INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part I: Background Information

Title: SST System Closure Plan; Appendix C: WMA C Closure Action Plan;Attah C-1:C-106 Component Closure Action Plan	Information Category: ☐ Abstract ☐ Journal Article ☐ Summary ☐ Internet ☐ Visual Aid ☐ Software ☐ Full Paper ☒ Report ☐ Other
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RPP-13774
Revision 2

Single-Shell Tank System Closure Plan

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

CH2MHILL
Hanford Group, Inc.
Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

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January 2004

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ATTACHMENT 1

RPP-13374, Revision 2, Single Shell Tank System Closure Plan

Consisting of 637 pages,
including coversheet

SINGLE-SHELL TANK SYSTEM CLOSURE PLAN

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PREFACE

This *Single-Shell Tank System Closure Plan* (Closure Plan) is being submitted to the State of Washington, Department of Ecology (Ecology), under the provisions of the *Resource Conservation and Recovery Act* (RCRA), the *Hazardous Waste Management Act* (HWMA), and applicable requirements thereunder. Consequently, this plan addresses hazardous and dangerous wastes only (as defined by these statutes and regulations) and does not address waste classification determinations and radioactive waste-specific closure actions that the U.S. Department of Energy (DOE) may take under the *Atomic Energy Act of 1954* (AEA). To the extent that this plan provides data or discussions about materials regulated under the AEA, that information is provided for informational purposes only.

Revision 0 of the Closure Plan was submitted on December 19, 2002, pursuant to Hanford Federal Facility Agreement (HFFACO) Milestones M-45-06A and M-45-05H. Revision 1 is being submitted in response to Revision 0 comments submitted by Ecology and subsequent comment resolution. Since submittal of Revision 0, the United States District Court, District of Idaho, issued a Judgment in *Natural Resources Defense Council, et al, v. Spencer Abraham, et al*, Civ. No. 01-0413-S-BLW (July 3, 2003) holding invalid certain portions of Order 435.1 relating to incidental waste. On August 27, 2003, DOE appealed this judgment to the U. S. Circuit Court of Appeals for the Ninth Circuit. This plan does not address the waste incidental to the reprocessing evaluation process described in DOE Order 435.1 and its accompanying Guidance and Manual. However, this plan does discuss other aspects of DOE O 435.1, DOE M 435.1-1, and DOE G 435.1-1.

The timing of certain actions contemplated in this plan, such as mixing grout with waste residuals during the closure process, may require decisions that must be made under the AEA and/or in accordance with other applicable requirements. Accordingly, even where apparently mandatory phrases such as “DOE will…” are used in this plan, the actions these phrases refer to are conditional based on the successful completion of required precursor actions which may be affected by the outcome of the litigation referred to above. No irreversible final closure actions will be taken for the RCRA purposes discussed in this plan unless and until they are shown to be consistent with radioactive waste management requirements DOE must address under the AEA, DOE Orders, and any other applicable requirements. As a specific example, grout will not be added to stabilize tank waste residuals for RCRA purposes unless and until DOE has determined that the waste characteristics of the residuals are suitable for addition of grout in the tank under applicable requirements and Ecology has issued the appropriate permits. In some cases, the paths forward to make the radioactive waste determinations are still under development and may impact schedule dates contemplated in this plan.

This *Single-Shell Tank System Closure Plan* describes the process for closure of 149 single-shell tanks at the Hanford Site, Washington, including the tanks themselves, ancillary equipment, contaminated soil, and contaminated groundwater, in accordance with the requirements of applicable laws and regulations. The document consists of three main sections that are arranged in a hierarchy. The highest-level document section (Tier 1) addresses closure topics and issues pertaining to the single-shell tank system. The mid-level section (Tier 2) addresses specific groupings of one or more single-shell tank farms known as waste management areas (WMAs). The lowest level document in the hierarchy (Tier 3) addresses closure activities for specific

components within a particular WMA. The following summarizes the general content of the Tier 1, 2, and 3 sections of the *Single-Shell Tank System Closure Plan*:

- Tier 1 – *Framework Plan for Single-Shell Tank System Closure:* Referred to as the Framework Plan, this section provides a general overview of the single-shell tank system, a general description of the administrative framework and process for closure, including key definitions, and a description of the process for incorporating Tier 2 and Tier 3 with soil and groundwater corrective actions, single-shell tank closure performance standards, an overall closure schedule, and an overall description of the certification and postclosure process.

- Tier 2 – *Waste Management Area Closure Action Plans*: This tier consists of appendices to the Tier 1 Framework Plan, one for each of the seven single-shell tank farm WMAs at Hanford. The seven WMAs include WMA A-AX; WMA B-BX-BY; WMA C; WMA S-SX; WMA T; WMA TX-TY; and WMA U. Each appendix provides a general description of the WMA, a description of the WMA groundwater monitoring effort, a general description of closure activities, a risk evaluation of the WMA, a closure schedule for the WMA, and a description of the certification and postclosure process.

- Tier 3 – *Component Closure Activity Plans* (for specific WMA components): This section of the *Single-Shell Tank System Closure Plan* consists of attachments to the Tier 2 appendices. Each attachment provides component closure actions for one or more components within each WMA, such as for individual single-shell tanks or pieces or groupings of ancillary equipment.

FRAMEWORK PLAN FOR
SINGLE-SHELL TANK SYSTEM CLOSURE

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LIST OF TERMS

AEA	Atomic Energy Act of 1954
BBI	best basis inventory
C-106	single-shell tank 241-C-106
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLUP	Comprehensive Land-Use Plan
DOE	U.S. Department of Energy
DST	double-shell tank
DQO	data quality objective
Ecology	Washington State Department of Ecology
EDE	effective dose equivalent
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERDF	Environmental Restoration Disposal Facility
ERPG	emergency response planning guidelines
FIR	field investigation report
FR	Federal Register
HFFACO	Hanford Federal Facility Agreement and Consent Order
HI	hazards index
HLW	high-level waste
HWMA	Hazardous Waste Management Act
ILCR	incremental lifetime cancer risk
ILAW	immobilized low activity waste
LAW	low activity waste
LCF	latent cancer fatality
LDMM	leak detection, monitoring, and mitigation
LDR	land disposal restriction
LLBG	low-level burial grounds
LLW	low-level waste
MCL	maximum contaminant level
MEI	maximally exposed individual
MTCA	Model Toxics Control Act
NEPA	National Environmental Policy Act of 1969
NPL	National Priorities List
OGT	overground transfer lines
PPS	past practice sluicing
RBE	relative biological effectiveness
RCRA	Resource Conservation and Recovery Act of 1976
RCW	Revised Code of Washington
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
ROD	Record of Decision

SAP	sampling and analysis plan
SEPA	Washington State Environmental Policy Act
SMWU	solid waste management unit
SST	single-shell tank
TEDE	total effective dose equivalent
TEEL	threshold emergency exposure limit
TRU	transuranic waste
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*
WIPP	Waste Isolation Pilot Plant
WMA	waste management area
WTP	waste treatment plant
X/Q	Atmospheric Dispersion Coefficents

KEY DEFINITIONS

Absorbed Dose. The amount of ionizing radiation energy absorbed by matter, including human tissue. The unit of absorbed dose is the rad or gray.

Activity. The rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the Becquerel (Bq).

Acute Exposure. The intake of a contaminant over a short period of time.

Acute Release. A release of radioactive or other hazardous material to the environment that occurs over a relatively short period of time (e.g., minutes or hours versus years).

Alpha Particle. A positively charged particle, consisting of two protons and two neutrons, that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

Americium. A transuranic element of the actinide series, having isotopes with mass numbers from 232 to 248 and half-lives from 55 seconds to 7,380 years. The longest-lived isotopes (241 and 243) are alpha-ray emitters used as radiation sources in research.

Ancillary Equipment. *Ancillary equipment* means any device including, but not limited to, such devices as piping, fittings, flanges, valves, and pumps, that is used to distribute, meter, or control the flow of dangerous waste from its point of generation to a storage or treatment tank(s), between dangerous waste storage and treatment tanks to a point of disposal onsite, or to a point of shipment for disposal offsite in accordance with WAC-173-303-040. Examples of ancillary equipment include components both internal and external to the tank including pipelines, conduit, pits, diversion boxes, ventilation systems, electrical/service connections, tank risers, pumps, measuring equipment (such as liquid level detection systems, thermocouples), shield plugs, and dip legs.

> **Diversion Boxes –** Diversion boxes are below-grade, reinforced concrete structures that provide a flexible method of directing liquid waste from a given point to any other given point. The top of the diversion box is a concrete cover block that usually extends above-grade. Cover blocks vary in thickness from box to box. Some diversion boxes are lined with steel. Transfer lines are connected in the diversion box by installing a jumper between the connecting nozzles. Jumpers can be either fixed or flexible. Jumper installation or removal can be a complex operation requiring a crane to remove and handle the cover block and to install the jumper.

> **Miscellaneous Structures –** These are special structures that support SST functions and do not fit into other listing categories.

> **Valve Pits –** Valve pits are reinforced concrete structures located below ground that contain valve and jumper assemblies to route the liquid waste through the connected pipelines within a tank farm. Heavy, thick, grade-level blocks cover each of the valve pits. When several tanks are undergoing simultaneous pumping to a single receiver tank, the flow is routed to a valve pit. In the valve pit, the transfer lines of the sending tank are

manifolded to the receiver tank line by means of a series of valves and jumper connections. Two- and three-way valves are built into each rigid jumper assembly to divert the flow in the required direction. Waste also can be routed through the valve pit with stainless steel flex jumpers. Each valve pit is equipped with a leak detection that is interlocked to shut down pumps. Each valve pit also has a flush line connected to a flush pit or a drain line connected to an underground storage tank.

Flush Pits – The components for pipeline back flushing and decontamination operations are located in flush pits. In-line backflow preventers protect the flush pit system from contamination from mixed waste backflowing into the flushing system.

Single-Shell Tank Pits – SST pits are located atop the tanks and provide a pathway into the tanks for pumps and monitoring equipment.

Waste Transfer Vaults – These vaults are shielded enclosures used to collect, clarify, and allow physical and chemical modification of contents before such contents are transferred elsewhere.

Transfer Lines – Piping used to transfer waste from one location to another.

Aquifer. A body of permeable rock, rock fragments, or soil through which groundwater moves.

Basalt. Dark to medium-dark colored, fine-grained rocks, volcanic in origin.

Best Basis Inventory (BBI). Best available estimate of chemical and radionuclide inventory of wastes in a SST.

Cancer. A subset of lesions of the disease neoplasia, which in turn, is defined as a heritably altered and relatively autonomous growth of tissue.

Carbon-14. A radioactive isotope of carbon with a mass number of 14 and half-life of 5,730 years (plus or minus 40 years). It occurs naturally as a result of reactions between atmospheric nitrogen and neutrons resulting from cosmic-ray collisions.

Carcinogen. An agent that causes or induces cancer.

Cascade. Tanks connected in series and placed at different elevations creating a downhill gradient for liquids to flow freely from one tank to another.

Cascade Line. Sloping transfer pipelines allowing fluid in one SST to flow by gravity to another SST.

CEDE. Committed effective dose equivalent. The sum of the products of absorbed dose from internally deposited radionuclides and appropriate factors to account for differences in biological effectiveness due to the quality of radiation and its distribution in the body of reference man over a fifty-year period. The units for this are the rem or siervert.

Cesium-137 (Cs-137). A gamma emitting radioisotope with a half-life of 30 years. Cesium-137 is generated during fission of uranium-235.

Cobalt-60 (Co-60). A radioactive isotope of a hard, brittle metallic element found associated with nickel, silver, lead, copper, and iron ores and resembling nickel and iron in appearance. This isotope has a mass number 60 and a half-life of 5.27 years. It is an intense gamma-ray emitter, used in radiotherapy, metallurgy, and materials testing.

Code of Federal Regulations (CFR). A documentation of the regulations of Federal executive departments and agencies.

Committed Dose Equivalent. Total dose equivalent accumulated in an organ or tissue in the 50 years following a single intake of radioactive materials into the body. The units for this are the rem or siervert.

Compliance Schedule. Timetable for completion of WMA and component closure activities when resource, safety, and technology constraints prevent closure from being practicably accomplished within normal regulatory time limits.

Component. *Component* is defined in WAC 173-303-040 as either the tank or ancillary equipment of a tank system. The meaning of the word 'component' is being expanded in this SST system closure plan to mean a subunit of a dangerous waste management unit associated with the SST system for which closure actions identified in the SST system closure plan may be implemented. For example, an individual tank, a piece or grouping of ancillary equipment, a contiguous area of contaminated soil, and a groundwater plume are each defined as components. Waste piles listed in Addendum 1 to this Framework Plan are also components. Figure 1-2 illustrates the components that make up the SST System.

Component Care Activities. Actions such as monitoring or inspection taken to ensure continued isolation of a component between completion of closure activities at the component and final closure.

Component Closure Activities. *Component closure activities* means actions on components taken in compliance with WAC 173-303-610 that contribute to closure of dangerous waste management units and to SST system final closure in accordance with WAC 173-303-610, HFFACO, and the Site-Wide Permit. By themselves, component closure activities do not constitute final closures. A component closure activity plan will address all of the requirements of a closure plan that are applicable to the specific closure activity described either directly or by reference to other applicable sections of the closure plan. It will demonstrate that closure activities can be achieved in compliance with closure requirements in WAC 173-303-610, including how the activities contribute to final closure and compliance with the closure performance standards of WAC 173-303. Evaluation of component closure activities will ordinarily include consideration of the risk associated with the end-state of the component in question and the risk associated with remaining WMA components.

After completion of closure activities of a component, DOE will take additional actions to care for the component until final closure. Component care activities may include actions such as monitoring or inspection of the component to ensure continued isolation.

Confined Aquifer. A subsurface water-bearing region that has defined, relatively impermeable upper and lower boundaries. The impermeable boundary is referred to as a confining layer.

Contaminant. Any gaseous, chemical or radioactive material that contaminates (pollutes) air, soil, or water. This term also refers to any hazardous substance that does not occur naturally or that occurs at levels greater than those naturally occurring in the surrounding environment (background).

Corrective Action. *Corrective action* means the process taken to address past and potential future tank system waste releases to the environment as necessary to protect human health and the environment including solid waste management units, areas of concern at the facility, and releases that have migrated beyond the facility boundary. This process will comply with Section 7.0 of the HFFACO, Condition II.Y of the Site-Wide Permit, WAC 173-303-646, and, for releases from a regulated unit after closure, WAC 173-303-645(1)(c). At the time of initial *SST System Closure Plan* submittal, contaminated soil at WMAs B/BX/BY, S/SX, and TX/TY is being investigated to assess the need for possible corrective actions.

Crib. An underground structure designed to receive liquid waste that can percolate into the soil directly or after traveling through a connected tile field. This is similar in concept to a septic tank system.

Criteria. General guidelines or principles from which more quantitative or definitive standards are prepared to regulate activities.

Curie (Ci). A unit of measurement of radioactivity or the quantity of a radionuclide, equal to 37 billion (3.7×10^{10}) disintegrations or nuclear transformations per second.

Dangerous Waste Management Unit/WMA. *Dangerous waste management unit* means a tank farm or group of tank farms that form a contiguous area. For the SST system, these groupings also are called WMAs. Seven SST WMAs have been identified in HFFACO Appendix B, as follows:

WMA A-AX:	241-A and AX tank farms
WMA B-BX-BY:	241-B, BX, and BY tank farms
WMA C:	241-C tank farm
WMA S-SX:	241-S and SX tank farms
WMA T:	241-T tank farm
WMA TX-TY:	241-TX and TY tank farms
WMA U:	241-U tank farm.

Dangerous Wastes. Those solid wastes designated in Washington Administrative Code as dangerous, or extremely dangerous, or mixed waste. In general, these include wastes classified as hazardous under the Federal Resource Conservation and Recovery Act (RCRA).

Data Quality Objective (DQO). A process implemented in accordance with the U.S. Environmental Protection Agency (EPA), *Guidance for the Data Quality Objectives Process QA/G4*. The DQO serves as a tool for determining type, quantity, and quality of data needed to support Agency decisions.

Decontamination. Those activities employed to reduce the levels of contamination in or on structures, equipment, materials, and personnel.

Disposal. The discharging, discarding, or abandoning of dangerous wastes or the treatment, decontamination, or recycling of such wastes once they have been discarded or abandoned. This includes the discharge of any dangerous wastes into or on any land, air, or water.

Dose Equivalent. Product of the absorbed dose, the quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the relative biological effectiveness (RBE) of different kinds of radiation on a common scale. The unit of dose equivalent is the rem or sievert. A millirem is one one-thousandth of a rem.

Downgradient. In hydrologic terms, this is used to designate downstream (e.g., direction of groundwater flow).

Drop Leg. Secondary drainage tube from a piece of equipment installed in a pit, such as a slurry distributor, which is routed to a riser.

Dry Well. Well, consisting of a steel cased borehole that terminates above groundwater, and is used for detecting and monitoring migration of tank waste constituents, mostly gamma-emitting radionuclides from a nearby source.

Dry Well Logging. Spectral or gross gamma-ray logging of dry wells to determine radionuclide levels of gamma-emitting radionuclides in soils and their variability with depth.

Effective Dose Equivalent (EDE). The sum over specified tissues of the products of the dose equivalent in a tissue and the weighting factor for that tissue. The units for this are rem or sievert.

ENRAF. Trade name for a liquid level measurement device.

Exhauster . Powered ventilation system for a storage tank

Exposure. Contact of an organism with a chemical or physical agent.

Field Investigation Report (FIR). Report stating findings and results of physical examination of a potentially contaminated area. The examination may include sampling and analysis or other characterization activities to develop information defining the existence, extent, and concentration of contaminants in the study area.

Final Closure of the SST System. *Final closure of the SST system* means the closure of all dangerous waste management units within the facility in accordance with all applicable closure requirements so that dangerous waste management activities are no longer conducted at the

facility. For the purposes of this *SST System Closure Plan* and contingent closure and postclosure plan, the SST system is regarded as the “facility.” Final closure of the SST system will occur after all components of the SST system have been added to the *SST System Closure Plan* portion of the Site-Wide Permit and all closure actions for WMAs and components have been completed.

At final closure, all closure activities will be completed and WMA/component postclosure care activities will be implemented. Postclosure care activities will include actions such as monitoring or inspection of the component to ensure continued isolation. **Groundwater.** Water occurring beneath the earth’s surface in the intervals between soil grains, in fractures, and in porous formations.

Groundwater Gradient. The slope of the water table that, together with permeability of the rock and soil material, determines the direction and rate of groundwater movement. Groundwater gradients include both a horizontal and vertical dimension.

Gross Alpha. The total alpha radiation from all sources (e.g., radioactive materials) reported in one measurement.

Gross Beta. The total beta radiation from all sources (e.g., radioactive materials) reported in one measurement.

Gross Gamma. The total gamma radiation emitted from all gamma-emitting radionuclide sources.

Grout. A thin mortar-like mixture, usually of Portland cement, water, sand and other agents.

Half-Life. Length of time in which a radioactive substance will lose one-half of its radioactivity by decay. Half-lives range from a fraction of a second to billions of years, and each radionuclide has a unique half-life.

Hazard Index (HI). The sum of more than one hazard quotient (i.e., ratio of a single substance exposure level over a specified time to a reference dose for that substance derived from a similar time) for multiple substances and/or mulitple exposure pathways. HI is unitless.

HFFACO. Hanford Federal Facility Agreement and Consent Order, also known as Tri-Party Agreement (TPA), an agreement signed in 1989 by the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology that identifies milestones for key environmental restoration and waste management actions.

Hydraulic Conductivity. A measurement that indicates the ease with which a porous medium permits fluids (e.g., water) to flow through it and the ease with which the fluid flows given its physical characteristics.

Incremental lifetime cancer risk (ILCR). A measure of the probability of developing cancer based on exposure to radionuclides or carcinogenic chemicals over a lifetime.

Institutional Controls. Methods to protect against intrusion on closed areas or waste sites. Controls include site access, restrictions, monitoring, and maintenance.

Iodine-129 (I-129). Beta emitting radioisotope with a half-life of 15,700,000 years. It is generated during the fission of uranium-235.

Isolation . Actions to control all potential pathways for liquid intrusion into a retrieved SST.

Isotope(s). Different forms of the same chemical element that are distinguished by different numbers of neutrons in the nucleus. A single element may have many isotopes. some may be radioactive and some may be nonradioactive (stable). For example, the three isotopes of hydrogen are protium, deuterium, and tritium.

Jumper. A prefabricated piping device used to make a temporary connection between two waste transfer nozzles, or between a nozzle and a piece of equipment (e.g., pump, sluicer). Usually remotely installed.

Latent Cancer Fatality (LCF). A delayed fatality resulting from cancer caused by an exposure to radionuclides or carcinogenic chemicals.

Lateral. Extension toward the side; extension horizontally rather than vertically. Also, part of a system of drywells extending horizontally beneath self-boiling SSTs in A and SX Tank Farms.

Maximally Exposed Individual (MEI). A hypothetical individual who, by virtue of location and living habits, could receive the highest dose from exposure to radionuclides or chemicals.

Mixed Waste. A dangerous, extremely hazardous, or acutely hazardous waste that contains both a nonradioactive hazardous component and, as defined by the 10 CFR 20.1003, source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.).

Monitoring. Periodic or continuous surveillance or testing to determine the level of compliance with regulatory requirements and pollutant levels in various media or in humans, animals, and other living things. This term also refers to actions intended to detect and evaluate radiological conditions.

Monitoring Wells. Boreholes drilled to groundwater to various depths, some of which are completed as Resource Protection Wells per WAC 173-160 where instruments are lowered or water samples are taken to determine what is present.

Neptunium. A silvery, metallic, naturally radioactive element with the atomic number 93. It is the first of the transuranium elements and has 13 isotopes with mass numbers from 228 to 243 and half-lives ranging from one minute to 2.14 million years. Neptunium is found in trace quantities in uranium ores and is produced synthetically by nuclear reactions.

Organics. Compounds that contain carbon.

Parameter. In statistics, a numerical quantity (such as the mean) that characterizes the distribution of a random variable or a population.

Permeability. The property or capacity of a porous rock, sediment, or soil for transmitting a fluid such as water.

pH. A measure of the relative acidity or alkalinity of a solution. A neutral solution has a pH of 7, acids have a pH of less than 7, and bases have a pH of greater than 7.

Pit. A covered, below grade facility, usually concrete, used for waste routing (with jumpers), servicing, monitoring, and for equipment installation and connection. Major pits directly connected to SSTs are heel pits, pump pits, salt well pits, and sluice pits. Farm support pits include diversion boxes and valve pits. Other pit facilities include condensate pump pits, condensate valve pits, condenser pits, flow meter pits, flush pits, heat exchanger pits, hold-up tank pits, instrument pits, jet pump pits, leak detection pits, receiver pits, salt tank pump pits, and service pits.

Plume. The distribution of contaminants a distance away from a point source in a medium like groundwater or air. It is a defined area of contamination.

Point of Compliance. A vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units.

Postclosure Actions. *Postclosure actions* mean actions taken after final closure of a waste management area (WMA) or closure of the entire SST system if contaminants are left in place that require postclosure monitoring and maintenance of the WMA or the entire SST system. Postclosure actions will include performing maintenance activities, and developing long-term monitoring systems. Postclosure actions will also include deed restriction and administrative controls, groundwater monitoring, and cover maintenance. Most postclosure actions will not be implemented until after a WMA has been closed and some may not be implemented until after the entire SST system has been closed. Postclosure actions will be detailed in WMA postclosure plans. Postclosure actions pertaining to the entire SST system will be detailed in the Framework Plan. The contingent postclosure plan for each WMA is contained in the WMA closure action plan and is discussed further in Section 1.4.1 of this framework plan.

Plutonium. A heavy, radioactive, anthropogenic metallic element consisting of several isotopes. One important isotope is plutonium-239, which is produced by irradiating uranium-238 with neutrons.

Postclosure Plan. Plan describing how the owner and/or operator will meet requirements placed on portions of the SST system closed as a landfill or landfills after closure to ensure their environmental safety for a number of years after closure.

Radionuclides. Nuclides that are radioactive. A nuclide is a species of atom with a specific mass, atomic number, and nuclear energy state. Standard practice for naming radionuclides is to

use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60 or Co-60).

Rem. Units for dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad mulitplied by the quality factor.

Record of Decision (ROD). An official document that states the decision on a selected action. A ROD is based on information, technical analysis, and consideration of any public comments and stated community concerns.

Retrieval. Removal of liquid and solid wastes from storage tanks.

Riser. Vertical access pipe from the dome of a single shell tank to the surface. Risers vary in diameter from ½ in to 42 in, and may terminate above grade on the floor of a pit.

Risk. Probability of an adverse outcome.

Single-Shell Tank (SST). Underground reinforced concrete containers with one carbon-steel liner, which are covered with 2 to 3 meters of earth. Capacity ranges from 209,175 liters to 3.79 million liters (55,000 gallons to 1 million gallons). The tanks have been used to store radioactive wastes.

SAC. System Assessment Capability. Computational tool for use in preparing the Hanford site-wide composite analysis of long-term impacts to groundwater.

Sampling Analysis Plan (SAP). A plan established for conducting sampling and analysis of waste to support regulatory requirements.

Seal Pot. A vapor trap. A liquid filled vertical loop of tubing designed to prevent the escape of vapors from a waste handling component.

Source Term. Quality and quantity of source material.

SST System Postclosure Permit. *SST postclosure permit* means the SST system portion of the Site-Wide Permit that will be issued after final closure of the SST system should removal or decontamination of all SST components not be achieved. Actions required to comply with the postclosure provisions of WAC 173-303-610 and -665(6) will be contained in this permit.

SST System. *SST system* means tanks and ancillary equipment, waste vaults, pits, diversion boxes, waste transfer lines, and associated devices as well as any soils and groundwater that have been contaminated by operation of the physical system. As such, the SST system contains multiple dangerous waste management units.

Stabilization. Removal of all flowable liquids from a SST, transfer of the liquids to a double shell tank, and solidification of any residual wastes.

Stratigraphy. The origin, composition, distribution, and succession of different layers or strata of rock or earth.

Strontium-90 (Sr-90). A heavy radioactive isotope of strontium that is hazardous because it can be assimilated by and deposited much like calcium in the bones of organisms. It is a beta emitter with a half-life of 28.6 years.

Technetium-99 (Tc-99). A pure beta emitting radioisotope with a half-life of 212,000 years. Technetium-99 is generated during the fission of uranium-235.

Topography. The general configuration of a land surface including its relief and its natural and manmade features.

TEDE. Total effective dose equivalent. The sum of the EDE due to external exposures and the CEDE due to internal exposures.

Thermocouple. Temperature measuring device consisting of two wires of different alloys welded at each end to form a circuit. One end is placed at the measurement location. The measured temperature is a function of the current flow.

Toxicological Health Effect. Adverse health effects which can span a range of biological effects including immediate versus delayed, reversible versus irreversible, and local versus systemic.

Transuranic Elements. Those elements having an atomic number greater than that of uranium (92).

Tritium. A radioactive isotope of hydrogen with one proton and two neutrons. This isotope has a half-life of 12.3 years.

Unconfined Aquifer. A subsurface water-bearing region that does not have impermeable confining boundary layers to restrict water movement. In an unconfined aquifer the water table forms the upper boundary.

Uranium. A naturally-occurring radioactive element found in natural ores with the atomic number 92 and an average atomic weight of approximately 238. The two principal natural isotopes are uranium-238 (99.3 percent of natural uranium) and uranium-235. Natural uranium also includes a minute amount of uranium-234.

Vadose Zone. The subsurface zone above the water table in which some water may be suspended within the pores of the soil and moving downward toward the water table or laterally toward a discharge point. Over time, contaminants in the vadose zone often migrate downward to the underlying aquifer.

Vault. A below grade concrete structure consisting of one or more cells usually containing tanks. Vaults were used as waste unloading points and for mixing and chemical adjustments prior to transfer to a storage tank.

Waste Analysis Plan (WAP). A plan that establishes the characterization frequency and analytical requirements to be satisfied for proper management of dangerous waste.

WMA Closure Actions. *WMA closure actions* mean actions that support and lead to final closure of a waste management area and ultimately to final closure of the SST system.

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1.0 INTRODUCTION

For more than four decades beginning in 1944, the Hanford Site produced defense materials, primarily from uranium fuels. The process of extracting defense materials from irradiated fuels generated radioactive and dangerous wastes. Between 1943 and 1964, 149 single-shell tanks (SST) were constructed in the 200 East and 200 West Areas to store waste underground. Figure 1-1 shows the location of the 200 Areas. Grouped into 12 tank farms, the tanks, piping, ancillary equipment, soil, and groundwater make up the SST system. These 12 tank farms have been geographically grouped into seven waste management areas (WMA), shown in Figure 1-2, for regulatory purposes. The seven WMAs are treatment and storage units under the Washington State Department of Ecology (Ecology) *Hazardous Waste Management Act of 1976* (HWMA), *Revised Code of Washington* (RCW) 70.105, and "Dangerous Waste Regulations" contained in *Washington Administrative Code* (WAC) 173-303.

From 1944, the U.S. Department of Energy (DOE) and its predecessors routed wastes from spent fuel reprocessing and other operations in the Hanford Site 200 East and 200 West Areas via buried lines to underground tanks for storage. The maximum quantity of waste in the SSTs was approximately 293,400,000 L (77,500,000 gal) in 1966. As of July 31, 2003, the SSTs contained 118,100,000 L (31,200,000 gal) of radioactive mixed waste.

DOE previously elected to manage the waste in Hanford's tanks as mixed (mixtures of dangerous waste and radiological contaminants) high-level waste (HLW) during the time the waste is stored in the tanks. For over a decade, the U.S. Nuclear Regulatory Commission and DOE have publicly acknowledged that not all waste stored in Hanford's tanks is mixed HLW. A number of these tanks contain mixed transuranic waste (TRU) from non-reprocessing sources and others may contain mixed low-level waste (LLW).

Over time, some waste has leaked from the SST system or has been discharged in an unplanned manner immediately adjacent to or within the SST farms. The maximum estimated volume of leaked waste from the SSTs is approximately 3,800,000 L (1,000,000 gal).

In 1989, Ecology, the U.S. Environmental Protection Agency (EPA), and DOE entered into an agreement and consent order, the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989, hereinafter referred to as HFFACO) as provided for under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), to clean up the Hanford Site. The agreement, an enforceable document, includes provisions for closing the SST system in accordance with the Washington State "Dangerous Waste Regulations" (WAC 173-303), primarily WAC 173-303-610. Proposals for closure actions under these provisions are to be submitted through this closure plan for regulatory approval and as a basis for modification of the dangerous waste portion of the *Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*, Rev. 7 (Ecology 2001, hereafter referred to as the Site-Wide Permit). Definitions used in this document can be found in a glossary beginning on page ix.

