7.20E+02	6.00E+02	6.00E+02	MCL	3.79E-01	CLARC 3.1	7.79E-02	CLARC 3.1	7.03E+00
95-57-8	chlorophenol;2-		4.00E+02		8.00E+01		8.00E+01	MTCA B	3.88E-01	CLARC 3.1	1.60E-02	CLARC 3.1	9.43E-01
95-95-4	trichlorophenol;2,4,5-		8.00E+03		1.60E+03		1.60E+03	MTCA B	1.60E+00	CLARC 3.1	1.78E-04	CLARC 3.1	5.75E+01
98-86-2	acetophenone		8.00E+03		1.60E+03		1.60E+03	MTCA B	0.00E+00	Default	0.00E+00	Default	6.40E+00
98-95-3	nitrobenzene		4.00E+01		8.00E+00		8.00E+00	MTCA B	1.19E-01	CLARC 3.1	9.84E-04	CLARC 3.1	5.11E-02
100-00-5	chloronitrobenzene;p-	5.56E+01		4.86E+00			4.86E+00	MTCA B	3.90E-01	Region 9	9.80E-01	Region 9	6.56E-02
100-25-4	Dinitrobenzene; 1,4-(para-)		3.20E+01		6.40E+00		6.40E+00	MTCA B	0.00E+00	Default	0.00E+00	Default	
100-41-4	ethylbenzene		8.00E+03		8.00E+02	7.00E+02	7.00E+02	MCL	2.04E-01	CLARC 3.1	3.23E-01	CLARC 3.1	6.05E+00
100-42-5	styrene	3.33E+01	1.60E+04	1.46E+00	1.60E+03	1.00E+02	1.46E+00	MTCA B	9.12E-01	CLARC 3.1	1.13E-01	CLARC 3.1	3.28E-02
106-42-3	xylene;p-						1.60E+04	MTCA B	3.11E-01	CLARC 3.1	3.14E-01	CLARC 3.1	1.72E+02

Table A-1. WAC 173-340 Method B Cleanup Levels for Chemicals in Order by Chemical Abstract Number[a].