1 Figure 1-1. Location of 200 Areas.

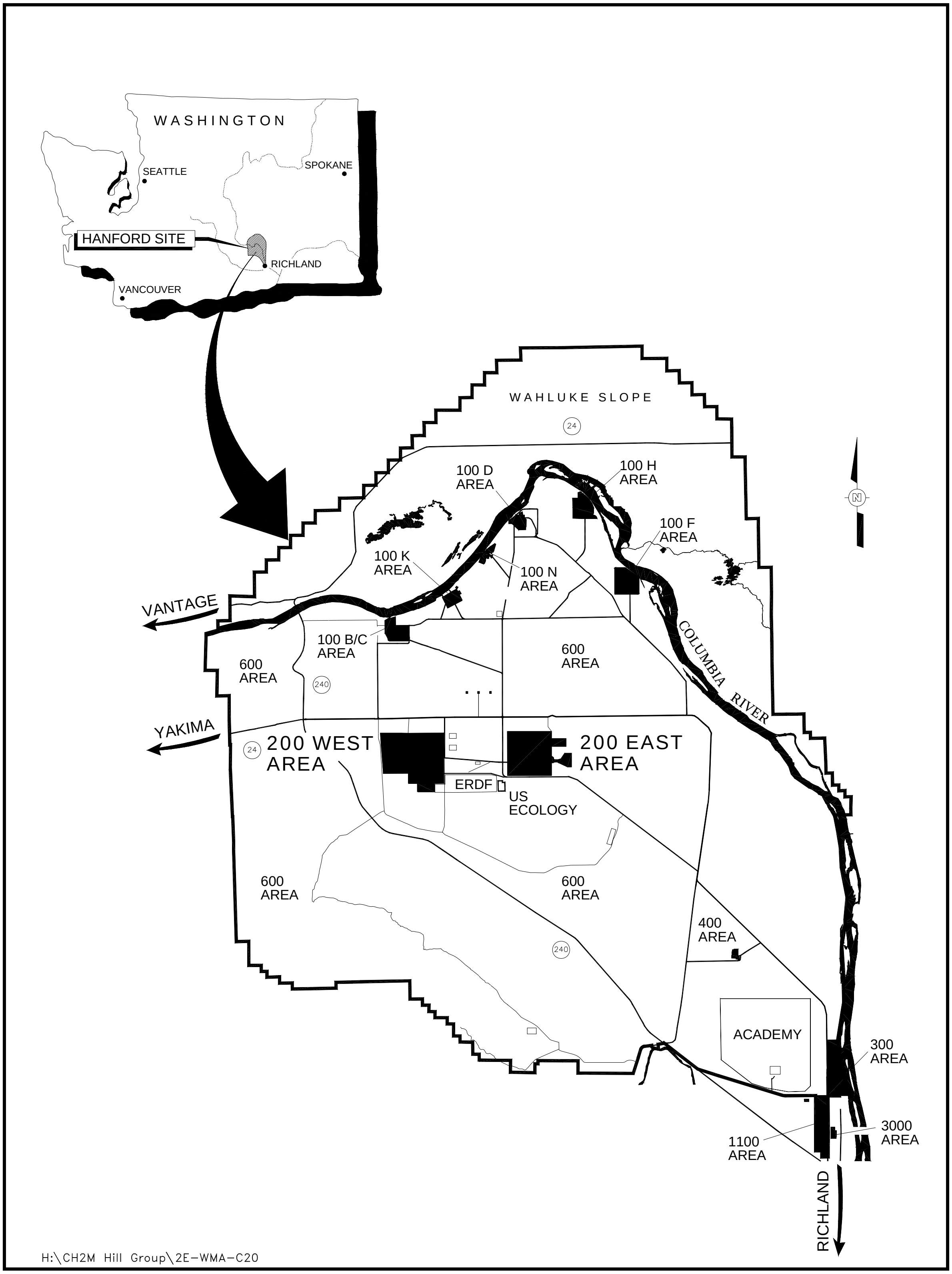
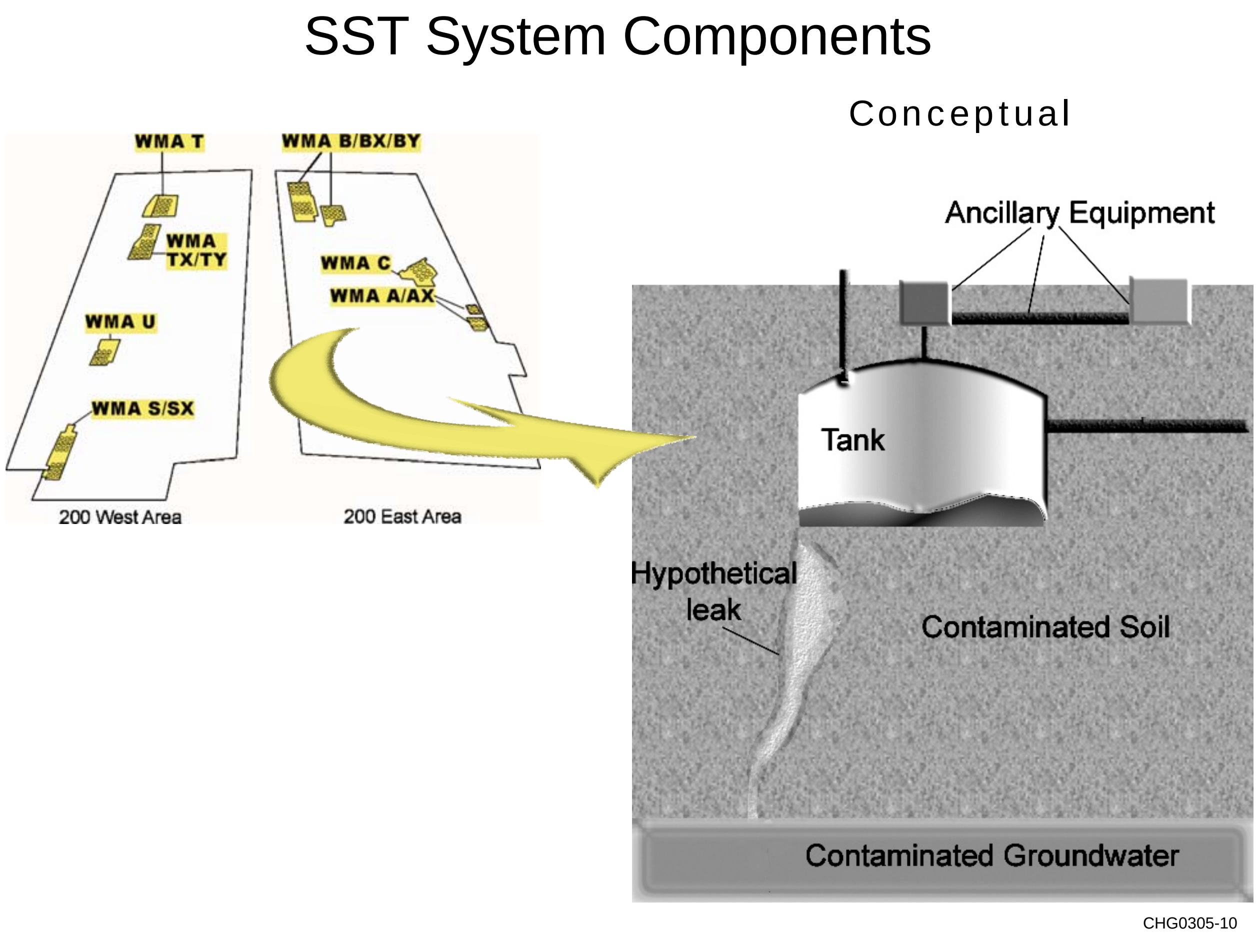


Figure 1-2. Location of Tank Farms.



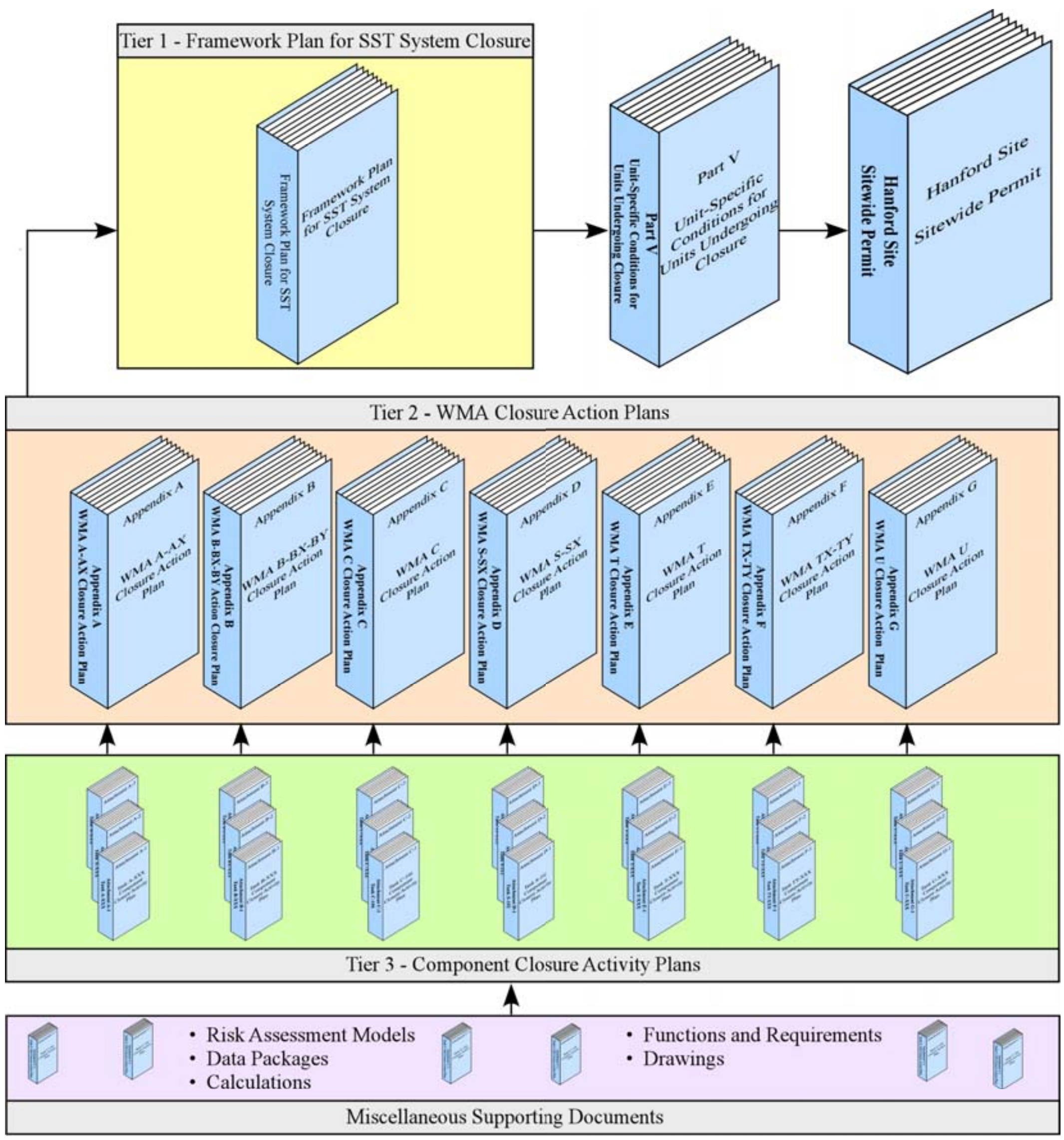
1.1 PURPOSE AND SCOPE

The purpose of this document is to comply with HFFACO Milestone M-45-06A and WAC 173-303 requirements. Milestone M-45-06A requires the submittal of this *SST System Closure Plan* along with submittal of a component closure activity plan for tank 241-C-106 (C-106), the first component closure activity for the SST system under WAC 173-303-610. The C-106 closure activity must also comply with WAC 173-303-640(8) for tank systems or WAC 173-303-665(6) for landfills.

The *SST System Closure Plan* describes the process for closing the entire SST system, including tanks, ancillary equipment, contaminated soil, and contaminated groundwater. Groundwater will be remediated and monitored as part of the tank closure effort, though certain final decisions regarding groundwater may be deferred until final closure of the Central Plateau or the Hanford Site.

The *SST System Closure Plan* consists of three tiers. The first, Tier 1, provides a general description of the system closure plans. Tier 1 is entitled *Framework Plan for Single-Shell Tank System Closure*, and is referred to as the Framework Plan. In Tier 1, the administrative framework and process, including key definitions, are described to identify how the SST system will be closed as a HWMA treatment, storage, and disposal (TSD) unit pursuant to implementing regulations of WAC 173-303. This first tier also contains a description of the process for incorporating WMA closure and postclosure action plans (second tier) and individual component closure activity plans (third tier) with vadose zone and groundwater corrective actions. It also describes how the SST system postclosure plans will be developed and integrated into Part V of the dangerous waste portion of the Site-Wide Permit. Figure 1-3 illustrates how these tiers are organized to make up the *SST System Closure Plan*.

Figure 1-3. *SST System Closure Plan* Document Structure.



1.1.1 Process for Incorporating Changes into the SST System Closure Plan

The *SST System Closure Plan* will be incorporated into Part V of the Site-Wide Permit as a separate chapter and will serve both as a skeletal structure for locating individual component and WMA closure action plan conditions and as the overall final closure document for the SST system. This section will describe the process for modifying the plan to incorporate component closure activity plans for individual SST components, component groups, and WMAs as closure actions proceed.

New information pertinent to making closure decisions will be provided as necessary in accordance with the WAC 173-303-830 permit modification process.

Final closure of the system will be accomplished on a WMA basis. No individual component closures will be deemed final until closure of the associated WMA. Each WMA closure must be preceded by a risk assessment. If risk associated with a final WMA closure is unacceptable, additional retrieval, stabilization, or isolation activities involving individual components for which closure actions have already taken place will be required to further mitigate risk.

When a component or group of components is scheduled for closure, closure activities will be developed in a plan specific to the component(s). DOE will not take component closure actions that hinder, interfere with, or in effect preclude final and/or adjacent component closure actions. The approved component closure activity plans will be attached to the appropriate WMA closure action plan, which will be an appendix to the Framework Plan. The addendums to the WMA closure action plan will be approved through a modification to Part V of the Site-Wide Permit.

The permit will require modification through time as closure actions and corrective actions are developed for the various WMAs and the components within the 200 Areas. Physical structures and contaminated media will be addressed to complete system closure actions. The SST system closure plan ultimately will describe closure actions and compliance with closure performance standards for the entire SST system. The SST system closure plan (including a contingent closure and postclosure plan) will be completed in accordance with WAC 173-303-610 (3). Section 3.0 of this plan discusses closure performance standards.

1.1.2 Process for Incorporating Corrective Actions on Soils into the SST System Closure Plan

Contaminated soil within the WMAs will undergo alternatives analyses within a *Resource Conservation and Recovery Act of 1976* (RCRA) Facility Investigation/Corrective Measures Study (RFI/CMS) approval document in accordance with the HFFACO. The RFI/CMS process is summarized in Section 3.2.1.5. All SST WMAs contain some contaminated soil. Decisions on appropriate soil cleanup or corrective actions will be determined through closure plans or the RFI/CMS process defined in condition II.Y of the Site-Wide Permit, WAC 173-303-645 and –(646, HFFACO Milestone M-45-55, and the RCRA corrective action process, as described in the HFFACO Action Plan.

Condition II of the Site-Wide Permit sets forth general conditions under which DOE must conduct operations, closures, and postclosure actions for RCRA dangerous waste management units on the Hanford site. Condition II.Y establishes specific conditions DOE must adhere to if it conducts corrective actions to protect human health and the environment from releases of dangerous waste and dangerous constituents from solid waste management units and areas of concern at the facility. Decisions regarding how the soil will be remediated through the HFFACO corrective action process will be documented in accordance with Condition II.Y of the Site-Wide Permit and applicable HFFACO milestones. The *SST System Closure Plan* will incorporate these decisions through reference to Part IV of the permit. Completion of corrective actions may be required to satisfy requirements of SST closure plans.

1.1.3 Process for Incorporating Corrective or Remedial Actions on Groundwater into the SST System Closure Plan

Contaminated groundwater will be remediated as part of an integrated Site-Wide Permit action in accordance with the HFFACO. Site-Wide Permit condition II.Y.3, DOE/RL-99-36, and HFFACO Milestones M-45-51, -52, -53, -54, and -55 address groundwater corrective actions. WMAs U, S-SX, B-BX-BY, T, and TX-TY are all under groundwater quality assessment programs.

Both federal and state requirements guide groundwater corrective action on the Central Plateau. Effectiveness and efficiency can be promoted if requirements of these programs can be met through a single, integrated groundwater program. While such a program has not to date been established for the Central Plateau, a collaborative effort among the regulatory agencies and DOE to support the objective of a single, integrated groundwater program is ongoing. As the collaborative process develops integrated remediation approaches applicable to SST closures, DOE will address and incorporate such measures into this *SST System Closure Plan.*

Groundwater actions associated with SSTs will be conducted within the integrated, long-term management approach set forth in HFFACO Milestone M-45 and the associated monitoring requirements of Milestone M-24. Condition II.Y.2 of the Site-Wide Permit recognizes and accepts work completed under the HFFACO for both CERCLA and RCRA past-practice units as potentially satisfying corrective action requirements. CERCLA Records of Decision (ROD) are accepted for integration within the closure process upon approval through incorporation into the Site-Wide Permit. At the Hanford Site, interim and final RODs to address RCRA solid waste management units (SWMU) and TSDs have been issued and are subject to the Hanford Site-Wide permitting process.

The SST System postclosure permit conditions in the Site-Wide Permit will be developed on a WMA-by-WMA basis. Postclosure care for each WMA will be performed to satisfy WAC-173-303-610(7) requirements. Postclosure care will be performed on a WMA-by-WMA basis and, at a minimum, will include: groundwater monitoring and reporting as required by WAC 173-303-645 and –665, and maintenance and monitoring of waste containment systems. Groundwater monitoring conducted during postclosure will be performed in accordance with performance

standards of WAC 173-303-645 and at WMA-specific points of compliance as defined by WAC 173-303-645(6).

1.1.4 Process for Developing SST System Postclosure Permit Conditions

DOE will prepare contingent postclosure plans that comply with the requirements of WAC 173-303-610 (8). The SST system postclosure permit conditions in the Site-Wide Permit may be developed on a WMA-by-WMA basis. It is anticipated that general administrative postclosure requirements such as access controls may be developed on a Central Plateau-wide basis. Nevertheless, the potential integration of WMA closures with other cleanup activities on the Central Plateau will not change SST system points of compliance, which remain the physical boundaries of subject WMAs, in accordance with the HWMA. Information on boundaries for specific WMAs will be provided in WMA closure action plans.

1.2 OVERVIEW OF SST FARMS

1.2.1 SST System Components

Part A of the *Dangerous Waste Permit Application, Single-Shell Tank System* (DOE/RL-88-21) defines the interim-status operating SST system for which closure actions will be developed within this *SST System Closure Plan*. Addendum 1 to this plan includes the most complete list currently available of components that comprise the SST system. This addendum, and any modifications to it based on new information, forms the basis for the identification of SST system components to be closed. DOE is undertaking a systematic effort to identify and define system components. The SST system includes 12 SST farms that contain a total of 149 mixed-waste storage tanks, ancillary equipment, active and miscellaneous underground storage tanks, miscellaneous facilities, and soils and groundwater that are contaminated from past leaks and unplanned releases. Most of the SST system is located within the WMAs; however, some components of the system, such as transfer lines and support facilities, are located outside WMA boundaries. The SST system contains:

- 133 100-series SSTs (2 to 3.8 million L [530,000 to 1 million gal] capacity)
- 16 200-series SSTs (200,000 L [55,000 gal] capacity)
- Waste transfer vaults and associated tanks
- Tanks pits, valve pits, and flush pits
- Pumps and valves
- 54 diversion boxes
- Numerous pipelines

- Above ground buildings and structures
- Other mechanical equipment.

The system piping is made of carbon steel and stainless steel. Much of the piping was placed underground to provide radiation shielding to protect workers. Transfer piping consisted of direct-buried pipe, steel-encased pipe, or single-wall pipe embedded in concrete encasements. The piping network allowed for transfer of waste between SSTs, tank farms, and various facilities that conducted waste management activities.

Cribs and other source features that have been identified either as RCRA past-practice sites, or as part of CERCLA operable units, are not included in the SST system unless otherwise noted in Addendum 1. The cleanup, closure, and/or remediation of such features are regulated under separate provisions of the HFFACO.

1.2.2 Composition of SST System Waste

SST waste is classified as mixed waste, meaning that it contains both radioactive and dangerous waste. The description of dangerous waste given in the RCRA Part A permit states that the dangerous waste information is based on a computer model and past process knowledge rather than on chemical analysis of waste. The SST waste has undergone chemical analysis for characterization to support the waste designation. The approach for waste characterization, in accordance with WAC 173-303, is described in the *Waste Characterization Plan for the Hanford Site Single-Shell Tanks* (WHC-EP-0210).

The bulk of the tank waste constituents are sodium hydroxide; sodium salts of nitrate, nitrite, carbonate, aluminate, oxalate, and phosphate; and hydrous oxides of aluminum, iron, and manganese. Radioactive components consist primarily of fission products (such as strontium-90 and cesium-137) and actinide elements (such as uranium, plutonium, thorium, and americium). There is a wide tank-to-tank variation in the waste type, volume, and inventory. A partial list of waste constituents stored in the SSTs is presented in Table 1-1.

Waste constituents of principal interest to closure planning are those contaminants that are persistent and mobile in the environment and therefore have the potential to impact groundwater over the long-term, or pose a threat to a receptor who inadvertently intrudes into the waste site. Specific constituent lists for SST WMA and component closure activities will be defined within individual component data quality objectives (DQOs) and other WMA characterization documents.

Engineering evaluations are underway to identify the potential waste volumes and characteristics associated with different types of ancillary equipment. Volumetric data is currently available for these facilities. Table 1-2 summarizes existing information. Table 1-3 provides supporting information on the transfer line system itself. Continuing efforts will provide additional information on waste characteristics associated with ancillary equipment.

Table 1-1. Partial Summary of SST Constituent Waste Inventories.
(2 pages)

Analyte	Unit	Quantity		Analyte	Unit	Quantity
Aluminum	kg	5.92 E+06		Europium-154	Ci	5.43 E+04
Bismuth	kg	5.54 E+05		Europium-155	Ci	3.09 E+04
Calcium	kg	2.16 E+05		Radium-226	Ci	6.80 E-02
Chloride	kg	4.93 E+05		Actinium-227	Ci	1.30 E+02
Chromium	kg	4.95 E+05		Radium-228	Ci	5.62 E+01
Fluroide	kg	7.76 E+05		Radium-229	Ci	2.05 E+00
Iron	kg	1.06 E+06		Protactinium-231	Ci	2.70 E+02
Mercury	kg	1.68 E+03		Uranium-232	Ci	3.88 E+01
Potassium	kg	2.40 E+05		Uranium-233	Ci	4.93 E+02
Lanthanum	kg	3.14 E+04		Uranium-234	Ci	1.93 E+02
Manganese	kg	1.39 E+05		Uranium-235	Ci	8.09 E+00
Sodium	kg	3.32 E+07		Uranium-236	Ci	4.03 E+00
Nickel	kg	1.05 E+05		Neptunium-237	Ci	5.89 E+01
Nitrite	kg	5.84 E+06		Plutonium-238	Ci	3.05 E+03
Nitrate	kg	4.39 E+07		Uranium-238	Ci	1.81 E+02
Lead	kg	7.16 E+04		Plutonium-239	Ci	5.74 E+04
Phosphate	kg	4.92 E+06		Plutonium-240	Ci	9.42 E+03
Silicon	kg	7.76 E+05		Americium-241	Ci	5.31 E+04
Sulfate	kg	3.10 E+06		Plutonium-241	Ci	7.53 E+04
Strontium	kg	3.88 E+04		Curium-242	Ci	7.20 E+01
Total Inorganic Carbon as Carbonate	kg	6.63 E+06		Plutonium-242	Ci	5.30 E-01
Total Organic Carbon	kg	6.65 E+05		Americium-243	Ci	1.84 E+00
Total Uranium	kg	5.42 E+05		Curium-243	Ci	4.18 E+00
Zirconium	kg	1.23 E+05		Curium-244	Ci	7.92 E+01
Ruthenium-106	Ci	3.60 E-02		Hydrogen	Ci	8.93 E+03
Cadmium-113m	Ci	8.49 E+03		Nickel-59	Ci	1.01 E+03
Antimony-125	Ci	4.27 E+03		Cobalt-60	Ci	4.07 E+03
Tin-126	Ci	3.69 E+02		Nickel-59	Ci	9.38 E+04
Iodine-129	Ci	2.99 E+01		Selenium-79	Ci	7.29 E+01
Cesium-134	Ci	2.47 E+01		Strontium-90	Ci	3.43 E+07

Table 1-1. Partial Summary of SST Constituent Waste Inventories.
(2 pages)

Analyte	Unit	Quantity		Analyte	Unit	Quantity
Cesium-137	Ci	1.61 E+07		Yttrium-90	Ci	3.43 E+07
Barium-137m	Ci	1.52 E+07		Niobium-93m	Ci	2.59 E+03
Carbon-14	Ci	2.59 E+03		Zirconium-93	Ci	3.13 E+03
Samarium-151	Ci	2.32 E+06		Technetium-99	Ci	1.55 E+04
Europium-152	Ci	6.79 E+02		—	—	—

Source: *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-shell Tanks at the Hanford Site, Richland, WA (Inventory and Source Term Data Package)* (DOE/ORP-2003-02).

Note: Inventories reflect tank contents as of July 1, 2002.

Table 1-2. SST System Ancillary Waste Volume Inventories

Component Type	Liquid Vol (gal)	Solid Vol (gal)	Total Vol (gal)
IMUSTs	11,000*	63,000*	74,000*
Vault Tanks Cells	 45,000* 16,000*	 50,000* 15,000*	 95,000* 31,000*
Evaporator tanks and vessels	9,000*	0	9,000*
Transfer Piping	0	1,200	1,200
Pits	0	450	450
Tank Ventilation	0	0	0
Totals	**81,000***	**130,000***	**211,000***

* Volumes rounded to nearest 1000 gal.

Reference: RPP- 11095, Rev.0; *SST Engineering Compliance and Assessment Summary Report*

Table 1-3. Characteristics of SST Transfer Line System.

Transfer Line System Characteristics	Data
Transfer lines associated solely with the SST system (estimated)	1400
Diameter of transfer lines associated solely with the SST system	Range: 2 to 6 inches Average: 3 inches
Length of transfer lines associated solely with the SST system (estimated)	506,880 feet, (96 miles)
Number of known plugged transfer lines	5*

*Hydraulic profiles for the piping system (Drawings H-2-44502 and H-2-44512) show that lines are generally sloped to allow self-drainage exist in a pipe. If low points exist in a pipe, they typically have low-point drains that feed into tanks.

Reference- RPP- 11095, Rev.0 (primary information source for RPP-11095: *H-14-104175 & H-14-104176 Routing Boards*)

1.3 INTEGRATED CENTRAL PLATEAU AND SST SYSTEM CLOSURE

Closure of the SST system will take place within the same time frame as other planned Central Plateau closure actions. These other closure actions involve facilities and operable units currently regulated under both RCRA and CERCLA. Certain facilities and operable units listed for closure are geographically adjacent to parts of the SST system. Closure of these facilities and units may require activities substantively similar to SST closure actions. As closure actions proceed for the SST system, achievement of protectiveness pursuant to CERCLA for all hazardous substances must be considered.

The existence of proximate facilities scheduled for closure in the same general time frame as the SST system and involving similar closure activities creates a potential to accelerate cleanup, increase efficiency, and avoid both duplicative effort and regulatory conflicts by integrating closure actions, where feasible. While SST system closure must ultimately satisfy RCRA and HWMA requirements, closure actions accomplished in accordance with CERCLA can address RCRA and HWMA requirements, including closure performance standards in WAC 173-303-610(2), and Site-Wide Permit standard condition II.Y.2.

Any closure action on SST system components or portions of WMAs that exist outside of the WMA boundary/fenceline must comply with all requirements/approvals set forth in this closure plan, addendums/attachments to this plan, and as specified in the Site-Wide Permit.

DOE, Ecology, and EPA are presently identifying and evaluating opportunities for integration of closure and postclosure activities on the Central Plateau through the Central Plateau regional strategy effort. As specific opportunities are defined for integrating actions involving the SST system, DOE will incorporate corresponding proposals into future modifications of this plan and into subsequently submitted WMA closure action plans and component closure activity plans.

The SST system includes seven WMAs. Closure of the SST system requires closing the WMAs and conducting closure activities for individual system components within the WMAs. DOE

will develop WMA closure action plans and component closure activity plans, or alternate decision processes such as corrective measures studies or CERCLA remedial investigation/ feasibility study, upon approval through incorporation into the Site-Wide Permit, to describe how the components or groups of components will be disconnected, dismantled, decontaminated, removed, and/or stabilized.

Figure 1-4 presents a relative timeline for major WMA closure activities. Together, these figures represent the relative timing for completion of closure and postclosure activities for the SST system. Key closure dates have been developed and are described in HFFACO Milestone M-45.

This timeline and major closure activities have been developed based upon an assumption that the WMAs would be landfill closed, if it is demonstrated that clean closure cannot be practicably achieved. The actual closure mode has yet to be determined. The contingent landfill requirements are contained in WAC 173-303-640(8). The first three columns in the timeline represent intervals during which closure activities occur. The fourth column represents Hanford's long-term stewardship program. WMA closure action plans contain detailed discussions of timeline elements.

Column one of the timeline generally includes performance of major component closure activities. The relative starting points for ancillary equipment, soil, and groundwater activities depict a logical order for these activities. Relative starting points for various closure activities may differ between WMAs. For instance, soil characterization activities for WMA S-SX have been initiated as part of the RFI/CMS process. Groundwater component closure activities are shown to extend beyond the dotted vertical line because programs outside the SST RCRA closure program (CERCLA operable unit corrective actions and the Central Plateau closure strategies) largely determine the completion of this component activity.

The second column represents the period during which WMA closure activities are completed. This period begins when closure activities on all SSTs, ancillary equipment, and soils in the WMA have been completed in accordance with WAC 173-303-610(2), and groundwater has been characterized and appropriately-dispositioned. Completion of the WMA closure action occurs when the final remedy (such as an engineered surface barrier) for the WMA has been implemented.

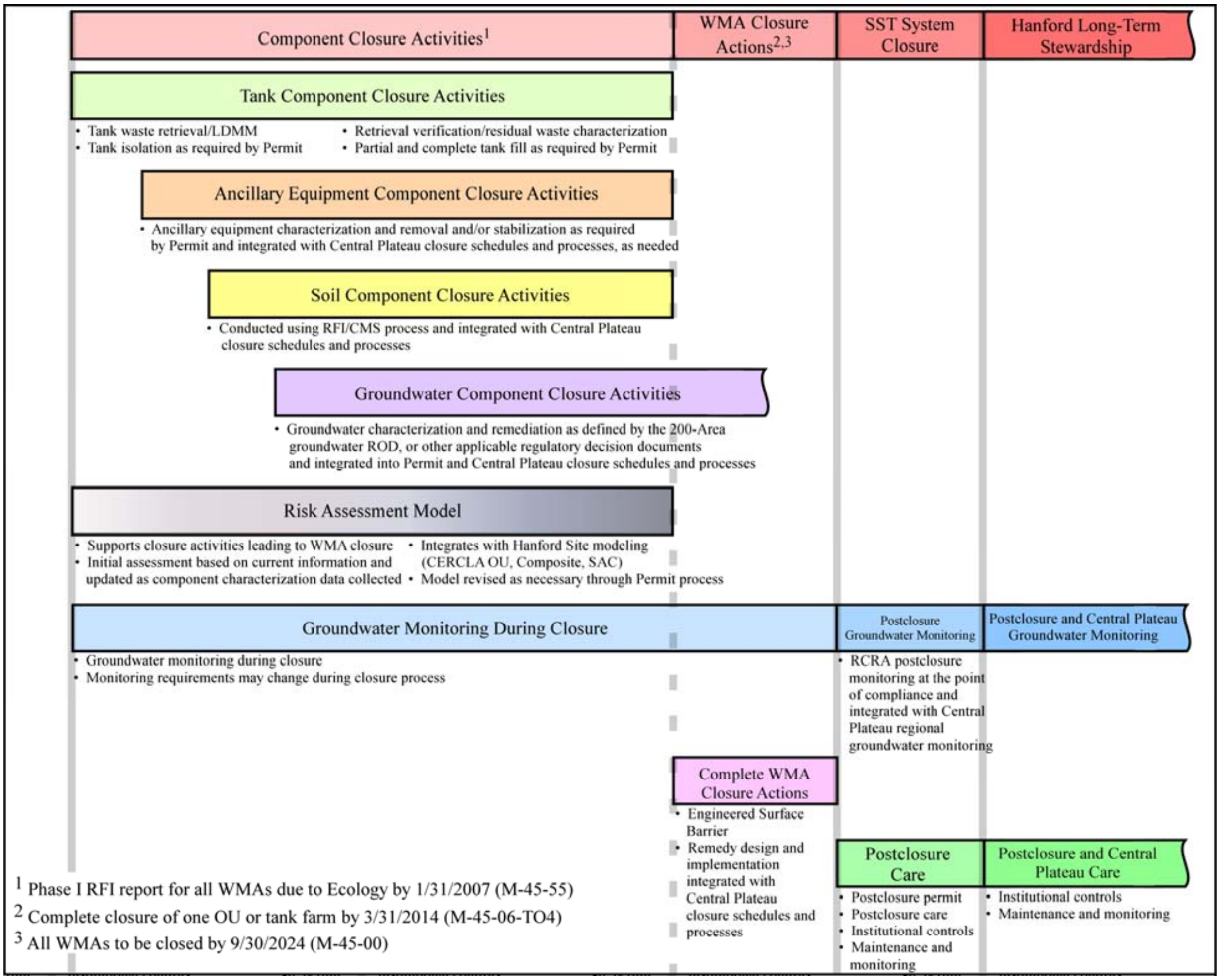
The third column represents the period during which WMA post-closure activities are performed, if required. During this period, other WMA closure actions within the SST system are ongoing. The period ends when the final WMA closure action is completed. Where possible, information obtained from WMA-specific groundwater monitoring will be integrated with Central Plateau regional groundwater monitoring. WMA-specific postclosure monitoring required by WAC 173-303-645 and –665 will be performed.

The fourth column depicts the integration of SST post-closure activities with the Hanford long-term stewardship program. Since the SST WMAs are located in the 200 Areas, the post-closure activities will be integrated as specified in the Site-Wide Permit with the Central Plateau closure strategies currently under development by Ecology, EPA, and DOE. These integration activities include:

- A relative timeline for general SST system closure and postclosure activities,
- A relative timeline for closure and postclosure actions involving other Central Plateau units and facilities, and
- Elements of a strategy and process for integrating SST closure and postclosure actions with the actions anticipated for other units and facilities.

The figure presents information in three rows from left to right, moving from the present period through completion of closure actions and into the period of postclosure activities. The figure depicts a strategy and process for integrating SST system closure and postclosure actions (bottom row) with similar actions planned for closure of other Central Plateau units and facilities (top row). Integration (middle row) would start with application of the *National Environmental Policy Act of 1969* (NEPA) and *Washington State Environmental Policy Act* (SEPA) processes to planned activities. Identification of closure elements as candidates for integration on the basis of characteristics such as geographic proximity and commonality of constituent wastes would be followed by evaluation against planning and strategy documents and regulatory process requirements. Decision documents and processes drawn from existing procedures would be used to define integrated activities and address the full range of applicable requirements. DOE would then take specific steps designed on an integrated basis to complete closure and postclosure activities and fulfill all requirements.

Figure 1-4. Relative Timeline of Major Activities for Closure of a Typical WMA.



1.4 REGULATORY BACKGROUND

The regulatory framework for SST system closure is complex, including requirements regarding planning and protection of human health and the environment. Closure activities are driven by requirements of the HFFACO, the *Atomic Energy Act of 1954* (AEA), as amended, and RCRA. The primary regulatory driver for this RCRA/dangerous waste SST closure plan is WAC 173-303. The radioactive portion of mixed waste is regulated under the AEA; the nonradioactive dangerous portion of mixed waste is regulated under RCRA, the HWMA, and WAC 173-303. Both radioactive and dangerous waste constituents will be considered and dealt with during the closure process (see Section 1.4.2 below).

Where information regarding treatment, management, and disposal of the radioactive source, byproduct material, and/or special nuclear components of mixed waste (as defined by the AEA)

has been incorporated into this plan, it is not incorporated for the purpose of regulating such components under the authority of the Site-Wide Permit and the HWMA. To the extent that RCRA/HWMA requirements are inconsistent with requirements under the AEA, Section 1006 of RCRA provides that the inconsistent RCRA requirements yield to those of the AEA.

As part of implementing the AEA, RCRA, and/or other regulatory requirements, either DOE or Ecology will identify potential conflicts in requirements and both parties will discuss the source of the conflict and the potential solution for the conflict through the closure process.

WAC 173-303-610 sets forth state requirements for closure and postclosure of dangerous waste TSD facilities such as the SST system. WAC 173-303-640 and 40 *Code of Federal Regulations (*CFR) 265.196 and 197 set forth state requirements for closure and postclosure care of tank systems incorporating by reference standards contained in WAC 173-340, the Model Toxics Control Act (MTCA) cleanup regulation.

DOE will attempt to achieve removal or decontamination standards on all SST system tanks and ancillary equipment; however, this may not be an achievable goal. In that event, DOE will demonstrate why it cannot practicably remove contaminants to these standards and subject to Ecology approval, will then close the WMA, and perform closure and postclosure care in accordance with landfill closure and postclosure requirements set forth in WAC 173-303-665(6) and with landfill requirements contained in WAC 173-303-610.

DOE proposes to close the Hanford Site 200 Areas SST system by 2028 in a manner compliant with the requirements of WAC 173-303-610 (2) and the HFFACO Milestone M-45. The SST system includes tanks, ancillary equipment, and associated contaminated soils and groundwater.

1.4.1 RCRA/HWMA Applicability

The HFFACO designates Ecology as the lead agency for SST closure. Ecology regulates the SSTs as hazardous waste storage and treatment units under the HWMA and WAC 173-303, which implement RCRA. The SSTs must be closed in accordance with applicable closure and postclosure portions of WAC 173-303-610. The HFFACO (Action Plan, Section 6.3.2) requires that TSD units close under final status closure requirements (WAC 173-303-610) irrespective of permit status. Thus, SSTs will be closed under final status standards. WAC 173-303-610 provides general closure requirements and references specific closure requirements for individual types of waste units. For tank systems such as the SST system, the specific requirements are provided in WAC 173-303-640(8).

WAC 173-303-610(2) and WAC 173-303-640(8) set out the fundamental closure performance standards applicable to closure of the SST system. Section 3.0 of this plan presents the exact language of those requirements, as well as other key federal and state requirements, and detailed information on the steps DOE will take to meet the requirements and ultimately to accomplish closure of the system.

It is not known whether removal and decontamination to clean closure standards in accordance with WAC 173-303-610(2)(b) can be achieved for SSTs; consequently, the SST system closure

plan includes both clean and contingent landfill options for closure allowed under WAC 173-303-640(8) and WAC 173-303-665(6). Under WAC 173-303-610 requirements, closure options include clean closure and landfill closure, where appropriate.

The baseline HWMA requirement for clean closure, as stated in WAC 173-303-610(2)(b)[1], is to remove or decontaminate tank waste residues and structures to the extent required by the closure performance standard (WAC 173-303-610(2)(a)(ii) for controlling, minimizing, or eliminating postclosure escape of dangerous waste constituents to the environment). Ecology clean closure guidance (Ecology F-HTWR-94-144) states that clean closure decontamination levels for metal tanks are generally considered to be satisfied upon meeting the performance treatment standards contained in 40 CFR 268.45, Table 1 (debris rule treatment standards). Clean closure of environmental media (such as soils and groundwater) that have been contaminated by SST system operations will require that SST dangerous waste constituents not exceed the cleanup levels stated in WAC 173-303-610(2)(b), which are primarily the numeric cleanup levels calculated according to WAC 173-340.

DOE will attempt to remove or decontaminate all waste residues from contaminated SST system components, contaminated soils, and structures and equipment, and evaluate removal and decontamination in accordance with WAC 173-303-610 and -640 requirements. DOE anticipates difficulty in accomplishing clean closure because of the extent and depth of contamination and because of potential worker safety issues. Therefore, DOE anticipates that a combination of landfill closure and clean closures may be used to achieve system closure.

Consequently, in accordance with WAC 173-303-640(8)(c), closure action plans for WMAs and component closure activity plans will be submitted both as clean closure plans and as contingent[2] landfill closure and postclosure plans. For closure as a land disposal unit, a contingent closure plan is required for each WMA that addresses design and placement of a barrier system and in addition, a contingent postclosure plan is required for each WMA that addresses maintenance and inspection activities, groundwater monitoring requirements, and final corrective actions implemented under the WMA closure action plan.

1.4.2 HFFACO Applicability

The HFFACO, signed by DOE, Ecology, and EPA on May 15, 1989, is an enforceable document that requires DOE to clean up and dispose of radioactive and hazardous waste at the Hanford Site and close facilities that have been used to generate, treat, store, or dispose of such waste. The HFFACO establishes work requirements (milestones), methods for resolving problems, and an action plan for cleanup that addresses priority activities.

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[1] WAC 173-303-610(2)(b) references WAC 173-303-640(8) closure and post-closure care for tanks.

[2] WAC 173-303-640(8)(c) requires that a tank system owner or operator whose tank system does not have secondary containment must submit both a clean closure plan and a contingent landfill closure and postclosure plan (i.e., a landfill closure plan that will be used if clean closure cannot be accomplished).

The HFFACO also recognizes the applicability of RCRA and its amendments to the Hanford Site. The HFFACO incorporates a regulatory strategy that specifically places SST activities, including waste retrieval, facility cleanup, remediation, waste disposal, and closure under the HWMA. Ecology serves as lead regulatory agency for all provisions of the HWMA, including those that have not been authorized pursuant to Section 3006 of RCRA. DOE is required to comply with the HFFACO requirements that establish terms for closing tank farms at the Hanford Site.

In its work requirements, specifically in the text of Milestone M-45-00, the HFFACO links tank waste retrieval and closure. In addition, groundwater contaminated by releases from the SSTs is considered part of the SST TSD facility for closure purposes. SST system closure requires addressing groundwater contaminated by releases from the SSTs.

The current planning for SST system closure is based on developing closure plans and closing the tank farms pursuant to WAC 173-303-610 and -640. As such, processes for completing closure activities typically will be defined in accordance with these regulations. Approval of WMA action plans and component closure activity plans will be accomplished through modification of the Site-Wide Permit. Potentially, implementation of certain conditions could require modifications to the HFFACO.

Section 6.3 of the HFFACO action plan provides in part:

> *The TSD units containing mixed waste will normally be closed with consideration of all hazardous substances, which includes radioactive constituents.*

The SST system closure plan will address all waste constituents that could potentially affect human health and/or the environment.

Section 6.3.2 of the HFFACO action plan provides in part:

> *The process to close any unit as a land disposal unit will be carried out in accordance with all applicable requirements described at 173-303 WAC. In order to avoid duplication under CERCLA for mixed waste, the radionuclide component of the waste will be addressed as part of the closure action.*

Article I of the HFFACO provides in part:

> *As stated in Section 1006 of RCRA, nothing in this Agreement shall be construed to require DOE to take any action pursuant to RCRA which is inconsistent with the requirements of the Atomic Energy Act of 1954, as amended.*

1.4.3 Applicability of the *Atomic Energy Act of 1954*

The AEA, as amended, provides fundamental jurisdictional authority to DOE and the U.S. Nuclear Regulatory Commission over governmental and commercial use of nuclear materials. The AEA ensures proper management, production, possession, and use of radioactive materials. Where information regarding treatment, management, and disposal of the radioactive source, byproduct material, and/or special nuclear portions of mixed waste (as defined by the AEA, as

amended) has been incorporated into this plan, it is not incorporated for the purpose of regulating such portions under Ecology's authority pursuant to RCRA or the HWMA.

1.4.4 *National Environmental Policy Act* and *Washington State Environmental Policy Act* Applicability

In the Tank Waste Remediation System environmental impact statement (EIS) ROD (62 *Federal Register* [FR] 8693, February 26, 1997), DOE committed to complete appropriate NEPA analysis to support decisions regarding remediation of Hanford Site tanks, ancillary equipment, and contaminated soils. Further NEPA analysis is required before formally selecting and implementing an overall closure path for the SST farms. DOE anticipates completion of an EIS analyzing SST system-wide closure issues in calendar year 2004. Ecology is a cooperating agency for this EIS. Data gathering activities, including demonstration projects, are ongoing to provide information for future NEPA analyses that will allow decision-makers to select specific closure methodologies. If needed, DOE will prepare additional NEPA analyses to consider environmental effects of any future actions not completely analyzed in the EIS.

The *Washington State Environmental Policy Act* (SEPA, RCW 43.21C) is intended to ensure that environmental values are considered during decision-making by state and local agencies. SEPA requires decision-making agencies like Ecology to conduct an evaluation of proposals in accordance with WAC 197-11 to determine the potential significance of impacts to the environment and public health. In lieu of preparing a separate SEPA EIS, the state may adopt a NEPA EIS if certain requirements in WAC 197-11-610(3) are met, or cooperate with a federal agency that is preparing an EIS. As a cooperating agency, the State may participate in a range of activities associated with the preparation of an EIS including co-authoring a document, providing input to development of alternatives, or similar actions[3]. DOE will complete and submit an environmental checklist for any proposed system closure action requiring SEPA review.

Both NEPA and SEPA apply to courses of action and decisions on closure of the SST system. The NEPA process provides essential environmental information to aid DOE in determining its course of action for closure. SEPA provides similar information to Ecology for that agency's decisions on approving or conditioning permits.

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[3] WAC 197-11-610. A NEPA document (Environmental Assessment or Environmental Impact Statement) may be adopted or incorporated by reference.

2.0 GROUNDWATER MONITORING

Groundwater is one of several media monitored for compliance with DOE Orders by the Hanford groundwater monitoring project (PNNL-13080). Groundwater in the vicinity of the SSTs is monitored to determine whether activities associated with the SSTs have affected groundwater quality in the uppermost aquifer.

DOE monitors groundwater at the Hanford Site to fulfill a variety of state and federal regulations, including the AEA, RCRA, CERCLA, and WAC regulations. The facility environmental monitoring program routinely monitors groundwater near facilities that have potential to discharge, or have discharged, stored, or disposed of radioactive or hazardous contaminants.

Groundwater monitoring requirements for all units subject to RCRA operating, closure/ postclosure, or corrective action requirements will be included in the Hanford Site-Wide Permit pursuant to WAC 173-303-645 (for land-based regulated units) and WAC 173-303-646 (for RCRA past-practice units). To date, permit conditions have not been developed for all RCRA land-based regulated units listed in Appendix B or RCRA past-practice units listed in Appendix C of the HFFACO. As operating closure/postclosure and corrective action conditions are developed pursuant to the HFFACO Milestone M-20 schedule, however, associated groundwater monitoring requirements will be based on satisfaction of the cited regulatory requirements. It is anticipated that each SST WMA will remain consistent with interim-status standards for groundwater monitoring, and each WMA will shift into postclosure monitoring when closure actions are completed. WMA postclosure monitoring requirements will be developed on a WMA-by-WMA basis and will be integrated with the requirements for regional past-practice, operating, and closure/postclosure units.

Present WMA groundwater monitoring (pre-WMA closure) is based on RCRA/HWMA interim-status standards that are described in 40 CFR 265 Subpart F and incorporated by reference into WAC 173-303, as well as on HFFACO Milestones, particularly the M-24-00 series. 40 CFR 265.91 provides the basic physical monitoring requirement.

Site-specific characteristics determine monitoring needs. Where appropriate, future groundwater monitoring programs will be designed and implemented consistent with WAC 173-303-645. For sites with multiple sources of groundwater pollutants, extensive groundwater pollution, or other unique site problems, groundwater monitoring programs could require more extensive information than is specified in WAC 173-303-645. Monitoring for radionuclides will be in accordance with DOE Orders dealing with radiation protection of the public and the environment and radioactive waste management requirements.

2.1 GROUNDWATER MONITORING AND CORRECTIVE MEASURES FOR THE SST SYSTEM

Groundwater monitoring for SSTs is a complex undertaking that is partially managed under HFFACO Milestones M-24 and M-45. SSTs are considered noncompliant tank systems with documented releases to the environment which must continue to be used to manage waste for an extended period of time pending retrieval and closure. Groundwater monitoring at the SSTs supports numerous environmental and regulatory data needs, including evaluating the sources of groundwater and vadose contamination, the fate and transport of existing and potential future releases, the aquifer characteristics, and the long-term risk for purposes of developing closure performance standards and postclosure care.

RCRA-related groundwater monitoring wells are generally located on the periphery of the WMA fenceline that represents the point of compliance. In some instances, isolated WMA components outside the fenceline may require integration with closure actions conducted for other groundwater operable units or other regional closure activities. General closure performance standards stated in WAC 173-303-610 nevertheless apply throughout all media actually or potentially affected by releases from tank system operations. For example, releases to groundwater that have migrated past the WMA fenceline are subject to closure authority and performance standards.

2.1.1 Program Status of SST System Groundwater Monitoring

The primary objectives of RCRA groundwater monitoring are to comply with regulatory requirements and agreements, to assess potential impact on groundwater quality, and to identify near-term corrective measures, if feasible, for the protection of human health and the environment. As presently performed in accordance with 40 CFR 265 Subpart F (which was incorporated, by reference, into WAC 173-303-400), SST RCRA interim-status facilities are monitored according to one of three levels:

- Background monitoring – Background monitoring is the initial program entered into during RCRA groundwater monitoring. In this program, background levels for groundwater quality and indicator parameters are established. Background concentrations for these values are statistically derived after at least four quarters (one year) of groundwater sample collection. Initial background monitoring programs are completed for all SST WMAs.

- Indicator evaluation – In the indicator evaluation program, concentrations for groundwater parameters in downgradient wells are compared to initial background concentrations. If statistically significant increases are noted, additional groundwater samples are collected to evaluate the data. If results of the additional samples verify the concentration increase, then the regulatory agencies must be notified that the facility may be affecting groundwater quality.

- Groundwater quality assessment – The assessment program is initiated when the indicator evaluation program determines that the facility may be affecting groundwater. The assessment program is implemented to determine the rate and extent of contaminant migration and the concentration of hazardous waste in the groundwater.

Table 2-1 summarizes the regulatory program currently implemented (as of fiscal year 2001) at each SST WMA. In addition, Table 2-1 summarizes the indicator and site-specific sampling parameters at each WMA (PNNL-13788).

Groundwater monitoring is evaluated as collected to determine such parameters as groundwater flow direction and chemistry to assure the adequacy of the groundwater monitoring network. Groundwater monitoring data is reported annually in the Hanford Site groundwater monitoring report.

Table 2-1. Summary of SST WMA Regulatory Program Status and Groundwater Sampling Parameters[a].

WMA	RCRA Program (FY01)	Sampling Frequency	Contaminant Indicator Parameters[a]	Site-Specific Parameters[a]
A-AX	Indicator-Evaluation	Semi-annually	pH, specific conductance, total organic carbon, total organic halides	alkalinity, anions, metals, phenols, turbidity, technetium-99, tritium, uranium
B-BX-BY	Assessment	Quarterly to Annually	pH, specific conductance, total organic carbon, total organic halides	alkalinity, anions, cyanide, metals, turbidity, total dissolved solids, iodine-129, strontium-90, technetium-99, tritium, uranium
C	Indicator-Evaluation	Semi-annually	pH, specific conductance, total organic carbon, total organic halides	alkalinity, anions, cyanide, metals, phenols, turbidity, technetium-99, tritium, uranium
S-SX	Assessment	Quarterly	pH, specific conductance	alkalinity, anions, metals, turbidity, total dissolved solids, hexavalent chromium, strontium-90, technetium-99, tritium, uranium
T	Assessment	Quarterly to Semi-annually	pH, specific conductance	alkalinity, anions, metals, turbidity, volatile organic compounds, iodine-129, strontium-90, technetium-99, tritium
TX-TY	Assessment	Quarterly	pH, specific conductance	alkalinity, anions, metals, turbidity, volatile organic compounds, iodine-129, strontium-90, technetium-99, tritium
U	Assessment	Quarterly	pH, specific conductance	alkalinity, anions, metals, volatile organic compounds, technetium-99, tritium

FY01 = fiscal year 2001

2.1.2 Groundwater Monitoring During Closure and Postclosure Periods

During the time that WMA component closure activities are underway and until WMA closure actions are achieved, groundwater monitoring will be conducted according to current approved groundwater monitoring plans or future modifications to those plans as implemented. It is recognized that groundwater monitoring may support numerous environmental and regulatory data needs. Groundwater monitoring will be coordinated with these activities, CERCLA remediation, and other site-wide activities as feasible. In addition, monitoring wells deemed no longer useful (for regulatory purposes or because of a declining water table) will be decommissioned as necessary. As WMA closures are completed, a postclosure groundwater monitoring plan will be developed for approval by Ecology and incorporation by reference into the Site-Wide Permit. This postclosure groundwater monitoring plan will integrate with the groundwater monitoring approach developed pursuant to the Central Plateau regional closure strategy. A compliance schedule for development of a postclosure groundwater monitoring plan should be developed in accordance with the relative timeline shown on Figure 1-4. The central plateau regional groundwater monitoring and WMA postclosure groundwater monitoring will be transitioned into monitoring conducted for a long-term stewardship program.

3.0 SST CLOSURE PERFORMANCE STANDARDS

WAC 173-303-610 sets forth primary state requirements for closure and postclosure of dangerous waste TSD facilities such as the SST system, referencing additional standards in WAC 173-303-640 (8) specific to closure of tank systems. DOE will close the SST system in compliance with applicable performance standards set out or referenced in WAC 173-303-610 (2). This section of the closure plan discusses how DOE will meet these standards.

WAC 173-303-610 (2)(a) contains generalized standards to ensure the functionality of closure systems, the protection of human health and the environment, and the promotion of restoration of land. Subsections 3.1 through 3.3 discuss how DOE will meet these requirements. The three general closure performance standards are paraphrased as follows:

1. Minimize the need for further maintenance (Section 3.1)

2. Control, minimize, or eliminate to the extent necessary to protect human health and the environment, post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere (Section 3.2)

3. Return the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity (Section 3.3).

WAC 173-303-610(2)(b) contains specific standards for waste removal or decontamination. Additionally, WAC 173-303-610(2)(b) references WAC 173-303-640(8). Subsection 3.4 discusses how DOE will address the specific removal or decontamination standards contained in WAC 173-303-610(2)(b) and WAC 173-303-640(8).

In addition, other sections of the Framework Plan describe in further detail how compliance with closure performance standards will be achieved. These include:

- Section 4.0 describes DOE's approach to assessing risk associated with SST system closure. Risk assessment is integral to meeting the second general closure performance standard described above.

- Section 5.0 describes DOE's approach to characterizing residual wastes. Waste characterization is also integral to meeting the second general closure performance standard described above.

- Section 1.3 to this plan discusses the potential for integrating SST system closure activities with closure and remedial actions planned for the Central Plateau, presenting a relative timeline for key events leading to and following after SST system closure. The collective actions described in Section 1.3 will contribute to and ultimately complete compliance with the closure performance standards of WAC 173-303-610(2) and -640(8).

3.1 MINIMIZE NEED FOR FURTHER MAINTENANCE

WAC 173-303-610 provides in part:

> (2) Closure performance standard. The owner or operator must close the facility in a manner that:
>
> (a)(i) Minimizes the need for further maintenance;…

Closure activities planned for the SST tank farms will be designed to minimize the maintenance required after closure of individual WMAs and the SST system. Closure activities will include removing waste from tanks and ancillary equipment, minimizing the potential for spills and leaks, characterizing residuals and contaminated media, isolating and stabilizing any remaining wastes in tanks or ancillary equipment, evaluating and implementing closure options for environmental media, and constructing engineered surface barriers where necessary. DOE will focus primarily on the following to meet this general performance standard:

- Waste removal to reduce consequences of any maintenance issues,
- Low-maintenance approaches to directly enhance containment of any residual wastes, and
- Other low-maintenance protective measures to reduce the potential for infiltration or intrusion.

DOE will remove waste from SSTs to the extent technically possible in accordance with retrieval goals established in HFFACO Milestone M-45-00 and Appendix H. DOE will retrieve wastes from other structures and equipment, remove or decontaminate contaminated structures and equipment, treat and decontaminate media, enhance containment of any remaining wastes, and isolate structures and equipment to the extent practicable to meet requirements.

DOE will employ various approaches for ancillary equipment and any other structures, either singly or in combination. Depending on effectiveness and practicability (including evaluation of worker exposure versus long-term risk reduction benefit), DOE will remove waste to the extent practicable, decontaminate equipment and structures, and/or remove and dispose of equipment and structures. Actions for different system components will be specified in WMA closure action plans and component closure activity plans. Also, depending on effectiveness and practicability, DOE will treat contaminated environmental media, including soil and groundwater and will dispose of contaminants and, as needed, contaminated soil. Goals for stabilization of any below-grade system components remaining after waste retrieval include minimizing the potential for long-term subsidence and settlement of the tank farm surface. Final closure activities will be described in WMA closure action plan submittals.

Following removal or decontamination actions, if dangerous waste or dangerous waste constituents remain to the extent that closure consistent with landfills is required, DOE will implement protective low-maintenance measures to minimize the potential for inadvertent intrusion into remaining contaminants. DOE will isolate tanks and similar below-grade

structures and fill them with layers of cementitious grout* or similar material to reduce the potential for water infiltration and contaminant mobility. These layers will also fill void spaces, provide barrier stability, and protect against inadvertent intrusion. DOE will isolate and stabilize the remaining below-grade ancillary components and structures.

As necessary, DOE will install engineered surface barriers at WMAs and other locations to minimize water infiltration into remaining structures and equipment, soil, and groundwater. Barriers will meet or exceed RCRA requirements, will require little or no maintenance, are expected to have no substantial subsidence issues, and will be designed to remain effective for hundreds of years. DOE will also employ institutional controls and markers to minimize the potential for inadvertent intrusion by humans.

DOE has not yet developed final barrier or marker designs for the Hanford site. Consequently, DOE has not established definitive monitoring and maintenance activities. Site programs are ongoing to test and improve the design of prototype barriers and to design markers. Information gained from these programs will be used to define specific SST barrier and marker designs and monitoring and maintenance activities. As designs and monitoring and maintenance activities are finalized, these final designs will be included in the appropriate WMA closure action plans submitted for Ecology approval.

The overall objective of barrier design is to develop a highly protective surface barrier system using natural materials, providing long-term isolation of wastes, requiring minimal maintenance, and exceeding RCRA cover design requirements. The primary function of a surface barrier is to contain waste in place by minimizing 1) the infiltration of precipitation into contaminated soil or debris, thereby minimizing the driving force for downward migration of contaminants; 2) the migration of windblown dust originating from contaminated surface soils; and 3) the potential for direct exposure of inadvertent intruders to contamination. Barriers will be designed to minimize the potential for intrusion and destructive effects by plants and burrowing animals that could reduce potential for limiting infiltration. Decommissioning of all wells that may be buried by the barrier will be required (WAC 173-160-460).

The objective of marker design is to provide a clearly and simply understood warning to a person of any cultural background at any time in the foreseeable future of the potential dangers remaining from past activities involving the SST system.

Initial removal or decontamination, and, as needed, containment, isolation, and stabilization measures will be taken on a component-by-component basis and described in component closure activity plans. Removal or decontamination, and, as needed, containment, isolation, and stabilization will be completed by the time of WMA closures. Barriers will be installed as appropriate after WMA field closure actions and WMA soil remediation are completed, and in a manner that does not inhibit groundwater remediation.

* See Preface in SST System Closure Plan (RPP-13774).

Effectiveness of measures to minimize the need for further facility maintenance can be assessed by facility monitoring and inspections and by groundwater and vadose zone monitoring.

3.2 PROTECT HUMAN HEALTH AND THE ENVIRONMENT

WAC 173-303-610 provides in part:

> *(2) Closure performance standard. The owner or operator must close the facility in a manner that:*
>
> *(a)(ii) Controls, minimizes or eliminates to the extent necessary to protect human health and the environment, post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground, surface water, ground water, or the atmosphere; and…*

Many of the measures described above in Section 3.1 to achieve compliance with WAC 173-303-610(2)(a)(i) will also have the consequence of ensuring compliance with WAC 173-303-610(2)(a)(ii). These previously described measures, together with additional measures discussed below, will minimize or eliminate, to the extent necessary to protect human health and the environment, any post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere.

Specific measures DOE will take to reduce or eliminate the potential for postclosure escape of any residual wastes after closure of individual WMAs and the SST system will include:

- Retrieval of waste from SSTs. According to HFFACO Milestone M-45-00, waste shall be retrieved from single-shell tanks to the limits of the technology (or technologies) selected. As much waste as technically possible will be retrieved, with remaining residuals of no more than 360 ft^3 for 100-series tanks and 30 ft^3 for 200-series tanks. If the retrieval goal is not met for a specific tank, DOE will request an exception to the criteria in the manner specified in Appendix H of the HFFACO. A risk assessment will be performed on any remaining residuals to ascertain their contribution to risks to human health and the environment using methods described in Attachment C-1 to this plan, or other methods as may be defined in future modifications to this plan.

- Development of DQOs for residual waste sampling and analysis to ensure appropriate characterization data are collected to support the tank component closure activities. (A detailed discussion regarding SST system characterization methodology is contained in Section 5.0.)

- Subsequent storage of retrieved SST waste in double-shell tanks (DST), treatment at waste treatment plant (WTP) or alternative facility (see Section 3.2.2), and disposal in a deep geologic repository

- Employment of risk analyses to evaluate risk to human health and the environment from any residual contaminants. (A detailed discussion regarding SST system risk assessment methodology is contained in Section 4.0.)

- Application of the following measures to ancillary equipment and structures, singly or in combination, depending on effectiveness and practicability:

  – Removal or decontamination of ancillary equipment and structures

  – Sealing in place

  – Disposal of debris in an environmentally protective manner

- Isolation and stabilization of SSTs and other remaining below-grade equipment and enhanced containment of residual wastes in those tanks and other equipment

- Removal/decontamination, treatment, or containment of contaminated soil as needed to achieve protection of human health and the environment, depending on effectiveness and practicability that will meet the standards of RCRA as an ARAR

- Removal/decontamination, treatment, or containment of contaminated groundwater as needed to achieve protection of human health and the environment, depending on effectiveness and practicability and periodic sampling of these wells for identified constituents as included in the postclosure monitoring plan

- Installation of engineered barriers that meet or exceed RCRA criteria

- Installation of groundwater monitoring equipment to meet postclosure monitoring goals

- Inspection and maintenance procedures to ensure the effectiveness of these protective measures.

Most actions will be taken on a component-by-component basis and described in WMA closure action plans and component closure activity plans. Barriers will be installed as appropriate after WMA field closure actions and WMA soil remediation are completed, and in a manner that does not preclude possible future groundwater remediation activities.

Effectiveness of measures to protect human health and the environment will be assessed by facility monitoring and inspections and by groundwater and vadose zone monitoring.

3.2.1 Methodologies for Protecting Human Health and the Environment

DOE will describe methodologies to accomplish these tasks and specify particular actions for individual system components in WMA closure action plans, component closure activity plans, and this revision of the Framework Plan or subsequent modifications.

3.2.1.1 Meeting SST Retrieval Criteria. In accordance with HFFACO Milestone M-45-00 criteria, DOE will retrieve waste from SSTs to the extent technically possible. The volume of any waste residuals will not exceed 360 ft^3 in 100-series tanks and will not exceed 30 ft^3 in 200 series tanks unless DOE requests and obtains approval of individual tank exceptions to the volume criteria. DOE must measure in-tank residual waste volumes in accordance with HFFACO Appendix H procedures as set forth below, and must request and obtain any exceptions to volume criteria from Ecology and EPA in accordance with Appendix H.