		Soil Direct Contact		Groundwater Cleanup Levels		Drinking Water MCL[b] mg/L	Overall GW Cleanup Level		3-Phase Partitioning Model Equation for Soil Protection of GW				
CAS No.	Chemical Name	Carcinogen mg/kg	Non-carcinogen mg/kg	Carcinogen mg/L	Non-carcinogen mgL		mg/L	Source	Kd uL/g	Source	Henry's Law Constant	Source	Soil Conc. for GW Protection mg/kg
106-44-5	cresol; p- (4-methylphenol)		4.00E+02		8.00E+01		8.00E+01	MTCA B	0.00E+00	Default	0.00E+00	Default	3.20E-01
106-46-7	dichlorobenzene;1,4-[para]	4.17E+01		1.82E+00		7.50E+01	1.82E+00	MTCA B	6.16E-01	CLARC 3.1	9.96E-02	CLARC 3.1	3.00E-02
106-93-4	ethylene dibromide (1,2-dibromoethane)	1.18E-02		5.15E-04		5.00E-02	5.15E-04	MTCA B	6.60E-02	CLARC 3.1	1.00E-01	Region 9	2.83E-06
106-99-0	butadiene;1,3-						1.14E-02	Region 9	7.20E-01	Region 9	7.30E+00	Region 9	3.55E-04
107-02-8	acrolein		1.60E+03		1.60E+02		1.60E+02	MTCA B	1.30E-01	Region 9	4.90E-03	Region 9	1.06E+00
107-05-1	allyl chloride [chloropropene; 3-]		4.00E+03		8.00E+02		8.00E+02	MTCA B	0.00E+00	Default	0.00E+00	Default	3.20E+00
107-13-1	acrylonitrile	1.85E+00	8.00E+01	8.10E-02	8.00E+00		8.10E-02	MTCA B	5.10E-03	Region 9	3.60E-03	Region 9	3.33E-04
107-87-2	methylcyclohexane						5.22E+03	Region 9	1.30E+01	Region 9	1.80E+01	Region 9	1.54E+03
108-38-3	xylene;m-		1.60E+05		1.60E+04	1.00E+04	1.00E+04	MCL	1.96E-01	CLARC 3.1	3.01E-01	CLARC 3.1	8.44E+01
108-39-4	cresol; m- (m-cresylic acid)		4.00E+03		8.00E+02		8.00E+02	MTCA B	0.00E+00	Default	0.00E+00	Default	3.20E+00
108-88-3	toluene		1.60E+04		1.60E+03	1.00E+03	1.00E+03	MCL	1.40E-01	CLARC 3.1	2.72E-01	CLARC 3.1	7.27E+00
108-90-7	chlorobenzene		1.60E+03		1.60E+02	1.00E+02	1.00E+02	MCL	2.24E-01	CLARC 3.1	1.52E-01	CLARC 3.1	8.74E-01
108-94-1	cyclohexanone		4.00E+05		8.00E+04		8.00E+04	MTCA B	0.00E+00	Default	0.00E+00	Default	3.20E+02
108-95-2	phenol		4.80E+04		9.60E+03		9.60E+03	MTCA B	2.88E-02	CLARC 3.1	1.63E-05	CLARC 3.1	4.39E+01
110-54-3	hexane;n-		4.80E+03		4.80E+02		4.80E+02	MTCA B	3.41E+00	CLARC 3.1	7.40E+01	CLARC 3.1	9.62E+01
110-80-5	ethoxyethanol; 2-		3.20E+04		6.40E+03		6.40E+03	MTCA B	0.00E+00	Default	0.00E+00	Default	2.56E+01
110-82-7	cyclohexane						3.47E+04	Region 9	9.60E-01	Region 9	8.20E+00	Region 9	1.30E+03
110-86-1	pyridine		8.00E+01		1.60E+01		1.60E+01	MTCA B	1.00E+00	Region 9	1.00E-01	Region 9	3.87E-01
118-74-1	hexachlorobenzene	6.25E-01	6.40E+01	5.47E-02	1.28E+01	1.00E+00	5.47E-02	MTCA B	8.00E+01	CLARC 3.1	5.41E-02	CLARC 3.1	1.50E-02
120-82-1	trichlorobenzene;1,2,4-		8.00E+02		8.00E+01	7.00E+01	7.00E+01	MCL	1.66E+00	CLARC 3.1	5.82E-02	CLARC 3.1	2.98E+00
121-14-2	dinitrotoluene;2,4-		1.60E+02		3.20E+01		3.20E+01	MTCA B	9.55E-02	CLARC 3.1	3.80E-06	CLARC 3.1	1.89E-01
121-44-8	triethylamine						1.22E+01	Region 9	1.30E-02	Region 9	3.70E-03	Region 9	5.19E-02
122-39-4	diphenylamine		2.00E+03		4.00E+02		4.00E+02	MTCA B	0.00E+00	Default	0.00E+00	Default	1.60E+00
123-91-1	dioxane;1,4-	9.09E+01		7.95E+00			7.95E+00	MTCA B	0.00E+00	Default	0.00E+00	Default	3.18E-02
126-73-8	tributyl phosphate	1.85E+02	1.60E+04	1.62E+01	3.20+03		1.62+01	Calc.	1.89+01	ORNL	6.13E-06	ORNL	6.18E+00
126-98-7	methacrylonitrile		8.00E+00		1.60E+00		1.60E+00	MTCA B	5.10E-03	Region 9	3.60E-03	Region 9	6.57E-03
127-18-4	tetrachloroethylene (PCE; tetrachlorethene)	1.96E+01	8.00E+02	8.58E-01	8.00E+01	5.00E+00	8.58E-01	MTCA B	2.65E-01	CLARC 3.1	7.54E-01	CLARC 3.1	9.10E-03
129-00-0	pyrene		2.40E+03		4.80E+02		4.80E+02	MTCA B	6.80E+01	CLARC 3.1	4.51E-04	CLARC 3.1	6.55E+02
141-78-6	ethyl acetate		7.20E+04		1.44E+04		1.44E+04	MTCA B	3.60E-01	Region 9	5.70E-03	Region 9	1.61E+02

Table A-1. WAC 173-340 Method B Cleanup Levels for Chemicals in Order by Chemical Abstract Number[a].