To implement Appendix H and ensure compliance with M-45-00 requirements, DOE will:

- Conduct in-tank surveying, including visual inspection techniques, to measure the waste inventory in each SST before retrieval,
- Conduct retrieval operations in accordance with approaches described in closure plans,
- Conduct in-tank surveying, including visual inspection techniques, to calculate the residual waste inventory after retrieval,
- Obtain one or more samples from residual waste in accordance with DQOs and sampling and analysis plans,
- Evaluate the residual volume against M-45-00 retrieval criteria, and
- Notify regulatory agencies if the residual complies with M-45-00 criteria, and move toward final approval of closure activities for the affected system component.

If evaluation of the residual volume shows that retrieval criteria have not been met, DOE will either attempt additional retrieval strategies or, if it believes that these criteria are not achievable for a specific tank, submit an Appendix H Attachment 2 request for an exception to EPA and Ecology. Any exception request will describe:

- The reason or reasons DOE does not believe the criteria can be met
- If possible, a schedule for meeting retrieval criteria using existing technology
- Any future technologies that could meet the criteria, including schedule and cost of implementing such technologies
- The volume, chemical characteristics, and radiological characteristics of the waste residual
- Expected impacts to human health and the environment from leaving the residual in place
- Any additional information requested by the regulatory agencies.

If Ecology and EPA approve the exception request, DOE will move to implement approved closure activities for the component. If the regulatory agencies deny the request, DOE will attempt to retrieve wastes or initiate dispute resolution.

3.2.1.2 Component Closure Activities for Tanks. Closure activities for the individual tanks in WMAs will occur in three major steps 1) tank waste retrieval, 2) tank stabilization, and 3) physical and administrative isolation of the tank. Tank stabilization and isolation will be required regardless of whether removal or decontamination in accordance with WAC 173-303-610(2)(b) and -640(8) is achieved by retrieval actions. For individual tanks, each step will be described in component closure activity plans.

Section 3.2.1.1 above describes DOE's approach to meeting HFFACO Milestone M-45-00 retrieval criteria. Once retrieval criteria are met and Ecology determines that risks associated with remaining contaminants are acceptable, each tank will be stabilized in accordance with Ecology approved component closure activity plans. Tank stabilization may consist of adding fill into the retrieved tanks. Stabilization activities may differ from tank to tank depending primarily on the volume and characteristics of the residual waste remaining after retrieval and the integrity of the tank.

Physical and administrative isolation of the tanks will occur before and after the tank retrieval and tank stabilization activities. Physical isolation refers to filling and/or capping of pipelines, drains, ducting, or other openings into the tank structure as needed, depending on effectiveness and practicability. Physical isolation will occur progressively as individual tanks near final stabilization. Administrative isolation controls tank access through procedural actions. Both physical and administrative isolation measures are intended to prevent infiltration of water or inadvertent reintroduction of waste and/or grout[*] into a partially stabilized or stabilized tank.

Determinations regarding the timing of isolation actions will be made on a tank-by-tank basis with consideration given to specific circumstances of individual tanks and the status of surrounding SST components. Component closure activity plans will include detailed information on isolation steps for individual SSTs. To prevent intrusion of waste or other liquids into retrieved tanks, isolation activities may be most optimally taken at individual tanks before Ecology approval of component closure activity plans, DOE may send letter reports to Ecology specifying near-term isolation actions to be taken and requesting Ecology's concurrence or permission to proceed with actions at appropriate times.

3.2.1.3 Component Closure Activities for Ancillary Equipment. Ancillary equipment refers to steel, concrete, electrical, and other components, both internal and external to the tank, including pipelines, conduit, pits, diversion boxes, ventilation systems, electrical/service connections, tank risers, pumps, measuring equipment (such as liquid level detection systems, thermocouples), shield plugs, and dip legs. A listing of ancillary equipment associated with the SST system is included in Addendum 1.

There are uncertainties associated with the level of contamination contained in ancillary equipment and with potential difficulties in accessing buried equipment. DQOs will be developed to ensure appropriate characterization data are collected to support the ancillary equipment component closure activities. Disposition of in-tank ancillary equipment (such as in-

[*] See Preface in *SST System Closure Plan* (RPP-13774).

tank measuring equipment and tank risers) will be described in the respective tank component closure activity plans. In-tank ancillary equipment will be dispositioned as debris during the tank closure activity. Disposition of ex-tank ancillary equipment (such as pipelines, diversion boxes) will be described in either an ancillary equipment component closure activity plan or other alternate decision documentation such as a corrective measures study or ROD (interim and final) upon approval through incorporation into the SST system chapter of the Site-Wide Permit. Additionally, for closure actions, including SST retrieval, where ancillary equipment is connected/attached, DOE must describe with sufficient detail how anticipated ancillary equipment or tank retrieval/closure actions will not preclude future retrieval/closure actions.

3.2.1.4 Fill and Stabilization for Below-Grade System Components. DOE will implement protective measures to minimize the potential for environmental or human intrusion to increase the potential for mobility and escape of any residual wastes into environmental media. DOE will fill tanks and similar structures with layers of cementitious grout* or similar material as prescribed by the approved plans to reduce the potential for water infiltration and contaminant mobility as well as provide protection against human or ecological intrusion. Grout* will fill void spaces, thereby avoiding subsidence, providing structural stability to prevent settlement of the tank dome, promoting barrier stability, and increasing protection against inadvertent intrusion. Stabilization activities may differ from tank to tank depending primarily on the volume and characteristics of the residual waste remaining after retrieval and the integrity of the tank.

Stabilization of any remaining below grade components following waste retrieval will be designed to immobilize any remaining waste residue, minimize contaminant transport, and avoid long-term subsidence and settlement of the tank farm surface.

3.2.1.5 Component Closure Activities for Soil. The two primary steps in the soil component closure activities are 1) characterizing the nature, extent, and mobility of the contamination in the soil column; and 2) performing necessary corrective actions. Characterization of soils involves an assessment of known and suspected contamination. DQOs are being developed to ensure appropriate characterization data are collected to support the soil component closure activities. Characterization information is used to assess the relative risk associated with the soil component.

A corrective measures analysis based on the risk assessment will be conducted to define appropriate remediation methodologies. Following this analysis, the corrective measures alternative(s) will be implemented.

Soil characterization and corrective measures for the WMAs are being performed using the RFI/CMS process as outlined in DOE/RL-99-36 and associated addenda (HNF-5085, RPP-6072, RPP-7578, and RPP-16608). Figure 3-1 depicts the major activities associated with the RFI/CMS process. The figure also shows the associated document for each of the completed activities and the associated milestone and date for activities in progress. While the scope of the

* See Preface in *SST System Closure Plan* (RPP-13774).

original RFI/CMS master work plan (DOE/RL-99-36) was not intended to support closure-related decisions, the process allows for an update to the work plan to allow for additional field investigation to support closure requirements.

Soil characterization and corrective measures activities for all WMAs will be integrated as appropriate with ancillary equipment and groundwater component closure activities and with the Ecology, EPA, and DOE Central Plateau regional closure strategies currently under development. Coordination of these integration actions will be implemented through the *SST System Implementation Plan* or component closure plans.

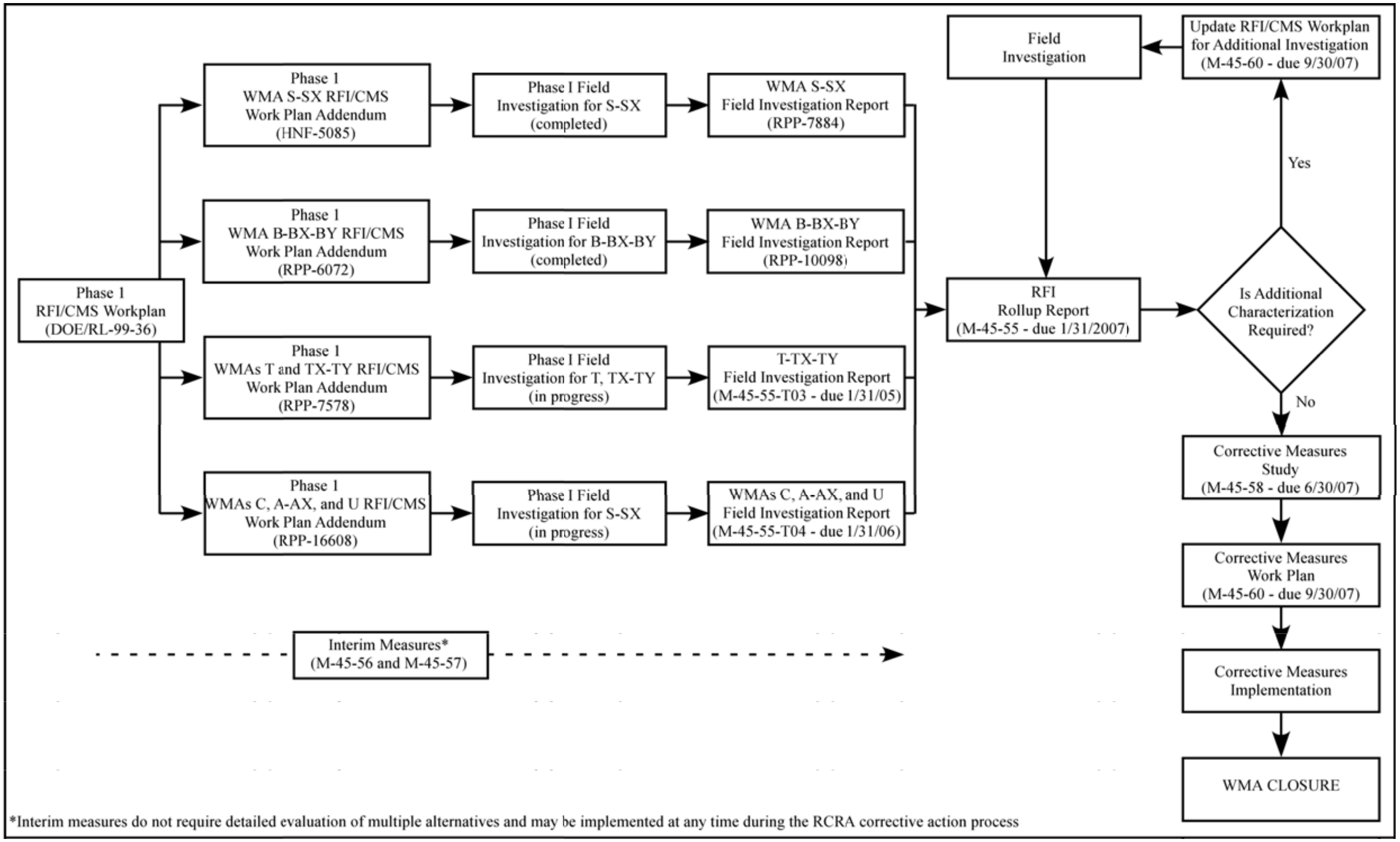

Figure 3-1. Major Activities Associated with the RFI/CMS Process.

3.2.1.6 Component Closure Activities for Groundwater. The two primary steps in the groundwater closure activities are characterizing the nature and extent of contamination, and performing necessary corrective measures. Characterization of groundwater will involve an assessment of groundwater conditions based on monitoring data and supplemental groundwater data obtained through field investigations. DQOs will be developed to ensure appropriate characterization data are collected to support subsequent groundwater component closure activities. Groundwater characterization will be conducted as a groundwater component closure activity under either WMA closure actions or corrective actions, and may be coordinated with other component closure activities. Characterization information will be used to assess the relative risk associated with the groundwater component. Based on the risk assessment, a corrective measures study will be conducted to define appropriate corrective actions.

If it is determined that groundwater corrective actions are necessary, groundwater remediation may be performed pursuant to a CERCLA ROD (interim and final) developed for the associated groundwater operable unit. Permit condition II.Y.2.c recognizes the overlap between the RCRA closure/postclosure requirements and corrective actions. Though closure and corrective action should achieve similar environmental outcomes, condition II.Y.2.c anticipates that the RCRA closure process will be the principal regulatory mechanism for dealing with environmental releases. Groundwater monitoring and response actions are integrated within the context of HFFACO Milestones M-24 and M-45 and, as feasible, will be integrated with the Central Plateau regional closure strategy.

3.2.1.7 Engineered Surface Barriers and Markers. Should removal or decontamination of dangerous waste constituents not be achievable at the WMA, the proposed contingent final remedy for the respective WMAs is the installation of an engineered surface barrier. DOE will install engineered surface barriers (also called “covers” in this document) at WMAs and potentially at other locations to minimize water infiltration. DOE barrier designs will also function to prevent intrusion by human and ecological receptors, limit wind and water erosion, and attenuate radiation from covered contaminants. Barriers will meet or exceed RCRA requirements, will require little or no maintenance, and will be designed to remain effective for hundreds of years.

Site-specific evaluations will be done to ensure that surface barrier designs are appropriate for specific WMA characteristics. Approved designs will ultimately be incorporated into the Site-Wide Permit.

When an engineered surface barrier has been installed, the barrier and surrounding disturbed area will be revegetated to enhance evapotranspiration, limit erosion, and blend the area into the surrounding landscape of the Central Plateau. Performance monitoring will ensure the surface barrier is performing as designed. Monitoring will include visual inspection and will be supplemented with groundwater sampling. DOE will also employ institutional controls and markers to minimize the potential for intrusion by humans.

Long-term effectiveness of surface barriers in the Central Plateau depends on maintaining each barrier throughout the natural attenuation of contaminants to prevent exposure to potential receptors. Maintenance activities would include erosion repairs and possible vegetation

maintenance. Subsidence is not considered a major factor in maintenance activities for Central Plateau waste site barriers.

For calculation of risk estimates associated with SST components, the design life of the engineered surface barrier (closure cover) is currently assumed to be 500 years. For purposes of computing risk estimates, the performance of that barrier and its ability to restrict infiltration into the closed system is assumed to degrade by approximately a factor of 10 at the end of the 500-year design life.

3.2.2 Treatment, Storage, and Disposal of Retrieved Wastes

DOE will treat, store, and dispose of waste retrieved from the SST system in permitted facilities. Treatment and relevant storage activities will be conducted on the Hanford Site. Disposal will be accomplished at onsite or offsite locations, depending on the nature of the waste and availability of facilities. Figure 3-2 illustrates primary elements of DOE's approach to treatment, storage, and disposal of wastes to be retrieved. Waste already retrieved and stored in the DST system will also be treated and disposed of in the manner shown in the figure.

DOE will move waste from the SST system to onsite treatment or storage facilities using permanent transfer lines or temporary overground transfer lines. Leak detection, monitoring and mitigation (LDMM) techniques are under development and will be demonstrated during the course of retrieval operations as a means to evaluate potential loss of fluids associated with retrieval and to implement mitigative actions if necessary. Retrieval functions and requirements documents will be prepared to guide retrieval operations. Strategies for LDMM will be included.

Wastes transferred to TSD facilities from the SST system may consist of HLW, low activity waste (LAW), and TRU wastes, all as mixed wastes. The following lists the intentions for subsequent TSD transfer of these waste types to date:

- The majority of retrieved HLW will be stored in DST and/or other permitted facilities. HLW wastes will then be pretreated and vitrified in WTP facilities, and packaged for disposal in a permitted geologic repository.

- Retrieved LAW will also be stored in DST and/or other permitted facilities or may be sent directly to supplemental processing facilities for pretreatment if needed, treatment and immobilization, and disposal in a permitted immobilized LAW (ILAW) disposal facility. LAW stored in DST or other permitted facilities may receive pretreatment at WTP facilities before being sent to supplemental processing facilities for treatment, immobilization, and eventual disposal.

- Retrieved TRU wastes may be sent directly to TRU processing facilities. There the waste will be treated and packaged for eventual disposal at a permitted facility.

Contaminated soil may be generated during WMA closure actions. The disposal site for soil will likely be the Low-Level Burial Grounds (LLBG) mixed waste trenches unless soil remediation is

done under CERCLA. If CERCLA is the statutory authority for soil remediation, then the Environmental Restoration Disposal Facility (ERDF) may be used. However, soil remediation is expected to occur as part of RCRA correction action or TSD closure, thus the LLBG would be the appropriate disposal unit. One exception could be soil remediation outside of the WMAs which may be remediated through the CERCLA process and referenced in the Site-Wide Permit.

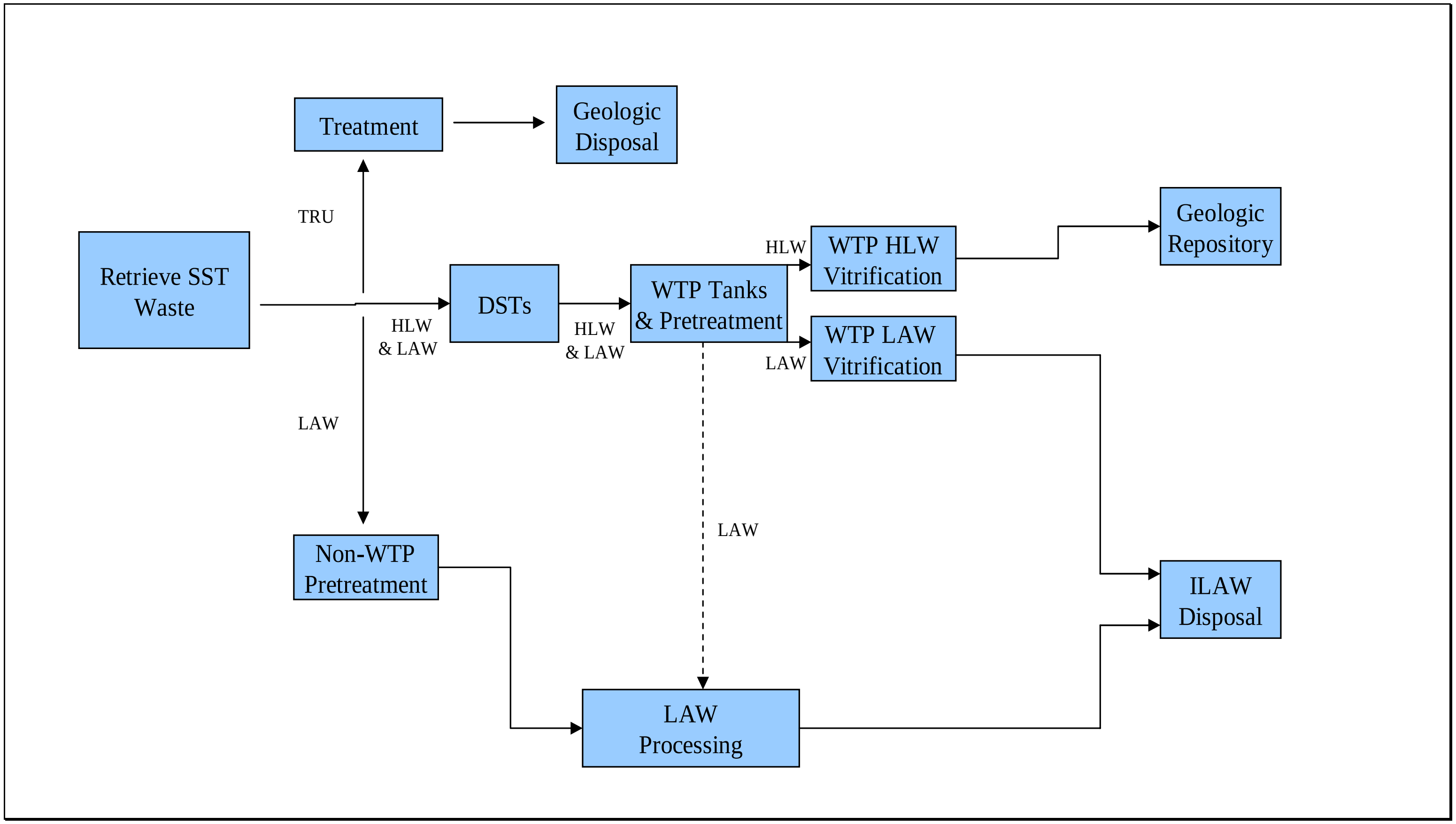

Figure 3-2. Treatment, Storage, and Disposal of Retrieved SST Waste.

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3.3 RETURN LAND TO APPEARANCE OF SURROUNDING LAND AREAS

WAC 173-303-610 provides in part:

> *(2) Closure performance standard. The owner or operator must close the facility in a manner that:*
>
> *(a)(iii) Returns the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity…*

After closure of the SST system, appearance and use of the land will be consistent with future uses in the 200 Areas. Future uses are expected to be determined in accordance with existing decisions, commitments, and recommendations, and the continuing need for waste management.

The future designation of the 200 Areas Central Plateau geographic area in the vicinity of the SSTs is assumed to be industrial-exclusive[4]. This is consistent with the ROD for the Hanford Comprehensive Land-Use EIS (DOE/EIS-0222-F). Industrial-exclusive land use is defined as an area suitable and desirable for TSD of hazardous, dangerous, radioactive, nonradioactive wastes, and related activities. This land use was determined in the ROD to last for a period of 50 years from the time of the EIS through duration of DOE's mission at Hanford.

An industrial-exclusive land-use designation will allow for continued waste management operations within the Central Plateau geographic area consistent with RODs following past NEPA analyses, and commitments or requirements established through RCRA or CERCLA decision processes. Designating the 200 Areas Central Plateau as industrial-exclusive is also consistent with the 1992 Future Site Uses Working Group recommendations (FSUWG 1992) and current DOE management practice.

As part of its obligations under WAC 173-303-610(2)(a)(iii) to return the land to the appearance and use of surrounding areas, the DOE will evaluate administrative, engineering, and legal measures that are necessary to protect public health and the environment in the future. Institutional controls that are robust and layered and that rely heavily on passive measures will reduce the potential for future adverse impacts on the environment and diminish public exposure to SST waste contaminants through the air, the soil, and the groundwater. The Parties to the HHFACO may evaluate the Comprehensive Land-Use Plan (CLUP) future land use industrial-exclusive designation during the establishment of the appropriate institutional controls.

A period of 100 years post-remedy completion is considered as a reasonable time frame for assuming active institutional controls at closure sites. The EPA in 40 CFR 191 and Nuclear Regulatory Commission in 10 CFR 61 consider 100 years to be the reasonable period of time for active institutional controls. However, longer time periods can be considered. It is also

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[4] "Industrial-exclusive" means that uses of the land would be restricted to industrial purposes. Other uses (e.g., residential, commercial, or recreational) would be prohibited.

conservatively assumed that a period of 50 years of active waste management in the Central Plateau will occur. Therefore, it is assumed that after a period of 150 years, active institutional controls may not be fully protective and future land use must be conservatively estimated beyond this timeframe. However, passive institutional controls, such as physical barriers, have design lives beyond this timeframe that will allow protection to the inadvertent intruder. Other passive control mechanisms such as permanent markers and communicating the existence and location of waste will also be key for control of human intrusion and should extend the timeframe for protection. Decisions by DOE, Ecology, and EPA regarding future land use will ultimately be required to close the SST system.

3.3.1 Specific Approach to Restoration

Returning the land to the appearance of surrounding areas will be handled on a larger, long-term scale. DOE will plan and implement habitat and topographical restoration actions consistent with Central Plateau land use and its duty to maintain ongoing protective and remedial measures and institutional controls.

Actions associated with restoration activities include the following:

- Design and implement practicable restoration measures consistent with restoration goals and estimates of future land use,
- Preserve achieved closure states of SST components,
- Avoid impairing the functionality of ongoing monitoring and remediation and of engineered and natural barriers, and
- Monitor and inspect restoration activities and restored areas.

Restoration activities will occur as part of closure and postclosure implementation, after final decisions are made on installing barriers. Restoration activities must be conducted in the context of ongoing long-term protective, remedial and restrictive activities and in the context of past activities involving the SST system.

3.4 REMOVAL OR DECONTAMINATION STANDARDS

In addition to standards stated in terms of general functionality, protection, and restoration, the SST closure action must comply with specific criteria for waste removal or decontamination, meet closure and postclosure requirements consistent with WAC 173-303-610(2)(b) standards applicable to closure of all dangerous waste facilities, WAC 173-303-640(8) standards applicable to closure of tank systems and landfill standards (WAC 173-303-665(6)), if applicable. Generated waste will be treated, as necessary, to comply with LDR requirements prior to land disposal. DOE will submit petitions for variances from these standards where necessary, such as any residuals and debris unable to be retrieved from SST.

3.4.1 General Removal or Decontamination Standards for All Facilities

WAC 173-303-610(2)(b) provides:

> *(b) Where the closure requirements of this section, or of WAC 173-303-630(10), 173-303-640(8), 173-303-650(6), 173-303-655(6), 173-303-655(8), 173-303-660(9), 173-303-665(6), 173-303-670(8), 173-303-680 (2) through (4), or 40 CFR 264.1102 (incorporated by reference at WAC 173-303-695) call for the removal or decontamination of dangerous wastes, waste residues, or equipment, bases, liners, soils or other materials containing or contaminated with dangerous wastes or waste residue, then such removal or decontamination must assure that the levels of dangerous waste or dangerous waste constituents or residues do not exceed:*
>
> *(i) For soils, ground water, surface water, and air, the numeric cleanup levels calculated using residential exposure assumptions according to the Model Toxics Control Act Regulations, chapter 173-340 WAC as now or hereafter amended. Primarily, these will be numeric cleanup levels calculated according to MTCA Method B, although MTCA Method A may be used as appropriate, see WAC 173-340-700 through 173-340-760, excluding WAC 173-340-745; and*
>
> *(ii) For all structures, equipment, bases, liners, etc., clean closure standards will be set by the department on a case-by-case basis in accordance with the closure performance standards of WAC 173-303-610 (2)(a)(ii) and in a manner that minimizes or eliminates post-closure escape of dangerous waste constituents.*

DOE will perform waste removal or decontamination activities in accordance with all applicable regulations. DOE will assess the alternative to clean up soil and groundwater associated with the SST system pursuant to WAC 173-303-610(2)(b)(i). Such assessment will be documented through a corrective action RFI/CMS upon approval through incorporation into the Site-wide permit or as part of a component closure activity plan. Should this assessment conclude that removal or decontamination to levels calculated according to MTCA Method B is not practicable in accordance with WAC 173-303-640(8)(b), the performance of closure and postclosure care in accordance with WAC 173-303-665(6) requirements that apply to landfills will be required.

DOE will attempt to achieve removal or decontamination standards on all SST system tanks and ancillary equipment in accordance with WAC 173-303-610(2)(b)(ii). According to this requirement, such removal or decontamination must assure that levels of dangerous waste or dangerous waste constituents or residues do not exceed those established by Ecology on a case-by-case basis and in accordance with the closure performance standard of WAC 173-303-610(2)(a)(ii) for controlling, minimizing, or eliminating postclosure escape of dangerous waste constituents to the environment. These levels are identified as clean closure standards. Ecology clean closure guidance (Ecology F-HTWR-94-144) states that clean closure decontamination levels for metal tanks are generally considered to be met upon meeting the performance treatment standards contained in 40 CFR 268.45, Table 1 (debris rule treatment standards).

Retrieval activities will remove waste from the tanks to the extent technically possible in accordance with HFFACO Milestone M-45-00 and Appendix H and to meet clean closure standards. However, it is unlikely that clean closure decontamination standards based on Ecology F-HTWR-94-144 clean closure guidance can be achieved for SST. In addition, it is unlikely that tank closure activities can practicably meet removal standards to the extent that the entire tank would be removed. However, in meeting the HFFACO Milestone M-45-00 requirements, removal or decontamination of dangerous wastes and dangerous waste residues will be required to be sufficient to ensure that closure will proceed in a manner that minimizes or eliminates postclosure escape of dangerous waste constituents in accordance with WAC 173-303-610(2)(b)(ii).

3.4.2 Waste Removal or Decontamination Standard for Tank Systems

WAC 173-303-640(8) provides:

(8) Closure and post-closure care.

(a) At closure of a tank system, the owner or operator must remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated soils, and structures and equipment contaminated with waste, and manage them as dangerous waste, unless WAC 173-303-070 (2)(a) applies. The closure plan, closure activities, cost estimates for closure, and financial responsibility for tank systems must meet all of the requirements specified in WAC 173-303-610 and 173-303-620.

(b) If the owner or operator demonstrates that not all contaminated soils can be practicably removed or decontaminated as required in (a) of this subsection, then the owner or operator must close the tank system and perform post-closure care in accordance with the closure and post-closure care requirements that apply to landfills (see WAC 173-303-665(6)). In addition, for the purposes of closure, post-closure, and financial responsibility, such a tank system is then considered to be a landfill, and the owner or operator must meet all of the requirements for landfills specified in WAC 173-303-610 and 173-303-620.

(c) If an owner or operator has a tank system that does not have secondary containment that meets the requirements of subsection (4)(b) through (f) of this section and is not exempt from the secondary containment requirements in accordance with subsection (4)(g) of this section, then:

(i) The closure plan for the tank system must include both a plan for complying with (a) of this subsection and a contingent plan for complying with (b) of this subsection.

(ii) A contingent post-closure plan for complying with (b) of this subsection must be prepared and submitted as part of the permit application.

(iii) The cost estimates calculated for closure and post-closure care must reflect the costs of complying with the contingent closure plan and the contingent post-closure plan, if those costs are greater than the costs of complying with the closure plan prepared for the expected closure under (a) of this subsection.

(iv) Financial assurance must be based on the cost estimates in (c)(iii) of this subsection.

(v) For the purposes of the contingent closure and post-closure plans, such a tank system is considered to be a landfill, and the contingent plans must meet all of the closure, postclosure, and financial responsibility requirements for landfills under this chapter (WAC 173-303-610 and 173-303-620).

As indicated in Section 3.4.1, DOE will attempt to achieve removal or decontamination standards on all SST system tanks and ancillary equipment; however, this may not be achievable. In that event, DOE will demonstrate why it cannot practicably remove contaminants to these standards, and will then close the WMA and perform closure and postclosure care in accordance with landfill closure and postclosure requirements set forth in WAC 173-303-665(6) and with landfill requirements contained in WAC 173-303-610.

The SST system was not built with or modified to and does not include secondary containment that meets the standards of WAC 173-303-640(4)(b) through (f). Because of the lack of secondary containment, DOE will submit WMA closure action plans and component closure activity plans that meet both WAC 173-303-640(8)(a) removal and decontamination requirements and the WAC 173-303-640(8)(b) requirements to perform closure and postclosure care in accordance with WAC 173-303-665(6) landfill closure and postclosure requirements and WAC 173-303-610 landfill requirements in the event that landfill closure is required.

Ecology will review the WMA closure action plans, and will approve either tank system clean closure activities or landfill closure activities, depending on the level of removal or decontamination DOE achieves for the components within the WMA. In accordance with Ecology’s approval, DOE will conduct either a tank system closure or a landfill closure with appropriate postclosure care at the WMA.

WMAs will become dangerous waste disposal units upon closure as landfills. Postclosure plans will describe postclosure activities at all portions of the SST system closed as landfills.

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4.0 SST SYSTEM RISK EVALUATION

The Washington Dangerous Waste Regulations (WAC 173-303) require that a risk assessment be performed to demonstrate that a permitted facility meets risk-based standards at closure. Under its AEA authority, DOE requires that all activities that could result in the release of radioactivity be assessed for the potential short-term risk to the occupational workforce and the general public (10 CFR 835; DOE Order 5400.1; DOE Order 5400.5; DOE O 440.1A). As low as reasonably achievable guidelines and radiological dose limits have been established under the AEA.

DOE will perform a risk evaluation to analyze whether SST system closure conditions are protective of human health and the environment. The Ecological Risk Assessment (ERA) shall be completed as part of the Tank Farm Feasibility Study and at WMA closure. Methods have been established to assess the impacts of potential releases of radioactivity. Risk also can occur from exposure to nonradioactive contaminants during and following waste retrieval and closure. DOE, EPA, and Ecology are developing a decision-making process that considers risk as well as the limits of technology (e.g., cost benefit analysis per Appendix H of HFFACO) in establishing waste retrieval system requirements and allowable residual waste volumes following retrieval.

The WMA closure risk assessment only evaluates the sources within the WMA. The results of WMA closure risk assessments will be given to the Site-Wide Assessment Program to be integrated with other site risk assessment activities. The Site-Wide Assessment Program uses the tool System Assessment Capability (*An Initial Assessment of Hanford Impact Performed with the System Assessment Capability*, [PNNL-14027]) to examine the risk of the WMA relative to other waste disposal sites, both liquid and solid, through the use of comparable exposure scenarios and incorporation into the site-wide composite analysis. The results of the site-wide composite analysis for both radionuclides and non-radionuclides are due out in late 2004 (radionuclides) and early 2005 (non-radionuclides).

Sections 4.0 and 5.0, respectively, provide a detailed description of DOE's methodology for evaluating SST system risk and a statement of DOE's approach to sampling and characterization of wastes that underlies the risk analysis.

The clean closure option risk assessment is being evaluated as part of the *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA* which expected to be published in 2004. It is anticipated that the clean closure option (e.g., excavating and removing all 149 SSTs, along with contaminated soil and disposing of this material) will not be feasible for the SSTs and that the WMAs that contain the SSTs will be closed as landfills. Therefore, the risk assessment presented in the closure plan only examines the landfill option. If the EIS indicates that clean closure is feasible, the risk assessment in the closure plan will be updated to reflect a clean closure option.

Closure of the SST system requires that long-term and short-term human health risks and long-term ecological risks be evaluated. However, at this time only the long- and short- term human

health risks are being evaluated. The ERA is postponed until WMA closure for the following reasons:

- Presently, the tank farms are managed in a way to eliminate, to the extent possible, the intrusion of plants and animals into the facilities.
- Ecological impacts will be much more impacted by engineered features (for example, surface barriers) than the present day conditions.
- Additionally, an ERA is presently being prepared for the 200 Area Plateau by the Groundwater Protection Project. The DQO for 200 Area Plateau's ERA is scheduled to be issued March 19, 2004 with the ERA being published in fiscal year 2006. The ERA conducted for WMA closure will be consistent with what is being agreed to by Ecology, EPA, and DOE for ERA for the 200 Area Plateau.

Estimates of risks must be comprehensive, quantitative, and compared to performance standards. The risk assessment for groundwater and long-term risk exposure will be conducted in a manner consistent with the approach to risk assessment described in the *Phase I RCRA Facility Investigation/Corrective Measures Study Work Plan for Single-Shell Tank Waste Management Areas* (DOE/RL-99-36). Short-term risk exposure will be assessed using an approach consistent with that used for the *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA -- Worker and Public Safety Data Package* (DOE/ORP-2003-03), documented safety analysis, or other appropriate existing safety documentation.

4.1 PURPOSE AND BACKGROUND

The purpose of this section is to present the strategy to conduct an SST system risk assessment that supports the ultimate closure of the system, including decisions regarding retrieval of waste and assessment of system closure conditions. Specific activities include the evaluation of risk impacts of the following tank features:

- Existing conditions
- Retrieval of wastes
- Partial retrieval of wastes
- Engineered and chemical mitigation methods
- Emplacement of selected fill material
- Performance of closure conditions, including final covers.

The risk assessment strategy for the SST system will be implemented by preparing comprehensive assessments of each WMA. By preparing risk assessments at the WMA level, risk contribution from individual source terms (tanks, past leaks/spills, and ancillary equipment)

can be examined either at an individual source term level or within the perspective of the entire WMA. Area-wide risk assessments will be integrated with the system assessment capability (PNNL-14027) to provide the site-wide composite analysis as required by DOE O 435.1[5] and CERCLA. The initial assessment will be performed based on the best information available and subsequently refined by incorporating the results of new field and engineering data, as the closure program matures. An iterative approach, documented in *Contents of Risk Assessments to Support the Retrieval and Closure of Tanks for the Washington State Department of Ecology* (RPP-14284), will allow the level of uncertainty in risk estimates to be progressively reduced as closure activities move from single tank actions to closure of single WMAs to eventual closure of the complete SST system. These iterative assessments will be integrated with data gathering efforts of the following Hanford Site programs:

- Vadose zone characterization program
- ILAW program
- RCRA groundwater monitoring program
- Improvements in the SST farm best basis inventory
- CERCLA remediation program.

Multiple performance criteria (maximum contaminant level [MCL] for non-radionuclides, MCL Derived Constituent Concentration for radionuclides, incremental lifetime cancer risk [ILCR], hazard index [HI], and radiological dose) will be evaluated at locations from WMA fencelines to the Columbia River for informational purposes and to provide comparability with past studies. As work progresses, it is expected that the number and locations will be refined in a manner that ensures protection of human health and environment. Risk projections will support evaluation of regulatory requirements (e.g., WAC 173-303), DOE Orders (e.g., DOE O 435.1[6]), and other pertinent guidance.

4.2 RISK ASSESSMENT SCOPE AND OBJECTIVES

The scope and objectives of risk assessment activities are described in the following subsections.

4.2.1 Risk Assessment Scope

The scope of the closure risk assessment consists of quantitative estimates of short- and long-term risks related to closure activities and anticipated final conditions of the SST system.

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[5] DOE M 435.1-1 Chapter IV D(4)

[6] DOE O 435.1 Change 1: 8-28-01

To describe the risk contribution of individual source terms (individual tanks, ancillary equipment, etc.), long-term risk estimates will be placed in the context of potential risk contributions from all sources within individual WMAs. Baseline assumptions will be made for source inventories and conditions within each WMA for which specific information is not available.

The need to perform risk assessment activities is identified in the HFFACO, dangerous waste TSD closure requirements (WAC 173-303), and supporting guidance (Ecology 94-111). Additional risk assessment requirements are defined in DOE O 435.1[7] and CERCLA. DOE will perform SST system risk assessments in a manner that is consistent with and can provide information required by, the various governing regulations and orders. If additional requirements are identified during the closure process, they will be evaluated and incorporated as appropriate.

The SST system risk assessment will be compiled from WMA-specific risk assessments. The WMA risk assessments will be prepared for individual WMAs or groups of contiguous WMAs. Grouping of WMAs for risk assessment will depend largely on apparent continuity of geologic and hydrologic conditions that allows fate and transport simulations to represent a selected WMA grouping. The following WMA risk assessments are anticipated:

- WMA A/AX
- WMA B/BX/BY
- WMA C (preliminary risk assessment completed spring 2003)
- WMA S/SX
- WMA T
- WMA TX/TY
- WMA U

The results of the WMA risk assessments will be published in the closure plans for the respective WMAs and attached to this SST system closure plan.

For each WMA, the following source terms will be identified and included as appropriate:

1. Residual waste in tanks
2. Residual waste in ancillary equipment (waste transfer piping, catch tanks, vault tanks, diversion boxes, etc.)

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[7] DOE M 435.1-1, Chapter IV D(4)

3. Past unplanned releases of waste (past tank leaks, past leaks/spills from pipes and other ancillary equipment)

4. Retrieval leaks occurring during retrieval of waste from tanks or other source terms. Hypothetical retrieval leaks will be used when the risk assessment is performed before retrieval. Following retrieval, leak monitoring data will be used to estimate the volume of the retrieval leak and associated risk from the leak.

5. Past intentional discharges to the ground within WMAs.

Other important elements of the SST system closure that will be evaluated in the risk assessment include the following:

1. The physical and chemical nature of residual wastes (comprehensive contents, solubility, etc.).

2. Potential performance of alternative tank fill, i.e., defense-in-depth barriers.

3. Potential performance of final covers/caps.

4.2.2 Risk Assessment Objectives

The general objectives of the SST system human health risk assessment are as follows:

1. Establish an approach and methodology for risk assessment that will be implemented consistently across the entire SST system and updated as new information becomes available.

2. Identify short-term risks and accident scenarios related to tank closure activities that may produce unacceptable risks to site workers or the public. These scenarios will be consistent with the tank closure EIS and will be used to ensure that adequate controls are implemented to mitigate the risks.

3. Provide quantitative estimates of long-term human health risk associated with the activities related to SST closure and final conditions of the SST system.

4. Provide sufficient quality and quantity of long-term human health risk estimates in a format that supports the decisions required by the applicable regulations.

5. Provide risk assessment information in sufficient level of detail and resolution to support closure management decisions for individual source terms as well as WMAs and the SST system as a whole.

Similar objectives shall be developed for the ERA conducted before closure of the WMA.

4.3 SST SYSTEM LONG-TERM RISK ASSESSMENT APPROACH

Long-term risk assessment is based on estimation of the potential for contaminants present within the SST system WMAs to migrate through the vadose zone, resulting in contamination of underlying groundwater. Subsequent exposure to or consumption of this contaminated groundwater by hypothetical future receptors may result in exposure to radioactive, toxic, and/or carcinogenic contaminants with resultant human health risks. The long-term risk related to transport of contaminants to groundwater exposure points will be evaluated for each WMA using the general approach described in the following subsections.

Additional long-term risks may be posed by the potential for future site intruders to penetrate the closed tank farm and be subsequently exposed to residual contamination in the tank(s) and subsurface soil. To prevent intrusion and direct contact of contaminants of concern, a modified RCRA Subtitle C barrier shall be placed over the WMA. This barrier has a design life of 500 years (*Focused Feasibility Study of Engineered Barriers for the Waste Management Units in the 200 Areas* [DOE/RL-93-033]) and is designed to prevent both bio-intrusion and human intrusion. Before the final design of the barrier, an analysis of intruder risk will be evaluated.

Long-term risk related to WMA closure is driven by potential for exposure to contaminated soil and groundwater. Long-term risks will be estimated using a combination of numerical and analytical solutions to describe the migration of contaminants from the source areas, through the vadose zone, and through the aquifer to selected groundwater exposure points. Numerical models used for this activity will be selected from models previously evaluated and shown to be applicable and appropriate for use in the identified cases. Modeling inputs will be defined prior to beginning the simulations and will be reviewed for appropriateness. Input parameters will be selected and prepared using the following priority of source: 1) site-specific measured values, 2) measured values from similar sites, 3) best estimates based on site or process knowledge and observations, and 4) information based on literature.

4.3.1 Define Performance Objectives

Formulation of the performance objectives against which project activities will be evaluated is central to the development of a long-term risk analysis. The primary performance objective is that the SST system closure conditions are protective of human health and the environment (the ERA will be completed before the closure of the WMA) on both short- and long-term bases. Relevant performance objectives may be defined by RCRA, CERCLA, HWMA, *Clean Water Act*, *Safe Drinking Water Act*, and the AEA. A comprehensive review of the pertinent regulations has been performed to develop a suite of performance objectives applicable to evaluation of the effectiveness and compliance of SST system closure activities. This information has been published in *Performance Objectives for Tank Farm Closure Risk Assessments* (RPP-14283) and is incorporated in this closure plan by reference. Additional details of selected individual risk-based metrics are presented below in Section 4.4.2.

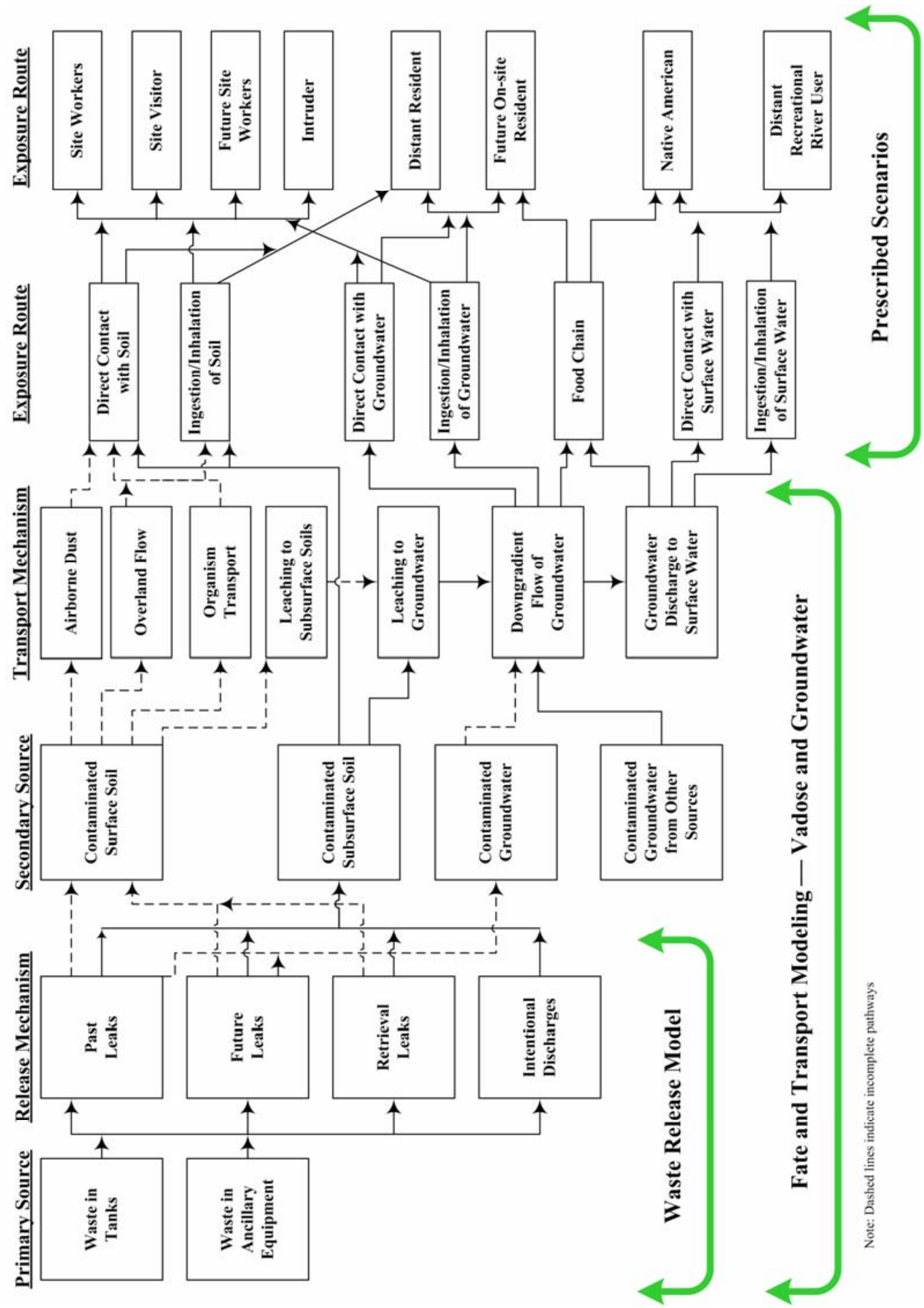
4.3.2 Define the Conceptual Exposure Model

The conceptual exposure model for Hanford tank farms is described in DOE/RL-99-36. Based on the referenced exposure model, a site-specific exposure model will be prepared and documented in an interim report. This exposure model will identify the specific primary and secondary sources that will be considered (an inventory data package shall be prepared for each WMA which identifies the contaminants-of-potential-concern and their inventory and concentrations), the contaminant release and transport mechanisms, contaminated media, and exposure routes. Sources to be considered for this effort will include the following:

- Residual waste in SSTs
- Residual waste in ancillary equipment
- Past leaks and previous unplanned releases
- Past intentional discharges of waste to the ground within WMAs
- Hypothetical leaks during waste retrieval

The preliminary conceptual exposure model for SST system closure is illustrated in Figure 4-1. A similar figure will be developed for the ERA at WMA closure.

Figure 4-1. SST System Closure Risk Assessment Conceptual Site Model.



The conceptual exposure model also will include the following aspects of the risk assessment, consistent with DOE/RL-99-36:

1. <u>Identification of anticipated future land use scenarios including discussion of how the risk assessment scenarios fit into the "core and buffer" zones identified by Ecology, EPA, and DOE</u>. All of the SST WMAs fall within the 200 Areas' Central Plateau area that has been identified as the "core" area. The anticipated land use scenario for the SST WMAs is exclusive industrial use from the present through 50 years after closure of the last WMA. Full institutional control is assumed to be in place during this period. For the period beyond 150 years post-closure, long-term risks related to a variety of land use scenarios will be evaluated for comparative purposes.

2. <u>Definition of receptor scenarios that will be evaluated for this risk assessment, including a residential farmer scenario among the scenarios selected.</u> A variety of hypothetical human health receptor scenarios have been identified for comparative purposes. These include the following:

   - Industrial worker with exposures via groundwater
   - Residential receptor with exposures via groundwater or surface water
   - Agricultural receptor with exposures via groundwater or surface water
   - Recreational receptor with exposures via groundwater or surface water
   - Native American receptor with exposures via groundwater or surface water

   These receptors have been identified for evaluation of ILCR, HI, and radiological dose (effective dose equivalent [EDE]). The industrial worker is identified as the selected receptor for assessing long-term risk during the postclosure period when institutional control is assumed to be in place. Terrestrial and aquatic receptors will be evaluated during the ERA.

   Additionally, DOE O 435.1 requires three additional hypothetical receptor scenarios be evaluated for radiological dose to support dose-related decisions. These receptors are as follows:

   - A two-part waste site intruder scenario involving an acute dose to a hypothetical well driller who inadvertently penetrates a tank and brings up contaminated drill cuttings. Then an onsite resident subsequently spreads the drill cuttings over a homestead site and lives on the contaminated site receiving a chronic dose.
   - A complex receptor called the All-Pathways Farmer who receives radiological doses from a variety of exposure pathways.
   - A complex Native American receptor who receives radiological doses from a variety of exposure pathways.

All of the preceding receptor scenarios are described in detail in *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment* (HNF-SD-WM-TI-707).

3. Identification of contaminants of concern for which contribution to long-term risk will be calculated. Contaminants of concern will be identified through evaluation of relative contribution to performance metrics from individual constituents. Relative effects of all identified waste constituents will be evaluated. Final selection of contaminants of concern for each WMA will not be made until sampling and analysis of post-retrieval tank residuals and residual vadose contamination are complete. The preliminary baseline WMA risk assessments prepared prior to full characterization will include the following constituents at a minimum:

   - Technetium-99 (assumed to be present as the pertechnetate ion with a distribution coefficient (K_d) = 0)
   - Iodine-129 (assumed to be present as the iodide ion with K_d = 0)
   - Chromium (assumed to be present as ionic hexavalent chromium with K_d = 0)
   - Nitrate and nitrite (assumed to be present as the ions with K_d = 0)
   - Uranium (assumed to be present as uranium^{VI} with K_d = 0.6)

   Based on previous fate and transport simulation efforts at Hanford, the constituents above are expected to account for the majority of long-term impacts to groundwater and a table will be prepared showing the relative contribution of these contaminants to a particular risk metric. Following sampling after retrieval, the impacts of the constituents listed in the approved DQO will be evaluated. For example, for C-106, there are 114 primary constituents and 134 secondary constituents listed in the DQO. Other constituents may be added to preliminary baseline risk assessment depending on WMA-specific inventory information.

4. Identification of the parameters that will be used to assess the estimated long-term risks (such as carcinogenic and noncarcinogenic risk and radiological dose criteria, and numerical regulatory standards [MCL]). The following primary risk-based performance objectives for WMA-related constituents are given in *Performance Objectives for Tank Farm Closure Risk Assessments* (RPP-14283) (see aforementioned document for additional risk assessment performance objectives):

   - Incremental lifetime cancer risk less than 1.0 x 10^{-5}.
   - Noncarcinogenic HI less than 1.0.
   - No exceedence of drinking water standards (MCLs) for individual constituents (this includes the MCL Derived Constituent Concentration [“C4” concentration] for individual beta/photon emitting radionuclides).

- No exceedence of DOE drinking water dose limit of 4 mrem/yr EDE for beta/photon emitters in water.
- No exceedence of DOE drinking water limit of 15 pCi/L alpha emitters.
- No exceedence of ambient surface water quality standards at the Columbia River.
- No exceedence of WAC 173-340 standards for direct contact.

5. Selection of receptor locations for long-term groundwater exposure assessment, including the WMA fenceline as a point of calculation. Three hypothetical receptor locations have been identified for calculation of preliminary groundwater concentration and resulting risk metric estimates. These locations are as follows:

   - The downgradient WMA fenceline, using a fenceline average concentration calculation.
   - The nearest downgradient boundary of the 200 Areas' exclusion zone.
   - The nearest downgradient point of potential groundwater discharge into the Columbia River.

6. Specification of the time frame for the risk assessment and supporting fate and transport simulations. The fate and transport simulations and resulting risk metric estimates will be limited to a simulation period extending from the present to a maximum of 10,000 years in the future. 10,000 years is the period of time recommended by the EPA for long-term risk assessments involving nuclear waste (10 or 40 CFR 144 and 191). Simulations extended beyond 1,000 years in the future present substantial and increasing uncertainty in estimation of land use and climatic and geologic conditions. Simulations beyond 10,000 years are deemed not to be credible.

4.3.3 Define the Site Conceptual Model for Physical Characteristics and Potential Contaminant Transport

A data package (i.e., *Modeling Data Package for an Initial Assessment of Closure for C-Tank Farm* [RPP-13310]) containing the detailed conceptual physical model of the site will be prepared for each WMA. The conceptual model describes the physical (e.g., hydrologic, stratigraphic, and placement) characteristics of the site. This conceptual model will also describe the physical interrelationships between the potential contaminant sources and the physical setting of the site and will become the basis for the fate and transport simulations. The model will be based on existing knowledge of site-specific conditions to the extent practical. Boundary conditions will be identified for use in transport simulations. The conceptual model will be constructed in a manner that supports extrapolation of fate and transport simulation results to all identified sources within a WMA and will be documented for each WMA in a data package.

Also documented in the data package are the codes to be used and the modeling approach for both the vadose zone and underlying aquifer.

The following elements will be defined for each WMA conceptual model:

- Site-specific vadose and aquifer stratigraphy extending from the ground surface to the selected exposure points
- Location of the contaminant sources
- Contaminant release scenarios that describe the manner in which the individual constituents in the selected source materials (tank residuals, past leaks, ancillary equipment residuals, and retrieval leaks) are assumed to enter the contaminant transport system (solubility limits, duration of release)
- A mechanism to reflect potentially variable effectiveness of engineered surface barriers at controlling infiltration through the site
- A mechanism to reflect the variability in hydraulic characteristics of alternative tank fill materials.

4.3.4 Identify and Catalog the Input Values for Fate and Transport Simulations

Values, or, where appropriate, ranges of values, will be identified for the site hydrologic properties (soil density, porosity, hydraulic conductivity, infiltration rates) and for the physical and chemical properties of the radioactive and nonradioactive constituents (solubility, half-life, distribution coefficient). These values will be derived from a literature search and discussions with local subject matter experts to derive values from previous work under similar conditions and, where possible, from empirical data derived from measurements of site-specific materials. In the event that the current state of knowledge regarding input values yields a substantial range of values for specific parameters, a strategy for quantifying the uncertainty in long-term risk related to the uncertain parameters will be prepared. In the absence of a body of information sufficient to determine the distribution of an observed range of input values, professional judgment will be applied to identify representative values.

4.3.5 Identify Relevant Closure Management Variables and Decisions

Tank closure management alternatives will be identified for analysis of their effects on long-term risk. These alternatives will be selected for specific sensitivity analyses to quantify their impacts on risk. The closure management alternatives to be considered for sensitivity analysis include the following:

- Retrieval efficacy/residual waste volume

- Tank fill effects on infiltration and attenuation of waste constituents
- Final cover's efficacy at reducing infiltration of precipitation through the site.

These alternatives and variables will be specified and included in the WMA-specific documentation.

4.3.6 Implement the Risk Assessment Simulations

The long-term risk assessment simulations will be conducted in a sequential manner using a combination of deterministic and stochastic simulation techniques, as appropriate. This sequential approach will provide a sound basis for the following determinations:

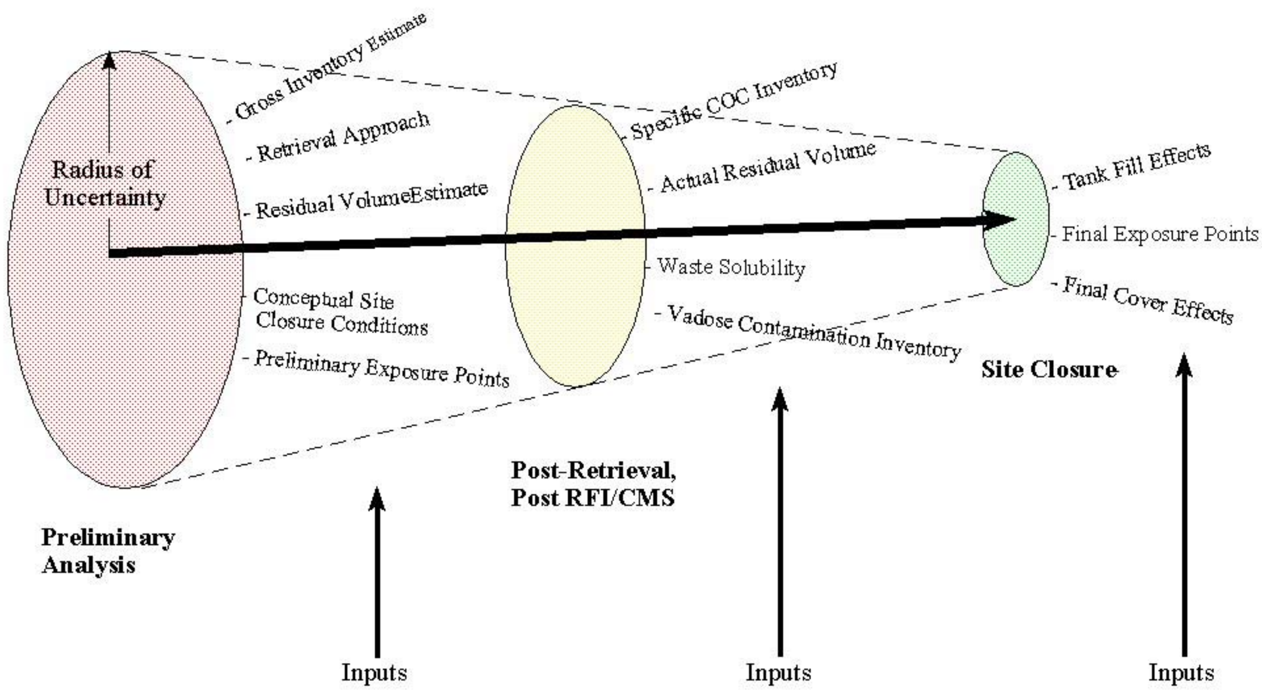
- Demonstrate risks related to expected closure conditions for each WMA.
- Identify variables to which risk estimates are highly sensitive.
- Quantify risk uncertainty related to the sensitive variables, with particular focus on sensitive closure management variables.
- Quantify risk estimate uncertainty resulting from cumulative effects of nonsensitive variables.

Graphical and tabulated risk estimate results will be presented. The objective of the risk estimate result presentation is as follows:

- Clearly indicate the resultant risk(s) and the criterion to which it is compared.
- Clearly indicate the input variable set that generated the resultant risks.
- Clearly indicate the efficacy and appropriateness of selected closure alternatives.

Additionally, the analysis of sensitivity and uncertainty will be used to identify closure data needs and support definition of data collection requirements. Iterative computation of quantitative risk estimates as new data are developed will reduce uncertainty in the estimates. The general effect of data collection and iteration of risk estimates is shown in Figure 4-2, with the uncertainty section in Addendum C-1 providing quantitative analysis showing this process for WMA C.

Figure 4-2. Conceptual Uncertainty Reduction through Data Collection and Iterative Risk Estimation.



4.4 SHORT-TERM WORKER AND GENERAL PUBLIC RISK ASSESSMENT APPROACH

Short-term risks are those risks posed by exposure of site workers and members of the public to contaminants during implementation of site closure activities and the effects of accident scenarios. Radiological short-term risk assessment approach information presented in this section is for information purposes only, in accordance with DOE's authority under the AEA. The hazards associated with these activities include 1) potential occupational hazards resulting in physical trauma, 2) radiological exposure resulting in latent cancer fatalities, 3) chemical exposure from accidents (HI), and 4) chemical hazards from routine exposure (HI). Initiating events that could result in hazardous health effects may include natural phenomena, human error, component failure, and spontaneous reactions. Health risks during normal conditions include anticipated exposure to radiation and chemical fields and radiological and chemical releases to

the atmosphere during normal retrieval activities. The following subsections present additional specific information regarding these approaches.

Worker and general public exposure scenarios will be developed for tank closure activities. These scenarios will be designed to accurately represent the types of exposure that are expected based on selected tank closure alternatives. Various options for tank filling following waste retrieval will be evaluated. Tank filling will present potential exposures to workers and the general public.

Because the short-term risks will be encountered in the near future while the site is under physical and administrative control of DOE, it can be reasonably anticipated that the tank closure activities will be conducted in a manner that maintains exposure to tank wastes as low as reasonably achievable through the use of engineered controls and protective equipment. It is assumed that after final closure of the tanks, short-term risk will be fully mitigated. The engineered controls necessary to maintain as low as reasonably achievable conditions as required by the AEA during closure activities may not be cost-effective and could impact retrieval actions.

4.4.1 Occupational Injuries, Illnesses, and Fatalities

The number of injuries, illnesses, and fatalities resulting from closure activities is calculated based on the most currently available incidence rates that would be applicable to the activities. The number of injuries, illnesses, and fatalities from construction or operations is calculated by multiplying the total person-years required to support the activity by the incidence rates.

4.4.2 Radiological Risk from Accidents Involving Mixed Wastes

The radiological risk is expressed as the number of latent cancer fatalities resulting from accidents in which people are exposed to radiation fields or radiological constituents released to the atmosphere. The probability of the accident occurring also is evaluated. The methodology used to identify and quantify the radiological risk from mixed-waste accidents is performed using the steps described as follows. These analyses are conducted in accordance with DOE's authority under the AEA.

Step 1. Accident Identification. Potential hazards associated with retrieval activities are identified from existing preliminary hazards analyses and other safety documents. The hazards will be reported in a tabular format showing, for each accident, the barriers within the facility that prevent or mitigate the consequences of the accident, a rough estimate of the magnitude of consequences of the accident assuming that the listed preventive barriers fail, and the estimated likelihood of the accident occurring.

Step 2. Accident Strategy Selection. The accident with the highest risk is screened for further analysis to determine, as accurately as possible, the consequences and

probability of occurrence. The risk of a given accident is the product of the consequences of the accident and the estimated likelihood of the event occurring. Screening for the highest risk accidents follows the same methodology as outlined in the *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports*, Section 3.3.2.3.5 (DOE-STD-3009-94). Accident frequencies are based on published safety hazard documents, for example *Tank Farm Final Safety Analysis Report* (HNF-SD-WM-SAR-067).

Step 3. **Accident Sequence Quantification.** The frequency of occurrence of the selected accidents is taken from referenced documents where available. Where accident frequencies are not available, they are estimated.

Step 4. **Source-Term Development.** The source term is the respirable fraction of inventory from which the receptor dose is calculated. The source term is developed based on the inventory that could potentially be released to the environment from an accident. The major reduction factors that control the source term are considered in the evaluation. The reduction factors include airborne release fractions, airborne release rates, and respirable fractions. Use of the reduction factors will be dependent on the nature of the accident (i.e., energy of accident at impact, waste form, and effectiveness of mitigating barriers). Direct exposure to radiation under mixed-waste accident conditions also is evaluated. Direct exposure is the direct beta and gamma radiation dose rate to a receptor. Exposure due to ingestion would be negligible compared to inhalation and is not analyzed.