		Soil Direct Contact		Groundwater Cleanup Levels		Drinking Water MCL[b] mg/L	Overall GW Cleanup Level		3-Phase Partitioning Model Equation for Soil Protection of GW				
CAS No.	Chemical Name	Carcinogen mg/kg	Non-carcinogen mg/kg	Carcinogen mg/L	Non-carcinogen mgL		mg/L	Source	Kd uL/g	Source	Henry's Law Constant	Source	Soil Conc. for GW Protection mg/kg
206-44-0	fluoranthene		3.20E+03		6.40E+02		6.40E+02	MTCA B	4.91E+01	CLARC 3.1	6.60E-04	CLARC 3.1	6.31E+02
309-00-2	aldrin	5.88E-02	2.40E+00	5.15E-03	4.80E-01		5.15E-03	MTCA B	4.87E+01	CLARC 3.1	6.97E-03	CLARC 3.1	5.04E-03
319-84-6	hexachlorocyclohexane; alpha (alpha-BHC)	1.59E-01		1.39E-02			1.39E-02	MTCA B	1.76E+00	CLARC 3.1	4.35E-04	CLARC 3.1	5.45E-04
319-85-7	hexachlorocyclohexane; beta- (beta-BHC)	5.56E-01		4.86E-02			4.86E-02	MTCA B	2.14E+00	CLARC 3.1	3.05E-05	CLARC 3.1	2.27E-03
319-86-8	hexachlorocyclohexane;delta- (delta-BHC)							MTCA B					
542-75-6	dichloropropene;1,3-	5.56E+00	2.40E+03	2.43E-01	2.40E+02		2.43E-01	MTCA B	2.70E-02	CLARC 3.1	7.26E-01	CLARC 3.1	1.41E-03
621-64-7	nitroso-di-n-propylamine;N-	1.43E-01		1.25E-02			1.25E-02	MTCA B	2.40E-02	CLARC 3.1	9.23E-05	CLARC 3.1	5.60E-05
1330-20-7	xylene		1.60E+05		1.60E+04	1.00E+04	1.00E+04	MCL	2.33E-01	CLARC 3.1	2.79E-01	CLARC 3.1	9.14E+01
7439-92-1	lead		2.50E+02			1.50E+01	1.50E+01	MCL	1.00E+04	CLARC 3.1	0.00E+00	CLARC 3.1	3.00E+03
7439-97-6	mercury		2.40E+01		4.80E+00	2.00E+00	2.00E+00	MCL	5.20E+01	CLARC 3.1	4.70E-01	CLARC 3.1	2.09E+00
7440-02-0	nickel, soluble salts[c]		1.60E+03		3.20E+02	1.00E+02	1.00E+02	MCL (WAC)	6.50E+01	CLARC 3.1	0.00E+00	CLARC 3.1	1.30E+02
7440-22-4	silver[c]		4.00E+02		8.00E+01	1.00E+02	8.00E+01	MTCA B	8.30E+00	CLARC 3.1	0.00E+00	CLARC 3.1	1.36E+01
7440-28-0	thallium, soluble salts		5.60E+00		1.12E+00	2.00E+00	1.12E+00	MTCA B	7.10E+01	CLARC 3.1	0.00E+00	CLARC 3.1	1.59E+00
7440-38-2	arsenic, inorganic	6.67E-01	2.40E+01	5.83E-02	4.80E+00	5.00E+00	5.83E-02	MTCA B	2.90E+01	CLARC 3.1	0.00E+00	CLARC 3.1	3.40E-02
7440-39-3	barium		5.60E+03		1.12E+03	2.00E+03	1.12E+03	MTCA B	4.10E+01	CLARC 3.1	0.00E+00	CLARC 3.1	9.23E+02
7440-41-7	beryllium		1.60E+02		3.20E+01	4.00E+00	4.00E+00	MCL	7.90E+02	CLARC 3.1	0.00E+00	CLARC 3.1	6.32E+01
7440-47-3	chromium (total)					1.00E+02	1.00E+02	MCL	1.00E+03	CLARC 3.1	0.00E+00	CLARC 3.1	2.00E+03
7440-62-2	vanadium		5.60E+02		1.12E+02		1.12E+02	MTCA B	1.00E+03	CLARC 3.1	0.00E+00	CLARC 3.1	2.24E+03
7782-49-2	selenium and compounds		4.00E+02		8.00E+01	5.00E+01	5.00E+01	MCL	5.00E+00	CLARC 3.1	0.00E+00	CLARC 3.1	5.20E+00
8001-35-2	toxaphene	9.09E-01		7.95E-02		5.00E+00	7.95E-02	MTCA B	9.58E+01	CLARC 3.1	2.46E-04	CLARC 3.1	1.53E-01
16065-83-1	chromium (III)		1.20E+05		2.40E+04		2.40E+04	MTCA B	1.00E+03	CLARC 3.1	0.00E+00	CLARC 3.1	2.00E+03
16984-48-8	fluoride					4.00E+03	4.00E+03	MCL	0.00E+00	Default	0.00E+00	Default	1.60E+01
18540-29-9	chromium(VI)		2.40E+02		4.80E+01		4.80E+01	MTCA B	1.90E+01	CLARC 3.1	0.00E+00	CLARC 3.1	1.84E+01

Notes:

GW – Ground Water

CAS – Chemical Abstract Service

(a) The lowest value of columns 3 and 4 (Soil Direct Contact) and column 14 (Soil Conc. for GW Protection mg/kg) is used in Tables 4-8 through 4-11.

(b) MCL is the drinking water maximum contaminant level from 40 CFR 141

(c) MCL for nickel, soluble salts, from WAC-173-201A "Water Quality Standards for Surface Waters of the State of Washington