Step 5. **Atmospheric Dispersion Coefficients (X/Q).** The X/Q values are generated using the GXQ computer code in the *GXQ Program Users Guide* (WHC-SD-GN-SWD-3002) following the methodology outlined in the *Atmospheric Dispersion Models for Potential Accident Consequence Assessment at Nuclear Power Plants* as referenced in the Nuclear Regulatory Commission Regulatory Guide 1.145 (NUREG 1.145). The meteorological data used by GXQ are in the form of joint frequency tables. The joint frequency data are taken from data collected at the Hanford Site meteorology tower in the 200 Areas. The X/Q values are used in equations to calculate the mixed-waste radiological dose experienced by the noninvolved and involved worker and general public receptors as a result of inhaling radioactive materials (ingestion will also be included for the general public receptor dose).

Step 6. **Receptor Determination.** Potential health effects from radiological exposures from mixed waste are estimated for three population subsets and maximally exposed individuals in those populations. The dose to a receptor depends on the location of the receptor relative to the point of release of the radioactive material from mixed waste. The involved workers are those involved in the proposed action and physically performing work at the facility. They are assumed to be in the center of a 10-m (33.0-ft) radius hemisphere where the airborne released material has spread instantaneously and uniformly. The noninvolved workers would be on the Hanford Site but not involved in the action. They are assumed to extend from

100 m (330 ft) out to the Hanford Site boundary. The general public is assumed to be located at the site boundary to a distance of 80 km (50 mi) from the point of release. The Hanford Site boundary used in the analysis is the adjusted site boundary that excludes areas designated as the Hanford Reach National Monument. These areas include the north slope of the Hanford Reach of the Columbia River. The site boundaries are as follows:

- North: Columbia River, 0.4 km (0.25 mi) south of the south river bank
- East: Columbia River, 0.4 km (0.25 mi) west of the west river bank
- South: A line running west from the Columbia River, just north of the Washington Public Power Supply System leased area, through the Wye Barricade to Highway 240
- West: Highway 240 and Highway 24.

Step 7. **Radiological Dose Assessment.** The inventory involved in each accident is evaluated to determine the activity concentrations. The activity concentrations are converted to unit liter dose factors. The GENII computer code (PNL-6584) is used to generate a single inhalation liter dose factor for each composite source term for a 50-year dose commitment period. The receptor doses are given in terms of committed effective dose equivalents. The unit inhalation dose factors are used along with the appropriate atmospheric dispersion coefficient, breathing rates and the source term to determine the radiological dose to the involved and noninvolved worker and general public receptors.

Step 8. **Latent Cancer Fatality (LCF) Risk Development.** The likelihood that a dose of radiation from mixed waste would result in a fatal cancer at some future time is calculated by multiplying the receptor dose by a dose-to-risk conversion factor. Conversion factors are predictions of health effects from radiation exposure. The dose-to-risk conversion factors used for estimating latent cancer fatalities from low doses of radiological exposure and from high doses are consistent with those taken from *Recommendations of the International Commissions on Radiological Protection* (ICRP 1991). They are summarized as follows:

- **Involved worker and noninvolved worker:** 4.0×10^{-4} LCF/rem for low doses less than 20 rem and 8.0×10^{-4} LCF/rem for doses greater than or equal to 20 rem.
- **General public:** 5.0×10^{-4} LCF/rem for low doses less than 20 rem and 1.0×10^{-3} LCF/rem for doses greater than or equal to 20 rem. The dose-to-risk conversion factors for the general public accounts for the presence of children.

4.4.3 Chemical Exposure from Accidents

The chemical inventory used for this assessment is made up of two components, the organic chemicals and the inorganic chemicals. The emission rates for organic chemicals are taken from *Organic Vapor Source Term for Tanks 241-C-201, 241-C-202, 241-C-203, and 241-C-204 During Waste Retrieval Operations*, RPP-14841. The emission rates for inorganic chemicals are taken from *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment*, HNF-SD-WM-TI-707. Potential acute hazards associated with exposure to concentrations of postulated accidental chemical releases were evaluated using a screening-level approach for the receptors. This involves directly comparing calculated exposure point concentrations of chemicals to a set of air concentration screening criteria, known as emergency response planning guidelines (ERPG). The ERPGs, as developed by the American Industrial Hygiene Association, are specific levels of chemical contaminants in air designed to be protective of acute adverse health impacts for the general population. ERPGs are the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing the following effects:

- ERPG 1 - Mild transient adverse health effects or perceiving a clearly defined objectionable odor
- ERPG 2 - Irreversible or other serious health effects, or symptoms that could impair ability to take protective action
- ERPG 3 - Irreversible or life-threatening health effects could result from exposures exceeding one hour.

In the event that an ERPG value does not exist, DOE requires the use of Threshold Emergency Exposure Limit (TEEL) values. Like the ERPGs, there are multiple levels of TEELs as follows:

TEEL-0 The threshold concentration below which most people will experience no appreciable risk of health effects.

TEEL-1 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.

TEEL-2 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

TEEL-3 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

Cumulative hazards or the acute hazard index (HI) for toxic and corrosive/irritant chemical classes were evaluated using the following equation.

$$HI = \sum \frac{C_{chemical}}{ERPG_{chemical}} \qquad (4\text{-}1)$$

where:

HI is the cumulative hazard index for acute exposure

$C_{chemical}$ is the concentration at the exposure point of each chemical (mg/m^3)

$ERPG_{chemical}$ is the ERPG (or TEEL if no ERPG available) for each chemical (mg/m^3).

A cumulative HI is calculated for each ERPG/TEEL level (1, 2, and 3). If the HI is greater than 1.0, this indicates that the acute hazard guidelines for a mixture of chemicals has been exceeded and the chemical mixture may pose a potential acute health impact. The potential impact is described in the level definition shown above. To be consistent with previous tank farm worker risk assessments and DOE guidance, TEELs and ERPGs were chosen as the hierarchy approach versus other hierarchy approaches used in the WTP risk assessment on-site.

Determining the accidents to be used in the strategies, the source term, atmospheric dispersion coefficients, and the receptor location followed the same methodology as that applied to radiological risk from accidents described in Section 4.4.2.

4.4.4 Radiological Latent Cancer Fatalities Risk from Routine Exposure

The involved worker exposure is a combination of exposure from inhalation and direct radiation. Involved worker dose rates are estimated based on time, distance, and shielding considerations associated with the various tasks. Noninvolved workers and general public exposure are estimated by determining the expected routine radiological releases during retrieval and closure. Exposure to the noninvolved worker is assumed to be from inhalation and external radiation from the plume continuously throughout the year and from deposition of radionuclides on the ground. The exposure pathways for the general public are assumed to be inhalation, external exposure from submersion in a plume, and ingestion of contaminated farm products. The receptors are in the same location and the same population size as defined in Section 4.4.2 for radiological accidents. The GENII computer code is used to calculate the dose based on X/Qs generated by GXQ. The latent cancer fatality is then calculated by multiplying the receptor dose by a dose-to-risk conversion factor from ICRP (1991) defined in Section 4.4.2 for radiological accidents.

4.4.5 Chemical Hazards from Routine Exposure

The chemical inventory used for this assessment is made up of two components, the organic chemicals and the inorganic chemicals. The emission rates for organic chemicals are taken from RPP-14841. The emission rates for inorganic chemicals are taken from HNF-SD-WM-TI-707.

To estimate the potential noncarcinogenic effects from exposure to multiple chemicals, the HI approach was used consistent to EPA methodology that was used in DOE/EIS-0189 and DOE/RL-98-72. The HI is defined as the summation of the inhalation HQ (chemical concentration divided by the reference concentration [RfC] for that chemical). This HI was calculated as follows:

$$HI = \sum \frac{C_{chemical}}{RfC_{chemical}} \quad (4\text{-}2)$$

where:

HI is the cumulative hazard index for acute exposure

$C_{chemical}$ is the concentration at the exposure point of each chemical (mg/m^3)

$RfC_{chemical}$ is the reference concentration of the chemical from the EPA IRIS database (mg/m^3).

A total HI less than or equal to 1.0 is indicative of acceptable levels of exposure.

4.5 ECOLOGICAL ASSESSMENT

The Hanford HLW tank farms, including the SST system, have been used for storage of high-level radioactive mixed waste since the mid-1940s. During this time, the tank farms have been managed in a manner intended to eliminate, to the extent possible, the intrusion of plants and wildlife into the facilities. An ecological assessment of the SST system and its WMAs is required for closure pursuant to WAC 173-340-7490.

It is anticipated that a two-phased approach shall be used to evaluate the ecological risk related to tank farm closure. The first phase would be a biological survey of the tank farms, followed by ecological mitigation planning associated with individual component closure actions. The second phase would be an ecological risk assessment of the effects of the closure activities and the postclosure conditions. These activities are discussed further in the following paragraphs.

The biological survey of tank farms would consist of a thorough on-the-ground examination of each WMA, including any area outside the existing WMA footprint. This survey will include adjacent areas that may be disturbed and reshaped during construction of the final engineered surface barrier and neighboring areas that may serve as habitat for potential receptors. The need and frequency of the biological surveys will be dependent upon the results from the 200 Area ERA that is being conducted by the Groundwater Protection Project.

The product of this survey would be a catalog of flora and fauna residing in and around the WMAs and a conceptual model that identifies all source terms, exposure pathways, and receptors. The catalog should identify those species identified as state or federal threatened or endangered species and will focus on representative receptor species.

The ecological risk assessment would be conducted following the biological survey. The effects of the planned WMA closure activities (such as the construction of the engineered surface barrier) on both affected threatened/endangered species as well as representative species will be assessed. A food chain evaluation shall also be made as part of the ecological risk assessment.

The end state of the closure (activity completed and final engineered surface barrier in place) will be assessed for potential ecological effects. This assessment will include local effects based on studies and observations made of ecological effects of the full-size prototype engineered surface barrier located in the 200 East Area. Additional ecological risk effect estimates will include comparison of estimated groundwater discharge impacts to applicable acute and chronic surface water quality criteria.

The results of the ecological risk assessment will be documented in the final closure report for the WMA(s).

4.6 RISK ASSESSMENT COMMUNICATION

Information will be shared among DOE, implementing contractors and subcontractors, regulators, and stakeholders regarding the elements of the risk assessment and inputs to the simulations. Effective communication of these concepts will be conducive to developing understanding of the process and lead to successful preparation of supporting documentation. The following information will be published as supporting data packages for the overall SST system risk assessment:

- *Performance Objectives for Tank Farm Closure Risk Assessments* (RPP-14283)
- *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment* (HNF-SD-TI-707).

These data packages will provide general information that will be applied to all WMAs in the system. In addition to the system-wide data packages, at least two additional data packages will be published for each WMA, as follows:

- A modeling input data package for each WMA that describes the unique geology/hydrology of the WMA as well as identifying WMA-specific inputs to the contaminant fate and transport simulations.
- A WMA-specific inventory data package, which will include the best-basis inventory and facilitating assumptions for the volume and constituent contents of source terms identified for the WMA (tank residuals, ancillary equipment residuals, past leaks, retrieval leaks, intentional discharges).

Together, these four data packages will form the basis for each WMA risk assessment. Following the risk assessment analysis for each WMA, a summary risk assessment document will be prepared for each WMA describing the results.

The data packages listed above focus on the human health risk. Similar data packages, if necessary, shall be developed for the ERA, which will be performed be a WMA can be closed.

WMA risk assessments will be updated when substantial new input data are generated. Examples of activities that may initiate risk assessment update include:

- Completion of waste retrieval from individual WMA components and generation of component-specific waste volume and residual waste characteristic data

- Completion of characterization of vadose zone and groundwater contaminant inventories (e.g., RFI/CMS)

- Completion of design for final tank fill and/or final WMA closure conditions (e.g., cover or cap designs).

An independent merit review board will evaluate the SST closure risk assessment methodology inputs and results. Results of the review will be documented in a report.

4.7 DATA AND INFORMATION REQUIREMENTS

Risk assessments are iterative in nature and improve as data gaps are filled. The risk assessment is updated as data gaps are filled to reflect a greater understanding of the system. This process begins with using existing data and supplementing known data gaps with assumptions. For this risk assessment, although current site-specific data needed were incomplete, enough relevant data from other sources were available that specific assumptions were made to satisfy the data gaps.

When made, these assumptions tended to be on the conservative side. As the risk assessment process continues, the conservative assumptions are replaced with site-specific data. In this case, sampling of residual waste following retrieval would provide the best residual waste inventory estimates.

The data gaps identified during the course of this analysis are given in Table 4-1. Included in this table are the following:

- **Information type** can be either data (measurable quantity) or analysis (derived)

- **Impacts** identifies what item in the analysis would change with additional information

- **Knowledge level** is based on professional judgment after reviewing available literature

- **Data collection feasibility** is based on professional judgment on the ease of collecting the data
- **Ranking** is based on professional judgment on how important this data is to the analysis
- **Path Forward** describes how the identified data gap should be addressed
- **Limitations** describe how the data gap is being addressed in this analysis.

Table 4-1. Data Gaps and Priorities (3 Pages)

Title	Information Type	Impacts	Knowledge Level	Data Collection Feasibility	Ranking	Path Forward	Limitations
Inventory estimates	Data and analysis	Peak concentrations and arrival times for breakthrough curves from various sources	Medium	Medium	1	Tank residual waste scheduled to be sampled following retrieval and the risk assessment will be updated.	Limited availability and uncertain quality for ancillary equipment and piping systems' inventory estimates.
Residual waste release models	Data and analysis	Peak concentrations and arrival times for breakthrough curves due to residual wastes	Low	High	1	Characterize residual tank wastes; obtain empirical data on their release behavior especially for stabilized (grouted*) and for solubility-driven waste forms. Waste constituent studies started on sludge from Tank AY-102(sludge originally from Tank C-106). Results indicate the release of technetium to water is much slower than previously believed. Additional characterization underway to better understand technetium release from the waste to develop a realistic release model. More realistic release models are also being developed for the other COC	In the absence of characterization data for release models, conservative values are being used for diffusion coefficients for stabilized (grouted*) tank wastes. Considerable uncertainty exists also with the solubility-dominated release model used in this assessment.
Retrieval leak volumes	Data	Peak concentrations and arrival times for retrieval leaks	Low	Not known	1	Evaluate current leak detection monitoring methods during retrieval operations.	Leak volumes used in this assessment are data used in past analyses.

* See Preface in *SST System Closure Plan* (RPP-13774).

Table 4-1. Data Gaps and Priorities (3 Pages)

Title	Information Type	Impacts	Knowledge Level	Data Collection Feasibility	Ranking	Path Forward	Limitations
Composition of leaked retrieval tank wastes	Data and analysis	Peak concentrations and arrival times for retrieval leaks	Low	Medium	1	Evaluate data collected during retrieval operations.	No data on composition available at this time and values used in this assessment are assumptions.
Two-dimensional versus three-dimensional modeling	Analysis	Peak concentrations and arrival times for breakthrough curves from various sources	Medium	High	1	Perform STOMP simulations for both two- and three-dimensional setup of the tank farm flow domain and evaluate the approach being used to account for the third dimension.	An untested approach is presently being used to account for the third dimension.
Hydraulic and transport parameters for unconfined aquifer	Data	Breakthrough curves from various sources at the proposed core zone boundary and Columbia River	Medium	Medium	1	RCRA Drilling just to the north of the WMA C fenceline is scheduled to penetrate the unconfined aquifer and the hydraulic conductivity of the aquifer will be evaluated.	Parameters being used in the initial assessment are believed to be conservative.
Short-term risk assessment closure accident scenarios	Analysis	Changes short-term risk for accident scenarios	Medium	High	1	Perform safety analysis for closure activities.	Uses retrieval accident scenarios as a bounding case.
Pre-closure (current) recharge estimates	Data	Peak concentrations and arrival times for breakthrough curves due to past and retrieval leaks	Medium	Medium	2	Review recently collected infiltration data for BX tank farm, and evaluate applicability for C farm conditions.	Data are derived from other sources and not a site-specific measurement.
Post-closure (barrier) recharge estimates	Data	Peak concentrations and arrival times for breakthrough curves due to residual wastes	High	Medium	2	Review multi-year infiltration data collected for 200-BP-1 prototype barrier, and evaluate applicability for C farm RCRA barrier.	Use available data after review.

Table 4-1. Data Gaps and Priorities (3 Pages)

Title	Information Type	Impacts	Knowledge Level	Data Collection Feasibility	Ranking	Path Forward	Limitations
Hydrologic properties of vadose zone units	Data	Peak concentrations and arrival times for breakthrough curves from various sources	Medium	Medium	3	Measure properties of site-specific soils.	Must extrapolate small scale (i.e., laboratory measurements) to large-scale estimates.
Existing vadose zone contamination	Data and analysis	Peak concentrations and arrival times for past leaks and unplanned releases	Low	Medium	2	Continue evaluating spectral gamma logging data as part of a FIR for WMA C.	Extrapolating local measurements to the entire vadose zone introduces uncertainty. Spectral data do not include long-lived mobile contaminants. Data are mostly from vertical point sources.

BBI = best-basis inventory
COC = constituent of concern
FIR = field investigation report
RCRA = *Resource Conservation and Recovery Act of 1976*
WMA = waste management area

Ranking gathering information rated 1 should be the highest priority, while gathering information for a ranking 3 would have a low priority

5.0 CHARACTERIZATION OF SST SYSTEM FOR CLOSURE

This section describes the general approach for characterizing components within the SST System for the purposes of closure. According to Condition II.D.1 of the Site-Wide Permit, all waste analyses are to be conducted in accordance with a written waste analysis plan (WAP), or sampling and analysis plan (SAP). Operating TSD units that receive waste are required to have a WAP; however, closing TSD units, and units in post-closure, are required to have a SAP and, if necessary, a WAP.

A WAP associated with the SST System for closing components is not considered to be necessary at this time. The purpose of a WAP is to confirm the owner/operator's knowledge about a dangerous waste before storage, treatment, or disposal of the waste (WAC 173-303-300(1)). For closing SST components, receipt of dangerous waste for storage will not occur with the possible exception of future introduction of DST supernatant liquids in some SSTs for retrieval purposes. Should this need arise in the future, the requirements of a WAP will be met for that specific activity in conjunction with retrieval actions. Similarly, treatment of waste within a closing SST system component is not contemplated at this time nor are SST System components intended to be used for receipt of waste for the purposes of disposal.

SAPs will be generated to support sampling activities for closure. A data quality objectives (DQO) process will be used to ensure agreement between Ecology and DOE on the appropriate sampling and analysis requirements for closure purposes. The SAP incorporates the results of the DQO process.

Waste profiles are developed for wastes generated during tank retrieval operations. These profiles ensure that "generated" wastes are properly characterized for the purposes of safe storage or treatment at the receiving facility (e.g., Double-Shell Tank Systems). The DST System WAP (WHC-SD-WM-EV-053, as amended, *DST System Waste Analysis Plan*, Appendix A) describes the process for ensuring that waste from the SST System is properly characterized prior to transfer to the DST System.

DOE will conduct characterization of soil, tank system, and ancillary equipment and measurements of any residual left in tanks in support of closure. Tank and ancillary equipment characterization will provide data and information on the composition and amounts (volume) of any waste remaining in the tanks and in related ancillary equipment. DOE will conduct tank closure characterization at the WMA level and component level.

The primary goals of tank characterization are to provide data to:

1) Identify and implement measures to protect workers, the general public, and the environment,

2) Determine the volume of waste remaining at the completion of waste retrieval activities,

3) Provide a defensible estimate of the constituents remaining in the tank at closure,

4) Reduce uncertainty in inventories of contaminants of concern used in risk assessments, and,

5) Provide samples and analysis to refine conceptual models of contaminant release mechanisms and release rates as used in risk assessment calculations.

Additional goals include providing tank waste for purposes such as laboratory testing to assess performance of sequestering agents and tank fill materials).

The characterization process will start with a single SST (C-106) and then continue for the remaining tanks. Characterization will be also conducted for soil, tank systems, and ancillary equipment at the tank farm or WMA level and details (e.g., crosswalk to DQO and/ or SAP) will be included in the appropriate WMA closure action plan, component closure activity plan and/or corrective action documentation. Groundwater characterization is expected to occur as part of the remedial investigation/ feasibility study process under CERCLA.

5.1 RELIABILITY AND ACCEPTANCE OF CHARACTERIZATION METHODS AND RESULTS

To achieve the goals listed above, characterization methods and results must be reliable and regulatorily acceptable. To ensure reliability and acceptance, Ecology and DOE have been developing DQOs. The DQOs establish agreed and consistent procedures and criteria for conducting sampling and analysis and for residual waste measurements. For example, tank DQOs will determine:

- Volume measurement techniques to be used
- Type of media to be sampled
- Sample collection methodologies
- Number of samples to be collected
- Analytical methods to determine composition
- Data quality requirements for the composition data.

The DQO process will aid in determining when other data or information is needed and how that data will be collected.

Key sampling and analysis results will be summarized and made available to Ecology. Sampling and analysis results pertinent to closure actions will also be summarized in WMA closure action plans and subsequent updates to those plans.

6.0 PLANNING AND SCHEDULING SST CLOSURE ACTIONS

The HFFACO M-45-00 milestone series contains requirements for two new documents that will serve to plan and develop schedule activities required to close the SST system: 1) the *Single-Shell Tank System Closure Plan*, the present document and 2) the *SST System Implementation Plan*. Section 1.3 of the Framework Plan presents the relative timing of major activities required for closure of the SST system. Closure actions must be scheduled/approved through the closure plan and/or the HFFACO and incorporated by reference. As of the initial submittal of the plan, very few of these activities have been planned and scheduled, other than at a conceptual level.

The HFFACO is an agreed-to mechanism for scheduling closure actions. These actions, including retrievals, will be incorporated by reference in the SST closure plan permit and will be subject to SST closure plan requirements.

HFFACO Milestone M-45-06-T20A requires the *SST System Implementation Plan* to cover actions and strategies in the following major work areas:

- Waste retrieval
- Operable units characterization
- Technologies development to support closure
- Risk assessments
- Groundwater monitoring strategies.

Refinement of major work areas is to be developed in a joint Ecology/DOE workshop. Upon completion of the joint Ecology/DOE workshop, refinement of the scope of the implementation plan will have occurred. The essential function of the *SST System Implementation Plan* is as a planning tool for development of strategies, approaches, methods, and schedules for closing the SST system in a manner that both satisfies applicable requirements and coordinates resources and regulatory processes.

The HFFACO establishes a high-level schedule for overall SST system closure activities. The milestones that have been negotiated in the HFFACO provide a structure for developing detailed plans that specify activities and requirements for SST system closure. Table 6-1 identifies HFFACO milestones associated with closure of the SST system.

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-45-00 LEAD AGENCY: ECOLOGY	COMPLETE CLOSURE OF ALL SINGLE SHELL TANK FARMS. CLOSURE WILL FOLLOW RETRIEVAL OF AS MUCH TANK WASTE AS TECHNICALLY POSSIBLE, WITH TANK WASTE RESIDUES NOT TO EXCEED 360 CUBIC FEET (CU. FT.) IN EACH OF THE 100 SERIES TANKS, 30 CU. FT. IN EACH OF THE 200 SERIES TANKS, OR THE LIMIT OF WASTE RETRIEVAL TECHNOLOGY CAPABILITY, WHICHEVER IS LESS. IF THE DOE BELIEVES THAT WASTE RETRIEVAL TO THESE LEVELS IS NOT POSSIBLE FOR A TANK, THEN DOE WILL SUBMIT A DETAILED EXPLANATION TO EPA AND ECOLOGY EXPLAINING WHY THESE LEVELS CANNOT BE ACHIEVED, AND SPECIFYING THE QUANTITIES OF WASTE THAT THE DOE PROPOSES TO LEAVE IN THE TANK. THE REQUEST WILL BE APPROVED OR DISAPPROVED BY EPA AND ECOLOGY ON A TANK-BY-TANK BASIS. PROCEDURES FOR MODIFYING THE RETRIEVAL CRITERIA LISTED ABOVE, AND FOR PROCESSING REQUESTS FOR EXCEPTIONS TO THE CRITERIA ARE OUTLINED IN APPENDIX H TO THE AGREEMENT. FOLLOWING COMPLETION OF RETRIEVAL, SIX OPERABLE UNITS (TANK FARMS), AS DESCRIBED IN APPENDIX C (200-BP-7, 200-PO-3, 200-RO-4, 200-TP-5, 200-TP-6, 200-UP-3), WILL BE REMEDIATED IN ACCORDANCE WITH THE APPROVED CLOSURE PLANS. FINAL CLOSURE OF THE OPERABLE UNITS (TANK FARMS) SHALL BE DEFINED AS REGULATORY APPROVAL OF COMPLETION OF CLOSURE ACTIONS AND COMMENCEMENT OF POST-CLOSURE ACTIONS. FOR THE PURPOSES OF THIS AGREEMENT ALL UNITS LOCATED WITHIN THE BOUNDARY OF EACH TANK FARM WILL BE CLOSED IN ACCORDANCE WITH WAC 173-303-610. THIS INCLUDES CONTAMINATED SOIL AND ANCILLARY EQUIPMENT THAT WERE PREVIOUSLY DESIGNATED AS RCRA PAST PRACTICE UNITS. ADOPTING THIS APPROACH WILL ENSURE EFFICIENT USE OF FUNDING AND WILL REDUCE POTENTIAL DUPLICATION OF EFFORT VIA APPLICATION OF DIFFERENT REGULATORY REQUIREMENTS: WAC 173-303-610 FOR CLOSURE OF THE TSD UNITS AND RCRA SECTION 3004(U) FOR REMEDIATION OF RCRA PAST PRACTICE UNITS. ALL PARTIES RECOGNIZE THAT THE RECLASSIFICATION OF PREVIOUSLY IDENTIFIED RCRA PAST PRACTICE UNITS TO ANCILLARY EQUIPMENT ASSOCIATED WITH THE TSD UNIT IS STRICTLY FOR APPLICATION OF A CONSISTENT CLOSURE APPROACH. UPGRADES TO PREVIOUSLY CLASSIFIED RCRA PAST PRACTICE UNITS TO ACHIEVE COMPLIANCE WITH RCRA OR DANGEROUS WASTE INTERIM STATUS TECHNICAL STANDARDS FOR TANK SYSTEMS (I.E., SECONDARY CONTAINMENT, INTEGRITY ASSESSMENTS, ETC.) WILL NOT BE MANDATED AS A RESULT OF THIS ACTION. HOWEVER, ANY EQUIPMENT MODIFIED OR REPLACED WILL MEET INTERIM STATUS STANDARDS. IN EVALUATING CLOSURE OPTIONS FOR SINGLE-SHELL TANKS, CONTAMINATED SOIL, AND ANCILLARY EQUIPMENT, ECOLOGY AND EPA WILL CONSIDER COST, TECHNICAL PRACTICABILITY, AND POTENTIAL EXPOSURE TO RADIATION. CLOSURE OF ALL UNITS WITHIN THE BOUNDARY OF A GIVEN TANK FARM WILL BE ADDRESSED IN A CLOSURE PLAN FOR THE SINGLE-SHELL TANKS. COMPLIANCE WITH THE WORK SCHEDULES SET FORTH IN THIS M-45 SERIES IS DEFINED AS THE PERFORMANCE OF SUFFICIENT WORK TO ASSURE WITH REASONABLE CERTAINTY THAT DOE WILL ACCOMPLISH SERIES M-45 MAJOR AND INTERIM MILESTONE REQUIREMENTS.	9/30/2024

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System. (15 pages)

	DOE INTERNAL WORK SCHEDULES (E.G., DOE APPROVED SCHEDULE BASELINES) AND ASSOCIATED WORK DIRECTIVES AND AUTHORIZATIONS SHALL BE CONSISTENT WITH THE REQUIREMENTS OF THIS AGREEMENT. MODIFICATION OF DOE CONTRACTOR BASELINE(S) AND ISSUANCE OF ASSOCIATED DOE WORK DIRECTIVES AND/OR AUTHORIZATIONS THAT ARE NOT CONSISTENT WITH AGREEMENT REQUIREMENTS SHALL NOT BE FINALIZED PRIOR TO APPROVAL OF AN AGREEMENT CHANGE REQUEST SUBMITTED PURSUANT TO AGREEMENT ACTION PLAN SECTION 12.0. COMPLETION OF THIS MAJOR MILESTONE REQUIRES THE COMPLETION OF THE WORK SCOPE IN ALL PRECEEDING MILESTONES AND TARGET DATES, UNLESS OTHERWISE AGREED TO BY THE PARTIES.	
M-045-00B	COMPLETE "NEAR TERM" SST WASTE RETRIEVAL ACTIVITIES. UNTIL THE WASTE TREATMENT COMPLEX IS OPERATIONAL, THE AMOUNT OF DST SPACE AVAILABLE TO RECEIVE SST WASTE IS LIMITED. THE NEAR TERM FOCUS FOR SST WASTE RETRIEVAL WILL INCLUDE MAXIMIZING THE TRANSFER OF CONTAMINANTS OF CONCERN (LONGLIVED, MOBILE RADIONUCLIDES) INTO THE DST SYSTEM. WORK UNDER THIS MILESTONE ALSO INCLUDES COMPLETION OF ONE "LIMITS OF TECHNOLOGY" RETRIEVAL DEMONSTRATION, INITIATION OF A SECOND "LIMITS OF TECHNOLOGY" RETRIEVAL DEMONSTRATION, AND RETRIEVAL OF SUFFICIENT SST WASTE CONTAINING NO LESS THAN 800 CURIES OF CONTAMINANTS OF CONCERN AND OCCUPYING A MINIMUM OF 2 MILLION GALLONS OF DST SPACE (PER DOE BEST-BASIS INVENTORY DATA, 8/01/2000). "LIMITS OF TECHNOLOGY" RETRIEVAL DEMONSTRATIONS WILL SEEK TO IMPROVE UPON PAST PRACTICE SLUICING (PPS) BASELINE TECHNOLOGY INCLUDING BUT NOT LIMITED TO RETRIEVAL EFFICIENCY, LEAK LOSS DURING RETRIEVAL, AND LEAK DETECTION MITIGATION AND MONITORING (LDMM). PROCEDURES FOR MODIFYING THE RETRIEVAL CRITERIA LISTED WITHIN THE ASSOCIATED MILESTONES, AND FOR PROCESSING REQUESTS FOR EXCEPTIONS TO THE CRITERIA ARE OUTLINED IN A NEW APPENDIX "H" TO THE AGREEMENT.	09/30/2006

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System. (15 pages)

M-045-00C	COMPLETE RENEGOTIATION OF SECOND PHASE (I.E., 9/30/2006 THROUGH 9/30/2015) SST WASTE RETRIEVAL ACTIVITIES. THESE NEGOTIATIONS SHALL TAKE INTO ACCOUNT VARIABLES SUCH AS WORK IN PROGRESS, E.G., DOE'S TANK WASTE TREATMENT COMPLEX ACQUISITION INITIATIVE AND ENVIRONMENTAL AND HUMAN HEALTH RISKS ASSOCIATED WITH RELEASES FROM DOE's SSTs. NEGOTIATIONS SHALL BE DESIGNED TO ESTABLISH A SUFFICIENT NUMBER OF AGREEMENT MILESTONES AND TARGET DATES TO EFFECTIVELY DRIVE EACH PHASE OF WORK INCLUDING BUT NOT LIMITED TO: 1.) WASTE RETRIEVAL TECHNOLOGY DEVELOPMENT, 2.) RETRIEVAL PERFORMANCE EVALUATIONS, 3.) LEAK DETECTION, MONITORING, AND MITIGATION, 4.) SELECTION OF SST RETRIEVAL SEQUENCE, 5.) DESIGN, CONSTRUCTION AND OPERATION OF SST WASTE RETRIEVAL SYSTEMS, AND 6.) CLOSURE PLANNING AND CLOSURE PLAN DEVELOPMENT. DOE, AND DOE’s CONTRACTOR(S) WILL RETRIEVE AND TRANSFER SST WASTES INTO THE DST SYSTEM AS SOON AS SPACE IS MADE AVAILABLE, ALLOWING DST SPACE FOR TREATMENT PLANT FEED STAGING AND SAFETY ISSUE RESOLUTION. TRANSFER OF SST WASTE WILL BE MADE ONCE SUFFICIENT DST SYSTEM SPACE IS AVAILABLE TO ALLOW A TRANSFER OF AN OPERATIONALLY PRACTICABLE VOLUME OF WASTE. SST WASTE WILL BE RETRIEVED ON A PRIORITY BASIS WITH THE GOALS OF REDUCING ENVIRONMENTAL RISK AND TREATMENT PROCESS OPTIMIZATION. DOE AND ECOLOGY WILL AGREE ON THE CRITERIA TO DETERMINE ENVIRONMENTAL RISK REDUCTION. NOTE: THESE NEGOTIATIONS WILL ALSO CONSIDER THE NEED FOR ADDITIONAL COMPLIANT STORAGE SPACE.	02/28/2004
M-45-00D	COMPLETE RENEGOTIATION OF THE REMAINDER OF THE SST WASTE RETRIEVAL AND CLOSURE PROGRAM. THESE NEGOTIATIONS WILL ESTABLISH REGULATORY REQUIREMENTS FOR THE REMAINDER OF THE SST WASTE RETRIEVAL AND CLOSURE PROGRAM (THROUGH COMPLETION OF CLOSURE AT ALL SINGLE SHELL TANK FARMS). NEGOTIATIONS WILL INCLUDE MODIFICATION AS MAY BE NECESSARY OF COMPLETION DATES FOR SST WASTE RETRIEVAL AND SST FARM CLOSURE BASED ON EXPERIENCE GAINED FROM SST AND DST WASTE RETRIEVAL WORK COMPLETED, CORRECTIVE ACTIONS, PHASE I TREATMENT COMPLEX OPERATIONS, PHASE II TREATMENT PLANNING, KNOWN AND LIKELY VADOSE ZONE AND GROUNDWATER IMPACTS, AND OTHER AVAILABLE ENVIRONMENTAL IMPACT INFORMATION. DOE, AND DOE’s CONTRACTOR(S) WILL RETRIEVE AND TRANSFER SST WASTES INTO THE DST SYSTEM AS SOON AS SPACE IS MADE AVAILABLE, ALLOWING DST SPACE FOR TREATMENT PLANT FEED STAGING AND SAFETY ISSUE RESOLUTION. TRANSFER OF SST WASTE WILL BE MADE ONCE SUFFICIENT DST SYSTEM SPACE IS AVAILABLE TO ALLOW A TRANSFER OF AN OPERATIONALLY PRACTICABLE VOLUME OF WASTE. SST WASTE WILL BE RETRIEVED ON A PRIORITY BASIS WITH THE GOALS OF REDUCING ENVIRONMENTAL RISK AND TREATMENT PROCESS OPTIMIZATION. DOE AND ECOLOGY WILL AGREE ON THE CRITERIA TO DETERMINE ENVIRONMENTAL RISK REDUCTION.	6/30/2011

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-045-02L	SUBMIT ANNUAL UPDATES TO SST RETRIEVAL SEQUENCE DOCUMENT. THIS PROVIDES FOR AN ANNUAL UPDATE OF A SST RETRIEVAL SEQUENCE DOCUMENT THAT WILL DEFINE THE TANK RETRIEVAL SEQUENCE, SELECTION CRITERIA AND, RATIONALE, REFERENCE RETRIEVAL METHOD(S) FOR EACH TANK, AND THE ESTIMATED RETRIEVAL SCHEDULES. THE RETRIEVAL SEQUENCE DOCUMENT WILL DETAIL RETRIEVAL METHODOLOGIES TO BE EMPLOYED AND ESTIMATED WASTE VOLUMES TO BE GENERATED DURING RETRIEVAL (TO BE TRANSFERRED TO THE DST's OR OTHER AVAILABLE SAFE STORAGE). THE REPORT WILL ALSO DETAIL TANK SELECTION RATIONALE BASED ON THE PRIMARY OBJECTIVE OF MAXIMIZING RISK REDUCTION THROUGH THE RETRIEVAL OF MOBILE, LONG-LIVED RADIONUCLIDES OR POTENTIAL AIRBORNE CONTAMINANTS AND PRINCIPLE NON RADIOLOGICAL HAZARDOUS CONSTITUENTS IN A MANNER WHICH IS SENSITIVE TO WASTE TREATMENT FACILITY REQUIREMENTS AND INFRASTRUCTURE CONSTRAINTS. THE SEQUENCING WILL ALSO TAKE IN CONSIDERATION DOUBLE-SHELL TANK (DST) SPACE AND DST WASTE COMPATABILITY WHEN SELECTING THE SST RETRIEVAL SEQUENCE. THE ANNUAL UPDATES WILL BE SUBMITTED TO ECOLOGY FOR APPROVAL AS AGREEMENT PRIMARY DOCUMENTS.	09/30/2003
M-045-02M	SUBMIT ANNUAL UPDATE OF SST RETRIEVAL SEQUENCE DOCUMENT. (SEE TEXT OF M-45-02L FOR FURTHER DETAILS). 09/30/2004	
M-045-02N	SUBMIT ANNUAL UPDATE OF SST RETRIEVAL SEQUENCE DOCUMENT. (SEE TEXT OF M-45-02L FOR FURTHER DETAILS). 09/30/2004	09/30/2005
M-045-02O	SUBMIT ANNUAL UPDATE OF SST RETRIEVAL SEQUENCE DOCUMENT. (SEE TEXT OF M-45-02L FOR FURTHER DETAILS).	09/30/2006
M-045-02P	SUBMIT ANNUAL UPDATE OF SST RETRIEVAL SEQUENCE DOCUMENT. (SEE TEXT OF M-45-02L FOR FURTHER DETAILS).	09/30/2007 AND ANNUALLY THEREAFTER
M-045-03C	COMPLETE FULL SCALE SALTCAKE WASTE RETRIEVAL TECHNOLOGY DEMONSTRATION AT SINGLE-SHELL TANK S-112. WASTE SHALL BE RETRIEVED TO THE DST SYSTEM TO THE LIMITS OF THE TECHNOLOGY (OR TECHNOLOGIES) SELECTED. SELECTED SALTCAKE RETRIEVAL TECHNOLOGY (OR TECHNOLOGIES) MUST SEEK TO IMPROVE UPON THE PAST-PRACTICE SLUICING BASELINE IN THE AREAS OF EXPECTED RETRIEVAL EFFICIENCY, LEAK LOSS POTENTIAL, AND SUITABILITY FOR USE IN POTENTIALLY LEAKING TANKS. THIS DEMONSTRATION SHALL ALSO INCLUDE THE INSTALLATION AND IMPLEMENTATION OF FULL SCALE LEAK DETECTION, MONITORING, AND MITIGATION (LDMM) TECHNOLOGIES. THE PARTIES RECOGNIZE AND AGREE THAT THIS ACTION IS FOR DEMONSTRATION AND INITIAL WASTE RETRIEVAL PURPOSES. COMPLETION OF THIS DEMONSTRATION SHALL BE BY WRITTEN APPROVAL OF DOE AND ECOLOGY.	09/30/2005
M-045-03D	COMPLETE S-112 SALTCAKE WASTE RETRIEVAL TECHNOLOGY DEMONSTRATION DESIGN (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING DESIGN AND OPERATING STRATEGIES NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION (LDMM)). DESIGN WILL BE CONSIDERED COMPLETE WHEN 90% OF THE DESIGN HAS BEEN APPROVED FOR FABRICATION AND/OR CONSTRUCTION.	05/31/2003

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-045-03E	COMPLETE S-112 SALTCAKE WASTE RETRIEVAL TECHNOLOGY DEMONSTRATION CONSTRUCTION (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING THOSE NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION). CONSTRUCTION WILL BE CONSIDERED COMPLETE WHEN ALL PROCESS EQUIPMENT IS INSTALLED AND ACCEPTANCE TESTS ARE COMPLETED.	09/30/2004
M-045-03F	COMPLETE FULL SCALE SLUDGE/HARD HEEL, CONFINED SLUICING AND ROBOTIC TECHNOLOGIES, WASTE RETRIEVAL DEMONSTRATION AT TANK C-104. WASTE SHALL BE RETRIEVED TO THE DST SYSTEM TO THE LIMITS OF THE TECHNOLOGY (OR TECHNOLOGIES) SELECTED. SELECTED SLUDGE/HARD HEEL TECHNOLOGY (OR TECHNOLOGIES) MUST SEEK TO IMPROVE UPON THE PAST-PRACTICE SLUICING BASELINE IN THE AREAS OF EXPECTED RETRIEVAL EFFICIENCY, LEAK LOSS POTENTIAL, AND SUITABILITY FOR USE IN POTENTIALLY LEAKING TANKS. CONFINED SLUICING IS DEFINED AS THE LOCALIZED ADDITION AND RETRIEVAL OF LIQUIDS AND WASTE. THIS DEMONSTRATION SHALL ALSO INCLUDE THE INSTALLATION AND IMPLEMENTATION OF FULL SCALE LEAK DETECTION, MONITORING, AND MITIGATION (LDMM) TECHNOLOGIES. THE PARTIES RECOGNIZE AND AGREE THAT THIS ACTION IS FOR DEMONSTRATION AND INITIAL WASTE RETRIEVAL PURPOSES. COMPLETION OF THIS DEMONSTRATION SHALL BE BY APPROVAL OF DOE AND ECOLOGY. GOALS OF THIS DEMONSTRATION SHALL INCLUDE THE RETRIEVAL TO SAFE STORAGE OF APPROXIMATELY 89 KG OF PLUTONIUM WHICH REPRESENTS APPROXIMATELY 17% OF THE TOTAL PLUTONIUM INVENTORY WITHIN THE SST SYSTEM), AND 99% OF TANK CONTENTS BY VOLUME (PER DOE'S BEST-BASIS INVENTORY DATA OF 8/01/2000).	09/30/2007
M-045-03G	COMPLETE C-104 SLUDGE/HARD HEEL, CONFINED SLUICING AND ROBOTIC TECHNOLOGIES, WASTE RETRIEVAL COLD DEMONSTRATION. THIS FULL SCALE DEMONSTRATION WILL BE SUFFICIENT TO SUPPORT FINAL DESIGN AND TESTING OF ALL EQUIPMENT, INCLUDING THE LDMM APPROACH USED IN THE ACTUAL SYSTEM. THE DEMONSTRATION MUST ESTABLISH THE PERFORMANCE OF THE EQUIPMENT SPECIFIED IN THE FUNCTIONS AND REQUIREMENTS DOCUMENT. A LETTER REPORT WILL BE SUBMITTED TO ECOLOGY TO DOCUMENT THE RESULTS OF THE COLD DEMONSTRATION.	06/30/2004
M-045-03H	COMPLETE C-104 SLUDGE/HARD HEEL, CONFINED SLUICING AND ROBOTIC TECHNOLOGIES, WASTE RETRIEVAL DEMONSTRATION DESIGN (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING DESIGN AND OPERATING STRATEGIES NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION (LDMM)). DESIGN WILL BE CONSIDERED COMPLETE WHEN 90% OF THE DESIGN HAS BEEN APPROVED FOR FABRICATION AND/OR CONSTRUCTION.	09/30/2004
M-045-03I	COMPLETE C-104 SLUDGE/HARD HEEL, CONFINED SLUICING AND ROBOTIC TECHNOLOGIES, WASTE RETRIEVAL DEMONSTRATION CONSTRUCTION (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING THOSE NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION). CONSTRUCTION WILL BE CONSIDERED COMPLETE WHEN ALL PROCESS EQUIPMENT IS INSTALLED AND ACCEPTANCE TESTS ARE COMPLETED.	09/30/2006

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System. (15 pages)

M-045-05	RETRIEVE WASTE FROM ALL REMAINING SINGLE-SHELL TANKS. COMPLETE WASTE RETRIEVAL FROM ALL REMAINING SINGLE-SHELL TANKS. RETRIEVAL STANDARDS AND COMPLETION DEFINITIONS ARE PROVIDED UNDER THE MAJOR MILESTONE. THE SCHEDULE REFLECTS RETRIEVAL ACTIVITIES ON A FARM-BY-FARM BASIS. IT ALSO ALLOWS FLEXIBILITY TO RETRIEVE TANKS FROM VARIOUS FARMS IF DESIRED TO SUPPORT SAFETY ISSUE RESOLUTION, PRETREATMENT OR DISPOSAL FEED REQUIREMENTS, OR OTHER PRIORITIES.	09/30/2018
M-045-05-T05	INITIATE TANK RETRIEVAL FROM FIVE ADDITIONAL SINGLE-SHELL TANKS.	09/30/2007
M-045-05-T06	INITIATE TANK RETRIEVAL FROM FIVE ADDITIONAL SINGLE-SHELL TANKS.	09/30/2008
M-045-05-T07	INITIATE TANK RETRIEVAL FROM SEVEN ADDITIONAL SINGLE-SHELL TANKS.	09/30/2009
M-045-05-T08	INITIATE TANK RETRIEVAL FROM EIGHT ADDITIONAL SINGLE-SHELL TANKS.	09/30/2010
M-045-05-T09	INITIATE TANK RETRIEVAL FROM TEN ADDITIONAL SINGLE-SHELL TANKS.	09/30/2011
M-045-05-T10	INITIATE TANK RETRIEVAL FROM 12 ADDITIONAL SINGLE-SHELL TANKS.	09/30/2012
M-045-05-T11	INITIATE TANK RETRIEVAL FROM 14 ADDITIONAL SINGLE-SHELL TANKS.	09/30/2013
M-045-05-T12	INITIATE TANK RETRIEVAL FROM 17 ADDITIONAL SINGLE-SHELL TANKS.	09/30/2014
M-045-05-T13	INITIATE TANK RETRIEVAL FROM 20 ADDITIONAL SINGLE-SHELL TANKS.	09/30/2015
M-045-05-T14	INITIATE TANK RETRIEVAL FROM 20 ADDITIONAL SINGLE-SHELL TANKS.	09/30/2016
M-045-05-T15	INITIATE TANK RETRIEVAL FROM 20 ADDITIONAL SINGLE-SHELL TANKS.	09/30/2017

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.

(15 pages)

M-45-05-T17	SUBMIT S-105, S-106, AND S-103 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION FUNCTIONS AND REQUIREMENTS DOCUMENT. THIS DOCUMENT WILL ESTABLISH DEMONSTRATION SYSTEM SPECIFICATIONS (INCLUDING LDMM SYSTEM SPECIFICATIONS) AND WILL ALSO INCLUDE A SCOPING LEVEL RETRIEVAL PERFORMANCE EVALUATION (RPE) FOR EACH TANK. THE FUNCTIONS AND REQUIREMENTS DOCUMENT AND ITS ASSOCIATED RPE SHALL ALSO PROVIDE, AS A SEPARATE EVALUATION FOR EACH OF THE THREE TANKS, ENVIRONMENTAL AND HUMAN HEALTH RISK EVALUATION DATA/INFORMATION ASSOCIATED WITH ESTIMATED WASTE VOLUMES TO BE RETRIEVED, THE MAXIMUM VOLUME WHICH COULD LEAK DURING RETRIEVAL, AND RISK FROM RESIDUAL WASTE. THIS DOCUMENT WILL DETAIL KNOWN AND ESTIMATED RADIONUCLIDE CONTAMINATION AND CONTAMINANT MIGRATION WITHIN THE VADOSE ZONE AS BASES OF CALCULATION. LDMM AND RPE DOCUMENTATION PROVIDED WILL BE ADEQUATE TO ALLOW ECOLOGY TO ASSESS THE ADEQUACY OF THE DEMONSTRATION SYSTEMS. THIS DOCUMENT WILL INCORPORATE LESSONS LEARNED, INCLUDING LDMM, RETRIEVAL, INSTRUMENTATION, AND OPERATIONAL EXPERIENCE FROM PREVIOUS DOE AND INDUSTRY RELATED RETRIEVAL PROJECTS. THE RETRIEVAL FUNCTIONS AND REQUIREMENTS DOCUMENT WILL DOCUMENT ALL PERTINENT RETRIEVAL AND CLOSURE REQUIREMENTS, E.G., THOSE SPECIFIC TO THE EXTENT OF RETRIEVAL NECESSARY TO ALLOW CLOSURE. DOE WILL SUBMIT ITS LDMM STRATEGY AS PART OF THE FUNCTIONS AND REQUIREMENTS DOCUMENT, PRIOR TO INITIATION OF DESIGN. THIS DOCUMENT WILL BE SUBMITTED FOR ECOLOGY APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT. THIS FUNCTIONS AND REQUIREMENTS DOCUMENT WILL BE SUBMITTED IN A TIMELY FASHION SO THAT PROJECT CRITICAL PATH IS NOT AFFECTED, AND SO AS TO ALLOW ADEQUATE TIME FOR DOE AND ECOLOGY REVIEW, REVISION, AND APPROVAL.	4/30/2005
M-045-05A	COMPLETE INITIAL WASTE RETRIEVAL FROM TANK S-102. THE S-102 INITIAL WASTE RETRIEVAL TECHNOLOGY (OR TECHNOLOGIES) WILL BE SELECTED BASED ON THE PRINCIPLE CRITERIA OF MAXIMIZING THE RETRIEVAL OF MOBILE, LONG-LIVED RADIOISOTOPES AND NON-RADIOLOGICAL HAZARDOUS CONSTITUENTS. THE PARTIES RECOGNIZE AND AGREE THAT THIS ACTION IS FOR INITIAL WASTE RETRIEVAL PURPOSES. COMPLETION OF THIS INITIAL RETRIEVAL SHALL BE BY APPROVAL OF DOE AND ECOLOGY. GOALS OF THIS INITIAL WASTE RETRIEVAL PROJECT SHALL INCLUDE THE RETRIEVAL TO SAFE STORAGE OF APPROXIMATELY 490 CURIES OF MOBILE, LONG-LIVED RADIOISOTOPES AND 99% OF TANK CONTENTS BY VOLUME (PER DOE BEST-BASIS INVENTORY DATA, 8/01/2000). COMPLETION OF S-102 INITIAL WASTE RETRIEVAL IS SUBJECT TO SAFE STORAGE SPACE AVAILABILITY CONSISTENT WITH M-45-00B.	09/30/2006
M-045-05B	COMPLETE S-102 INITIAL RETRIEVAL PROJECT DESIGN (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING DESIGN AND OPERATING STRATEGIES NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION (LDMM). THE DESIGN WILL BE CONSIDERED COMPLETE WHEN 90% OF THE DESIGN HAS BEEN APPROVED FOR FABRICATION AND/OR CONSTRUCTION.	03/31/2004

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-045-05C	COMPLETE S-102 INITIAL WASTE RETRIEVAL PROJECT CONSTRUCTION (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING THOSE NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION). CONSTRUCTION WILL BE CONSIDERED COMPLETE WHEN ALL PROCESS EQUIPMENT IS INSTALLED AND ACCEPTANCE TESTS ARE COMPLETED.	11/30/2005
M-45-05E	COMPLETE S-105, S-106, AND S-103 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT DESIGN (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING DESIGN AND OPERATING STRATEGIES NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION (LDMM) FOR EACH TANK). THE DESIGN WILL BE CONSIDERED COMPLETE WHEN 90% OF THE DESIGN HAS BEEN APPROVED FOR FABRICATION AND/OR CONSTRUCTION.	6/30/2007
M-45-05F	COMPLETE S-105, S-106, AND S-103 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT CONSTRUCTION (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING THOSE NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION). CONSTRUCTION WILL BE CONSIDERED COMPLETE WHEN ALL PROCESS EQUIPMENT IS INSTALLED AND ACCEPTANCE TESTS ARE COMPLETED.	9/30/2008
M-45-05G-T01	COMPLETE S-105, S-106, AND S-103 WASTE RETRIEVAL. WASTE SHALL BE RETRIEVED TO THE DST SYSTEM TO THE LIMITS OF THE TECHNOLOGY (OR TECHNOLOGIES) SELECTED. RETRIEVAL SHALL RETRIEVE AS MUCH WASTE AS TECHNICALLY POSSIBLE, WITH A REMAINING RESIDUAL OF NO MORE THAN 360 CUBIC FEET (CU. FT.).	10/31/2009
M-45-05H	INTERIM COMPLETION OF TANK C-106 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. THE C-106 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT WILL BE CONSIDERED INTERIM COMPLETE WHEN THE FOLLOWING CRITERIA HAVE BEEN MET: 1. FULL SCALE WASTE RETRIEVAL HAS BEEN COMPLETED IN ACCORDANCE WITH APPLICABLE REGULATORY REQUIREMENTS INCLUDING WASHINGTON'S HAZARDOUS WASTE MANAGEMENT ACT AND REQUIREMENTS SET BY THIS AGREEMENT (DOE WILL DOCUMENT PROJECT DATA AND RESULTS IN A WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT REPORT). 2. REMAINING WASTES HAVE BEEN ADEQUATELY CHARACTERIZED, AND A RISK ASSESSMENT, APPROVED BY ECOLOGY, HAS BEEN COMPLETED FOR RESIDUALS THAT REMAIN IN THE TANK. 3. THE C-106 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN HAS BEEN SUBMITTED BY DOE AND APPROVED BY ECOLOGY, I.E., INCORPORATED INTO THE SITE-WIDE PERMIT. 4. IF APPROPRIATE, DOE HAS REQUESTED, AND ECOLOGY HAS APPROVED, AN EXCEPTION TO WASTE RETRIEVAL CRITERIA PURSUANT TO AGREEMENT APPENDIX H.	4/30/2004
M-45-05J-T01	COMPLETE C-106 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT DESIGN (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING DESIGN AND OPERATING STRATEGIES NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION (LDMM)). THE DESIGN WILL BE CONSIDERED COMPLETE WHEN 90% OF THE DESIGN HAS BEEN APPROVED FOR FABRICATION AND/OR CONSTRUCTION.	4/30/2003

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-45-05K-T01	COMPLETE C-106 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT CONSTRUCTION (TO INCLUDE ALL PHYSICAL SYSTEMS INCLUDING THOSE NECESSARY FOR LEAK DETECTION MONITORING AND MITIGATION). CONSTRUCTION WILL BE CONSIDERED COMPLETE WHEN ALL EQUIPMENT IS INSTALLED AND ACCEPTANCE TESTS ARE COMPLETED.	9/30/2003
M-45-05L-T01	COMPLETE FULL SCALE C-106 WASTE RETRIEVAL. WASTE SHALL BE RETRIEVED TO THE DST SYSTEM TO THE LIMITS OF THE TECHNOLOGY (OR TECHNOLOGIES) SELECTED. RETRIEVAL SHALL RETRIEVE AS MUCH WASTE AS TECHNICALLY POSSIBLE, WITH A REMAINING RESIDUAL OF NO MORE THAN 360 CUBIC FEET (CU. FT.).	11/1/2003
M-45-05M-T01	SUBMIT C-106 WASTE RETRIEVAL RESULTS, ANALYSIS OF RESIDUAL WASTE(S), AND (IF APPROPRIATE) REQUEST FOR EXCEPTION TO THE CRITERIA PURSUANT TO AGREEMENT APPENDIX H.	2/27/2004
M-45-05N-T01	FINAL COMPLETION OF TANK C-106 SST RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. COMPLETION OF THE TANK C-106 RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT IS DEFINED AS THE COMPLETION OF NECESSARY FIELD PROJECT ACTIONS REQUIRED BY THE APPROVED C-106 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN.	12/31/2004
M-45-06	COMPLETE CLOSURE OF ALL SINGLE-SHELL TANK FARMS IN ACCORDANCE WITH APPROVED CLOSURE/POST CLOSURE PLAN(S).	9/30/2024
M-45-06-T03	INITIATE CLOSURE ACTIONS ON AN OPERABLE UNIT OR TANK FARM BASIS. CLOSURE SHALL FOLLOW COMPLETION OF THE RETRIEVAL ACTIONS UNDER PROPOSED MILESTONE M-45-05. CLOSURE WILL BE DEFINED IN AN APPROVED CLOSURE PLAN FOR THE DEMONSTRATION FARM. FINAL CLOSURE IS DEFINED AS REGULATORY APPROVAL OF COMPLETION OF CLOSURE ACTIONS.	3/31/2012
M-45-06-T04	COMPLETE CLOSURE ACTIONS ON ONE OPERABLE UNIT OR TANK FARM.	3/31/2014
M-45-06-T20A	SUBMIT SST SYSTEM IMPLEMENTATION PLAN IN SUPPORT OF RETRIEVAL AND CLOSURE ACTIVITIES. MAJOR WORK AREAS COVERED IN THE IMPLEMENTATION PLAN WILL INCLUDE WASTE RETRIEVAL OPERABLE UNITS CHARACTERIZATION, TECHNOLOGIES DEVELOPMENT TO SUPPORT CLOSURE, RISK ASSESSMENTS, AND GROUNDWATER MONITORING STRATEGIES. (REFINEMENT OF THE MAJOR WORK AREAS WILL BE DEVELOPED IN A JOINT ECOLOGY/DOE WORKSHOP.) DOE's SST SYSTEM IMPLEMENTATION PLAN UPDATE WILL BE SUBMITTED TO ECOLOGY AS A PRIMARY DOCUMENT.	6/30/2004
M-45-06-T20B	SUBMIT SST SYSTEM IMPLEMENTATION PLAN IN SUPPORT OF RETRIEVAL AND CLOSURE ACTIVITIES. MAJOR WORK AREAS COVERED IN THE IMPLEMENTATION PLAN WILL INCLUDE WASTE RETRIEVAL OPERABLE UNITS CHARACTERIZATION, TECHNOLOGIES DEVELOPMENT TO SUPPORT CLOSURE, RISK ASSESSMENTS, AND GROUNDWATER MONITORING STRATEGIES. (REFINEMENT OF THE MAJOR WORK AREAS WILL BE DEVELOPED IN A JOINT ECOLOGY/DOE WORKSHOP.) DOE's SST SYSTEM IMPLEMENTATION PLAN UPDATE WILL BE SUBMITTED TO ECOLOGY AS A PRIMARY DOCUMENT.	6/30/2006

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-45-06-T20C	SUBMIT SST SYSTEM IMPLEMENTATION PLAN IN SUPPORT OF RETRIEVAL AND CLOSURE ACTIVITIES. MAJOR WORK AREAS COVERED IN THE IMPLEMENTATION PLAN WILL INCLUDE WASTE RETRIEVAL OPERABLE UNITS CHARACTERIZATION, TECHNOLOGIES DEVELOPMENT TO SUPPORT CLOSURE, RISK ASSESSMENTS, AND GROUNDWATER MONITORING STRATEGIES. (REFINEMENT OF THE MAJOR WORK AREAS WILL BE DEVELOPED IN A JOINT ECOLOGY/DOE WORKSHOP.) DOE's SST SYSTEM IMPLEMENTATION PLAN UPDATE WILL BE SUBMITTED TO ECOLOGY AS A PRIMARY DOCUMENT.	6/30/2008 (AND EVERY 2 YEARS THEREAFTER)
M-45-06A	SUBMIT A CERTIFIED (FRAMEWORK) SST SYSTEM CLOSURE PLAN AND C-106 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN, AS AN APPLICATION FOR A MODIFICATION TO THE HANFORD SITE-WIDE HAZARDOUS WASTE FACILITY PERMIT TO ECOLOGY. THIS SUBMITTAL WILL INCLUDE ALL REQUIRED CLOSURE PLAN ELEMENTS. ADDITIONALLY, THIS SUBMITTAL WILL INCLUDE THE FOLLOWING: 1. CHARACTERIZATION APPROACH FOR RESIDUAL WASTES. THIS APPROACH WILL SUPPORT DECISIONS REGARDING THE COMPLIANCE OF THE RESIDUAL WASTE WITH APPLICABLE REGULATORY REQUIREMENTS (INCLUDING BUT NOT LIMITED TO: CHARACTERIZATION NEEDS, WORK REQUIREMENTS, WORK SCHEDULES, AND CONTAMINANTS OF CONCERN FOR; RISK ASSESSMENT, LAND DISPOSAL RESTRICTION (LDR), AND THE WASHINGTON STATE HAZARDOUS WASTE MANAGEMENT ACT). 2. A RISK ASSESSMENT METHODOLOGY INCLUSIVE OF THE ASSUMPTIONS, APPROACH, CONCEPTUAL MODEL, AND METRICS (E.G., POINT OF COMPLIANCE, RECEPTOR SCENARIOS). THE CHARACTERIZATION REQUIREMENTS AND RISK ASSESSMENT METHODOLOGY WILL BE JOINTLY DEVELOPED BY DOE AND ECOLOGY PRIOR TO THE SUBMITTAL.	12/19/2002
M-45-06B	SUBMIT A CERTIFIED (FRAMEWORK) SST SYSTEM CLOSURE PLAN MODIFICATION AND S-112 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN, AS AN APPLICATION FOR A MODIFICATION TO THE HANFORD SITE-WIDE HAZARDOUS WASTE FACILITY PERMIT TO ECOLOGY. THIS SUBMITTAL WILL INCLUDE ALL REQUIRED CLOSURE PLAN ELEMENTS. ADDITIONALLY, THIS SUBMITTAL WILL INCLUDE THE FOLLOWING: 1. CHARACTERIZATION APPROACH FOR RESIDUAL WASTES. THIS APPROACH WILL SUPPORT DECISIONS REGARDING THE COMPLIANCE OF THE RESIDUAL WASTE WITH APPLICABLE REGULATORY REQUIREMENTS (INCLUDING BUT NOT LIMITED TO: CHARACTERIZATION NEEDS, WORK REQUIREMENTS, WORK SCHEDULES, AND CONTAMINANTS OF CONCERN FOR; RISK ASSESSMENT, LAND DISPOSAL RESTRICTION (LDR), AND THE WASHINGTON STATE HAZARDOUS WASTE MANAGEMENT ACT). 2. A RISK ASSESSMENT METHODOLOGY INCLUSIVE OF THE ASSUMPTIONS, APPROACH, CONCEPTUAL MODEL, AND METRICS (E.G., POINT OF COMPLIANCE, RECEPTOR SCENARIOS). THE CHARACTERIZATION REQUIREMENTS AND RISK ASSESSMENT METHODOLOGY WILL BE JOINTLY DEVELOPED BY DOE AND ECOLOGY PRIOR TO THE SUBMITTAL.	3/31/2005

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System. (15 pages)

M-45-06C	SUBMIT A CERTIFIED (FRAMEWORK) SST SYSTEM CLOSURE PLAN MODIFICATION AND S-102 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN, AS AN APPLICATION FOR A MODIFICATION TO THE HANFORD SITE-WIDE HAZARDOUS WASTE FACILITY PERMIT TO ECOLOGY. THIS SUBMITTAL WILL INCLUDE ALL REQUIRED CLOSURE PLAN ELEMENTS. ADDITIONALLY, THIS SUBMITTAL WILL INCLUDE THE FOLLOWING: 1. CHARACTERIZATION APPROACH FOR RESIDUAL WASTES. THIS APPROACH WILL SUPPORT DECISIONS REGARDING THE COMPLIANCE OF THE RESIDUAL WASTE WITH APPLICABLE REGULATORY REQUIREMENTS (INCLUDING BUT NOT LIMITED TO: CHARACTERIZATION NEEDS, WORK REQUIREMENTS, WORK SCHEDULES, AND CONTAMINANTS OF CONCERN FOR; RISK ASSESSMENT, LAND DISPOSAL RESTRICTION (LDR), AND THE WASHINGTON STATE HAZARDOUS WASTE MANAGEMENT ACT). 2. A RISK ASSESSMENT METHODOLOGY INCLUSIVE OF THE ASSUMPTIONS, APPROACH, CONCEPTUAL MODEL, AND METRICS (E.G., PONIT OF COMPLIANCE, RECEPTOR SCENERIOS). THE CHARACTERIZATION REQUIREMENTS AND RISK ASSESSMENT METHODOLOGY WILL BE JOINTLY DEVELOPED BY DOE AND ECOLOGY PRIOR TO THE SUBMITTAL.	3/31/2006
M-45-06D	SUBMIT A CERTIFIED (FRAMEWORK) SST SYSTEM CLOSURE PLAN MODIFICATION AND C-104 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN, AS AN APPLICATION FOR A MODIFICATION TO THE HANFORD SITE-WIDE HAZARDOUS WASTE FACILITY PERMIT TO ECOLOGY. THIS SUBMITTAL WILL INCLUDE ALL REQUIRED CLOSURE PLAN ELEMENTS. ADDITIONALLY, THIS SUBMITTAL WILL INCLUDE THE FOLLOWING: 1. CHARACTERIZATION APPROACH FOR RESIDUAL WASTES. THIS APPROACH WILL SUPPORT DECISIONS REGARDING THE COMPLIANCE OF THE RESIDUAL WASTE WITH APPLICABLE REGULATORY REQUIREMENTS (INCLUDING BUT NOT LIMITED TO: CHARACTERIZATION NEEDS, WORK REQUIREMENTS, WORK SCHEDULES, AND CONTAMINANTS OF CONCERN FOR; RISK ASSESSMENT, LAND DISPOSAL RESTRICTION (LDR), AND THE WASHINGTON STATE HAZARDOUS WASTE MANAGEMENT ACT). 2. A RISK ASSESSMENT METHODOLOGY INCLUSIVE OF THE ASSUMPTIONS, APPROACH, CONCEPTUAL MODEL, AND METRICS (E.G., POINT OF COMPLIANCE, RECEPTOR SCENARIOS). THE CHARACTERIZATION REQUIREMENTS AND RISK ASSESSMENT METHODOLOGY WILL BE JOINTLY DEVELOPED BY DOE AND ECOLOGY PRIOR TO THE SUBMITTAL.	6/30/2007

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-45-06E	SUBMIT A CERTIFIED (FRAMEWORK) SST SYSTEM CLOSURE PLAN MODIFICATION FOR TANKS S-105, S-106, AND S-103 CLOSURE DEMONSTRATION PLAN, AS AN APPLICATION FOR A MODIFICATION TO THE HANFORD SITE-WIDE HAZARDOUS WASTE FACILITY PERMIT TO ECOLOGY. THIS SUBMITTAL WILL INCLUDE ALL REQUIRED CLOSURE PLAN ELEMENTS, AND PROVIDE A SEPARATE STAND ALONE EVALUATION FOR EACH TANK. ADDITIONALLY, THIS SUBMITTAL WILL INCLUDE THE FOLLOWING: 1. CHARACTERIZATION APPROACH FOR RESIDUAL WASTES IN S-105, S-106, AND S-103. THIS APPROACH WILL SUPPORT DECISIONS REGARDING THE COMPLIANCE OF THE RESIDUAL WASTE WITH APPLICABLE REGULATORY REQUIREMENTS (INCLUDING BUT NOT LIMITED TO: CHARACTERIZATION NEEDS, WORK REQUIREMENTS, WORK SCHEDULES, AND CONTAMINANTS OF CONCERN FOR; RISK ASSESSMENT, LAND DISPOSAL RESTRICTION (LDR), AND THE WASHINGTON STATE HAZARDOUS WASTE MANAGEMENT ACT). 2. A RISK ASSESSMENT METHODOLOGY FOR TANKS S-105, S-106, AND S-103, INCLUSIVE OF THE ASSUMPTIONS, APPROACH, CONCEPTUAL MODEL, AND METRICS (E.G., POINT OF COMPLIANCE, RECEPTOR SCENARIOS). THE CHARACTERIZATION REQUIREMENTS AND RISK ASSESSMENT METHODOLOGY WILL BE JOINTLY DEVELOPED BY DOE AND ECOLOGY PRIOR TO THE SUBMITTAL.	12/31/2008
M-45-13	INTERIM COMPLETION OF TANK S-112 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. THE S-112 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT WILL BE CONSIDERED INTERIM COMPLETE WHEN THE FOLLOWING CRITERIA HAVE BEEN MET: 1. FULL SCALE WASTE RETRIEVAL HAS BEEN COMPLETED IN ACCORDANCE WITH APPLICABLE REGULATORY REQUIREMENTS INCLUDING WASHINGTON’S HAZARDOUS WASTE MANAGEMENT ACT, REQUIREMENTS SET BY THIS AGREEMENT, AND THE APPROVED S-112 SALTCAKE WASTE RETRIEVAL TECHNOLOGY FUNCTIONS AND REQUIREMENTS DOCUMENT (DOE WILL DOCUMENT PROJECT DATA AND RESULTS IN A WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT REPORT). 2. REMAINING WASTES HAVE BEEN ADEQUATELY CHARACTERIZED, AND A RISK ASSESSMENT, APPROVED BY ECOLOGY, HAS BEEN COMPLETED FOR RESIDUALS THAT REMAIN IN THE TANK. 3. THE S-112 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN HAS BEEN SUBMITTED BY DOE AND APPROVED BY ECOLOGY, I.E., INCORPORATED INTO THE SITE-WIDE PERMIT. 4. IF APPROPRIATE, DOE HAS REQUESTED, AND ECOLOGY HAS APPROVED AN EXCEPTION TO WASTE RETRIEVAL CRITERIA PURSUANT TO AGREEMENT APPENDIX H.	6/30/2006
M-45-13-T01	FINAL COMPLETION OF TANK S-112 SST RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. COMPLETION OF THE TANK S-112 RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT IS DEFINED AS THE COMPLETION OF NECESSARY FIELD PROJECT ACTIONS REQUIRED BY THE APPROVED S-112 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN.	6/30/2007

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-45-14	INTERIM COMPLETION OF TANK C-104 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. THE C-104 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT WILL BE CONSIDERED INTERIM COMPLETE WHEN THE FOLLOWING CRITERIA HAVE BEEN MET: 1. FULL SCALE WASTE RETRIEVAL HAS BEEN COMPLETED IN ACCORDANCE WITH APPLICABLE REGULATORY REQUIREMENTS INCLUDING WASHINGTON'S HAZARDOUS WASTE MANAGEMENT ACT, REQUIREMENTS SET BY THIS AGREEMENT, AND THE APPROVED C-104 SLUDGE/HARD HEEL, CONTAINED SLUICING AND ROBOTIC TECHNOLOGIES WASTE RETRIEVAL FUNCTIONS AND REQUIREMENTS DOCUMENT (DOE WILL DOCUMENT PROJECT DATA AND RESULTS IN A WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT REPORT). 2. REMAINING WASTES HAVE BEEN ADEQUATELY CHARACTERIZED, AND A RISK ASSESSMENT, APPROVED BY ECOLOGY, HAS BEEN COMPLETED FOR RESIDUALS THAT REMAIN IN THE TANK. 3. THE C-104 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN HAS BEEN SUBMITTED BY DOE AND APPROVED BY ECOLOGY, I.E., INCORPORATED INTO THE SITE-WIDE PERMIT. 4. IF APPROPRIATE, DOE HAS REQUESTED, AND ECOLOGY HAS APPROVED AN EXCEPTION TO WASTE RETRIEVAL CRITERIA PURSUANT TO AGREEMENT APPENDIX H.	6/30/2008
M-45-14-T01	FINAL COMPLETION OF TANK C-104 SST RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. COMPLETION OF THE TANK C-104 RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT IS DEFINED AS THE COMPLETION OF NECESSARY FIELD PROJECT ACTIONS REQUIRED BY THE APPROVED C-104 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN.	6/3/2009

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-45-15	INTERIM COMPLETION OF TANK S-102 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. THE S-102 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT WILL BE CONSIDERED INTERIM COMPLETE WHEN THE FOLLOWING CRITERIA HAVE BEEN MET: 1. FULL SCALE WASTE RETRIEVAL HAS BEEN COMPLETED IN ACCORDANCE WITH APPLICABLE REGULATORY REQUIREMENTS INCLUDING WASHINGTON'S HAZARDOUS WASTE MANAGEMENT ACT, REQUIREMENTS SET BY THIS AGREEMENT, AND THE APPROVED S-102 INITIAL WASTE RETRIEVAL FUNCTIONS AND REQUIREMENTS DOCUMENT (DOE WILL DOCUMENT PROJECT DATA AND RESULTS IN A WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT REPORT). 2. REMAINING WASTES HAVE BEEN ADEQUATELY CHARACTERIZED, AND A RISK ASSESSMENT, APPROVED BY ECOLOGY, HAS BEEN COMPLETED FOR RESIDUALS THAT REMAIN IN THE TANK. 3. THE S-102 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN HAS BEEN SUBMITTED BY DOE AND APPROVED BY ECOLOGY, I.E., INCORPORATED INTO THE SITE-WIDE PERMIT. 4. IF APPROPRIATE, DOE HAS REQUESTED, AND ECOLOGY HAS APPROVED AN EXCEPTION TO WASTE RETRIEVAL CRITERIA PURSUANT TO AGREEMENT APPENDIX H.	6/30/2007
M-45-15-T01	FINAL COMPLETION OF TANK S-102 SST RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. COMPLETION OF THE TANK S-102 RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT IS DEFINED AS THE COMPLETION OF NECESSARY FIELD PROJECT ACTIONS REQUIRED BY THE APPROVED S-102 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN.	6/30/2008

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System.
(15 pages)

M-45-16	INTERIM COMPLETION OF TANK S-105, S-106, AND S-103 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. THE S-105, S-106, AND S-103 SST WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT WILL BE CONSIDERED INTERIM COMPLETE WHEN THE FOLLOWING CRITERIA HAVE BEEN MET AND DOCUMENTED FOR EACH OF THE TANKS: 1. FULL SCALE WASTE RETRIEVAL HAS BEEN COMPLETED IN ACCORDANCE WITH APPLICABLE REGULATORY REQUIREMENTS INCLUDING WASHINGTON'S HAZARDOUS WASTE MANAGEMENT ACT, REQUIREMENTS SET BY THIS AGREEMENT, AND THE APPROVED S-105, S-106, AND S-103 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION FUNCTIONS AND REQUIREMENTS DOCUMENT (DOE WILL DOCUMENT PROJECT DATA AND RESULTS IN A WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT REPORT). 2. REMAINING WASTES HAVE BEEN ADEQUATELY CHARACTERIZED, AND A RISK ASSESSMENT, APPROVED BY ECOLOGY, HAS BEEN COMPLETED FOR RESIDUALS THAT REMAIN IN THE TANK. 3. THE S-105, S-106, AND S-103 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN HAS BEEN SUBMITTED BY DOE AND APPROVED BY ECOLOGY, I.E., INCORPORATED INTO THE SITE-WIDE PERMIT. 4. IF APPROPRIATE, DOE HAS REQUESTED, AND ECOLOGY HAS APPROVED, AN EXCEPTION TO WASTE RETRIEVAL CRITERIA PURSUANT TO AGREEMENT APPENDIX H. A REQUEST MAY BE MADE FOR EACH AND/OR ALL TANKS.	7/31/2010
M-45-16-T01	FINAL COMPLETION OF TANK S-105, S-106, AND S-103 SST RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT. COMPLETION OF THE TANK S-105, S-106, AND S-103 RETRIEVAL AND CLOSURE DEMONSTRATION PROJECT IS DEFINED AS THE COMPLETION OF NECESSARY FIELD PROJECT ACTIONS REQUIRED BY THE APPROVED S-105, S-106, AND S-103 WASTE RETRIEVAL AND CLOSURE DEMONSTRATION PLAN.	7/31/2011
M-045-55	SUBMIT TO ECOLOGY FOR REVIEW AND APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT A PHASE 1 RFI REPORT INTEGRATING RESULTS OF DATA GATHERING ACTIVITIES AND EVALUATIONS FOR WMAS S-SX, T, TX-TY, AND B-BX-BY, AND RELATED ACTIVITIES, INCLUDING GROUNDWATER MONITORING AND IMPACTS ASSESSMENT USING HANFORD SITE GROUNDWATER MODELS, WITH CONCLUSIONS AND RECOMMENDATIONS.	02/28/2004
M-045-55-T03	SUBMIT TO ECOLOGY FOR REVIEW AND COMMENT AS AN AGREEMENT SECONDARY DOCUMENT A FIELD INVESTIGATION REPORT PURSUANT TO THE SITE-SPECIFIC SST WMA PHASE 1 RFI/CMS WORK PLAN ADDENDA FOR WMA T AND WMA TX-TY.	01/31/2005

Table 6-1. HFFACO Milestones[a] Associated with Closure of the SST System. (15 pages)

M-045-56	COMPLETE IMPLEMENTATION OF AGREED-TO INTERIM MEASURES. SPECIFIC INTERIM MEASURES WILL BE IMPLEMENTED PURSUANT TO AGREEMENT COMMITMENTS (E.G., SEE INTERIM MILESTONE M-45-57). INTERIM MEASURES MAY ALSO BE REQUIRED BY ECOLOGY, PROPOSED BY DOE IN THE SST WMA RFI REPORT (M-45-55) (OR ENGINEERING STUDIES INCLUDING THAT ADDRESSED IN TARGET MILESTONE M-45-56-T01), OR ESTABLISHED BY AGREEMENT OF THE PARTIES AT ANY TIME DURING THE CORRECTIVE ACTION PROCESS. ALSO SEE TABLE 1 OF AGREEMENT CHANGE CONTROL FORM #M-45-98-03. ECOLOGY AND DOE AGREE, AT A MINIMUM, TO MEET YEARLY (BY JULY OR AS NEEDED TO SUPPORT ANNUAL BUDGETING) FOR THE SPECIFIC PURPOSE OF ASSESSING THE ADEQUACY OF INFORMATION, AND THE NEED FOR THE ESTABLISHMENT OF ADDITIONAL AGREEMENT INTERIM MEASURES. ADDITIONAL AGREEMENT INTERIM MEASURES SHALL BE DOCUMENTED THROUGH ESTABLISHMENT OF INTERIM MILESTONES AND ASSOCIATED TARGET DATES AS AGREED NECESSARY BY THE PARTIES.	To Be Determined
M-045-58	SUBMIT TO ECOLOGY FOR REVIEW AND APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT A CORRECTIVE MEASURES STUDY FOR INTERIM CORRECTIVE MEASURES (PENDING RESULTS AND CONCLUSIONS IN THE PHASE 1 RFI REPORT-MILESTONE M-45-55 OR SUBSEQUENT RFI REPORTS).	To Be Determined
M-045-59	CONTROL SURFACE WATER INFILTRATION PATHWAYS AS NEEDED TO CONTROL OR SIGNIFICANTLY REDUCE THE LIKELIHOOD OF MIGRATION OF SUBSURFACE CONTAMINATION TO GROUNDWATER AT THE SST WMAS (PENDING THE CMS REPORT, MILESTONE M-45-58, AND IMPLEMENTATION OF OTHER INTERIM CORRECTIVE MEASURES. DECISIONS ON CONTROLLING SURFACE WATER INFILTRATION PATHWAYS WILL BE MADE BY EVALUATING THE ROLE OF SURFACE WATER INFILTRATION AND THE TRANSPORT OF SUBSURFACE CONTAMINATION TO GROUNDWATER. BASED ON THE CORRECTIVE MEASURES STUDY (M-45- 58) INTERIM SURFACE BARRIERS AND/OR OTHER INFILTRATION CONTROLS MAY BE REQUIRED.	To Be Determined
M-045-60	SUBMIT TO ECOLOGY FOR REVIEW AND APPROVAL AS AN AGREEMENT PRIMARY DOCUMENT DOE'S RFI/CMS WORK PLAN FOR SST WMAS. THIS RFI/CMS WORK PLAN SHALL DOCUMENT THE ADDITIONAL INTERIM MEASURES AND FURTHER INVESTIGATIONS NEEDED FOR DECISIONS ON RETRIEVAL, CLOSURE, AND CORRECTIVE MEASURES FOR THE SST WMAS.	SIX MONTHS FOLLOWING RFI REPORT APPROVAL

[a] Appendix D to the HFFACO Action Plan

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7.0 CERTIFICATION OF CLOSURE, SURVEY PLAT, AND NOTICE IN DEED

After DOE completes closure activities at each WMA included in the SST system closure, DOE will submit to Ecology, by registered mail, a certification that the WMA has been closed according to the specifications in the approved WMA closure action plan. The certification will be signed by DOE and an independent registered Professional Engineer registered in the State of Washington (WAC 173-303-610(6)). Not later than the date of submission of the certification of closure of the WMA, DOE will provide a survey plat to Benton County indicating the location and dimensions of the closed dangerous waste units with respect to permanently surveyed benchmarks. The survey plat will be prepared and certified by a Professional Land Surveyor. After final closure, the survey plat of the WMA will be submitted to Benton County and Ecology (WAC 173-303-610(9-10). Closure certification will also be conducted at the SST system level.

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8.0 POSTCLOSURE PLAN

Postclosure care is required for TSD units after closure if waste has been left in place. Following completion of waste retrieval, completion of tank and ancillary equipment stabilization activities, and construction of a surface barrier, each WMA will enter a postclosure care period during which surface barrier inspection, barrier maintenance and performance monitoring, administrative controls, and groundwater monitoring will be implemented. These activities may be integrated with the Hanford Site long-term stewardship program and Central Plateau closure strategies.

Postclosure will be performed on a WMA-by-WMA basis. Each postclosure plan will be incorporated into Chapter VI of the Site-Wide Permit through a permit modification. DOE will submit a postclosure plan for the entire SST system to take effect after final system closure actions are complete to comply with the postclosure requirements in WAC 173-303-610(7), -610(8), -610(9), -610(10), and -665(6)(b).

Appropriate measures will be implemented upon closure of each component within a WMA to protect both the integrity of the component closure prior to installation of the engineered surface barrier, and to protect human health and the environment from exposure.

8.1 INSTITUTIONAL CONTROLS

Following completion of final closure activities and construction of a surface barrier, DOE will place each WMA in a period of administrative control during which monitoring and maintenance activities will take place.

As noted, DOE anticipates that components of the SST system may require land disposal. Landfill closure standards require that institutional controls be in place to protect human health and the environment. Institutional controls generally include all non-engineered restrictions on activities, access, or exposure to land, groundwater, surface water, waste, and waste disposal areas or media. Institutional controls may be temporary or permanent restrictions or requirements. The main institutional control types include 1) access controls, 2) land and groundwater controls, 3) performance assessment and reporting of controls, and 4) permanent markers and distributed records that pass on information regarding the nature and location of hazards to future generations.

DOE will develop specific institutional controls as a part of each closure plan and integrate these controls with similar institutional controls for the Hanford Site and other 200 Area waste sites. Specific information regarding marking, signs, and/or monuments has not been developed to date for SST WMAs. DOE has authorized programs to develop a site-wide institutional controls plan to provide for the implementation and maintenance of institutional controls including the placing of marking, signs, and/or monuments at the Hanford Site to protect human health and the environment. DOE will specifically integrate the planning, development, and implementation of institutional controls for SST system closure with appropriate elements of the site-wide institutional controls plan.

8.2 GROUNDWATER MONITORING

During the time from the closure of the first component of a WMA through final closure of that entire WMA, groundwater monitoring will continue according to the approved groundwater monitoring plan for that WMA, which is described in its WMA closure action plan. After this period, groundwater monitoring requirements may be redefined relative to the 200 East Area and 200 Area West SST system boundaries or to the entire SST system.

8.3 INSPECTION AND MAINTENANCE

An inspection schedule is required as part of postclosure care of land disposal units (WAC 173-303-610(7)) including tanks that are land disposed, if any (WAC 173-303-665(6)). An inspection schedule will be developed for postclosure of each closed component prior to final closure of each WMA and then for each WMA and the SST system after their respective final closures. Activities will include inspecting engineered surface barriers after final closure. Surface barrier inspections will monitor vegetation conditions, signs of intrusion, and run-on/run-off control. Maintenance will be performed if problems are discovered during inspections.

8.4 CERTIFICATION OF POSTCLOSURE PERFORMANCE

No later than 60 days after completion of the established postclosure care period for each WMA and the entire SST system, DOE will submit by registered mail a certification that the postclosure period for the WMA (or the SST system, as appropriate) was performed according to the specifications in the approved postclosure plan. The certification will be signed by DOE and an independent Registered Professional Engineer.

9.0 REFERENCES

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*, as amended.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations,* as amended.

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, as amended.

40 CFR 144, "Underground Injection Control," *Code of Federal Regulations*, as amended.

40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level, and Transuranic Radioactive Wastes.", *Code of Federal Regulations,* as amended.

40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities: Groundwater Monitoring," *Code of Federal Regulations*, as amended.

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations,* as amended.

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ADDENDUM 1

DANGEROUS WASTE UNITS INCLUDED IN THE SINGLE-SHELL TANK SYSTEM CLOSURE

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The tables in this addendum contain listings of the dangerous waste units included in closure of the single-shell tank (SST) system. The list is based on Appendix D of the *Single-Shell Tank Closure Work Plan* (DOE/ORP- 2001-18) and represents units listed on the *Resource Conservation and Recovery Act of 1976* (RCRA) Part A, Form 3, permit application, in addition to RCRA Past Practice (RPP), *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) Past Practice (CPP), and miscellaneous storage tank units. This addendum details the single-shell tank (SST) system as currently defined. If future efforts modify the listing, changes will be incorporated in subsequent updates of this addendum.

1.0 SINGLE-SHELL TANKS

Table 1 lists the SSTs that are included in the SST system. For each tank, the table summarizes year of construction, year removed from service, and operating capacity.

The volume capacity of each tank varies from 208,000 to 3.8 million L (55,000 to 1 million gal). One hundred thirty-three of the SSTs are 22.86 m (75 ft) in diameter and 9.07 to 16.46 m (29.75 to 54 ft) high (at their highest points), with nominal capacities of 1.9 million to 3.8 million L (500,000 to 1 million gal). The larger tanks are numbered in the 100-series. Sixteen of the tanks are smaller units of a similar design, 6.1 m (20 ft) in diameter and 7.77 m (25.5 ft) high, with capacities of 208,000 L (55,000 gal). The smaller tanks are numbered in the 200-series.

Table 1. Single-Shell Tanks. (4 Pages)

Tank Number	Year of Construction	Year Removed[a] from Service	Operating Capacity L	(gal)
200 EAST AREA				
Waste Management Area A-AX				
241-A-101	1954-1955	1980	3,785,000	(1,000,000)
241-A-102	1954-1955	1980	3,785,000	(1,000,000)
241-A-103[b]	1954-1955	1980	3,785,000	(1,000,000)
241-A-104[b]	1954-1955	1975	3,785,000	(1,000,000)
241-A-105[b]	1954-1955	1963	3,785,000	(1,000,000)
241-A-106	1954-1955	1980	3,785,000	(1,000,000)
241-AX-101	1963-1964	1980	3,785,000	(1,000,000)
241-AX-102[b]	1963-1964	1980	3,785,000	(1,000,000)
241-AX-103	1963-1964	1980	3,785,000	(1,000,000)
241-AX-104[b]	1963-1964	1978	3,785,000	(1,000,000)
Waste Management Area B-BX-BY				
241-B-101[b]	1943-1944	1974	1,892,500	(500,000)
241-B-102	1943-1944	1978	1,892,500	(500,000)
241-B-103[b]	1943-1944	1977	1,892,500	(500,000)
241-B-104	1943-1944	1972	1,892,500	(500,000)
241-B-105[b]	1943-1944	1972	1,892,500	(500,000)
241-B-106	1943-1944	1977	1,892,500	(500,000)
241-B-107[b]	1943-1944	1969	1,892,500	(500,000)
241-B-108	1943-1944	1977	1,892,500	(500,000)
241-B-109	1943-1944	1977	1,892,500	(500,000)
241-B-110[b]	1943-1944	1971	1,892,500	(500,000)
241-B-111[b]	1943-1944	1976	1,892,500	(500,000)
241-B-112[b]	1943-1944	1977	1,892,500	(500,000)
241-B-201[b]	1943-1944	1971	208,175	(55,000)
241-B-202	1943-1944	1977	208,175	(55,000)
241-B-203[b]	1943-1944	1977	208,175	(55,000)
241-B-204[b]	1943-1944	1977	208,175	(55,000)
241-BX-101[b]	1946-1947	1972	1,892,500	(500,000)
241-BX-102[b]	1946-1947	1971	1,892,500	(500,000)
241-BX-103	1946-1947	1977	1,892,500	(500,000)
241-BX-104	1946-1947	1980	1,892,500	(500,000)
241-BX-105	1946-1947	1980	1,892,500	(500,000)
241-BX-106	1946-1947	1971	1,892,500	(500,000)
241-BX-107	1946-1947	1977	1,892,500	(500,000)
241-BX-108[b]	1946-1947	1974	1,892,500	(500,000)
241-BX-109	1946-1947	1974	1,892,500	(500,000)
241-BX-110[b]	1946-1947	1977	1,892,500	(500,000)
241-BX-111[b]	1946-1947	1977	1,892,500	(500,000)
241-BX-112	1946-1947	1977	1,892,500	(500,000)

Table 1. Single-Shell Tanks. (4 Pages)

Tank Number	Year of Construction	Year Removed[a] from Service	Operating Capacity L	(gal)
Waste Management Area B-BX-BY (Cont'd)				
241-BY-101	1948-1949	1971	2,838,750	(750,000)
241-BY-102	1948-1949	1977	2,838,750	(750,000)
241-BY-103[b]	1948-1949	1973	2,838,750	(750,000)
241-BY-104	1948-1949	1977	2,838,750	(750,000)
241-BY-105[b]	1948-1949	1974	2,838,750	(750,000)
241-BY-106[b]	1948-1949	1977	2,838,750	(750,000)
241-BY-107[b]	1948-1949	1974	2,838,750	(750,000)
241-BY-108[b]	1948-1949	1972	2,838,750	(750,000)
241-BY-109	1948-1949	1979	2,838,750	(750,000)
241-BY-110	1948-1949	1979	2,838,750	(750,000)
241-BY-111	1948-1949	1977	2,838,750	(750,000)
241-BY-112	1948-1949	1978	2,838,750	(750,000)
Waste Management Area C				
241-C-101[b]	1943-1944	1970	1,892,500	(500,000)
241-C-102	1943-1944	1976	1,892,500	(500,000)
241-C-103	1943-1944	1979	1,892,500	(500,000)
241-C-104	1943-1944	1980	1,892,500	(500,000)
241-C-105	1943-1944	1979	1,892,500	(500,000)
241-C-106	1943-1944	1979	1,892,500	(500,000)
241-C-107	1943-1944	1978	1,892,500	(500,000)
241-C-108	1943-1944	1976	1,892,500	(500,000)
241-C-109	1943-1944	1976	1,892,500	(500,000)
241-C-110[b]	1943-1944	1976	1,892,500	(500,000)
241-C-111[b]	1943-1944	1978	1,892,500	(500,000)
241-C-112	1943-1944	1976	1,892,500	(500,000)
241-C-201[b]	1943-1944	1977	208,175	(55,000)
241-C-202[b]	1943-1944	1977	208,175	(55,000)
241-C-203[b]	1943-1944	1977	208,175	(55,000)
241-C-204[b]	1943-1944	1977	208,175	(55,000)
200 WEST AREA				
Waste Management Area S-SX				
241-S-101	1950-1951	1980	2,838,750	(750,000)
241-S-102	1950-1951	1980	2,838,750	(750,000)
241-S-103	1950-1951	1980	2,838,750	(750,000)
241-S-104[b]	1950-1951	1968	2,838,750	(750,000)
241-S-105	1950-1951	1974	2,838,750	(750,000)
241-S-106	1950-1951	1979	2,838,750	(750,000)
241-S-107	1950-1951	1980	2,838,750	(750,000)
241-S-108	1950-1951	1979	2,838,750	(750,000)
241-S-109	1950-1951	1979	2,838,750	(750,000)
241-S-110	1950-1951	1979	2,838,750	(750,000)
241-S-111	1950-1951	1972	2,838,750	(750,000)
241-S-112	1950-1951	1974	2,838,750	(750,000)

Table 1. Single-Shell Tanks. (4 Pages)

Tank Number	Year of Construction	Year Removed[a] from Service	Operating Capacity L	(gal)
Waste Management Area S-SX (Cont'd)				
241-SX-101	1953-1954	1980	3,785,000	(1,000,000)
241-SX-102	1953-1954	1980	3,785,000	(1,000,000)
241-SX-103	1953-1954	1980	3,785,000	(1,000,000)
241-SX-104[b]	1953-1954	1980	3,785,000	(1,000,000)
241-SX-105	1953-1954	1980	3,785,000	(1,000,000)
241-SX-106	1953-1954	1980	3,785,000	(1,000,000)
241-SX-107[b]	1953-1954	1964	3,785,000	(1,000,000)
241-SX-108[b]	1953-1954	1962	3,785,000	(1,000,000)
241-SX-109[b]	1953-1954	1965	3,785,000	(1,000,000)
241-SX-110[b]	1953-1954	1976	3,785,000	(1,000,000)
241-SX-111[b]	1953-1954	1974	3,785,000	(1,000,000)
241-SX-112[b]	1953-1954	1969	3,785,000	(1,000,000)
241-SX-113[b]	1953-1954	1958	3,785,000	(1,000,000)
241-SX-114[b]	1953-1954	1972	3,785,000	(1,000,000)
241-SX-115[b]	1953-1954	1965	3,785,000	(1,000,000)
Waste Management Area T				
241-T-101[b]	1943-1944	1979	1,892,500	(500,000)
241-T-102	1943-1944	1976	1,892,500	(500,000)
241-T-103[b]	1943-1944	1974	1,892,500	(500,000)
241-T-104	1943-1944	1974	1,892,500	(500,000)
241-T-105	1943-1944	1976	1,892,500	(500,000)
241-T-106[b]	1943-1944	1973	1,892,500	(500,000)
241-T-107[b]	1943-1944	1976	1,892,500	(500,000)
241-T-108[b]	1943-1944	1974	1,892,500	(500,000)
241-T-109[b]	1943-1944	1974	1,892,500	(500,000)
241-T-110	1943-1944	1976	1,892,500	(500,000)
241-T-111[b]	1943-1944	1974	1,892,500	(500,000)
241-T-112	1943-1944	1977	1,892,500	(500,000)
241-T-201	1943-1944	1976	208,175	(55,000)
241-T-202	1943-1944	1976	208,175	(55,000)
241-T-203	1943-1944	1976	208,175	(55,000)
241-T-204	1943-1944	1976	208,175	(55,000)
Waste Management Area TX-TY				
241-TX-101	1947-1948	1980	2,838,750	(750,000)
241-TX-102	1947-1948	1977	2,838,750	(750,000)
241-TX-103	1947-1948	1980	2,838,750	(750,000)
241-TX-104	1947-1948	1977	2,838,750	(750,000)
241-TX-105[b]	1947-1948	1977	2,838,750	(750,000)
241-TX-106	1947-1948	1977	2,838,750	(750,000)
241-TX-107[b]	1947-1948	1977	2,838,750	(750,000)
241-TX-108	1947-1948	1977	2,838,750	(750,000)
241-TX-109	1947-1948	1977	2,838,750	(750,000)
241-TX-110[b]	1947-1948	1977	2,838,750	(750,000)
241-TX-111	1947-1948	1977	2,838,750	(750,000)

Table 1. Single-Shell Tanks. (4 Pages)

Tank Number	Year of Construction	Year Removed[a] from Service	Operating Capacity	
			L	(gal)
Waste Management Area TX-TY (Cont'd)				
241-TX-112	1947-1948	1974	2,838,750	(750,000)
241-TX-113[b]	1947-1948	1971	2,838,750	(750,000)
241-TX-114[b]	1947-1948	1971	2,838,750	(750,000)
241-TX-115[b]	1947-1948	1977	2,838,750	(750,000)
241-TX-116[b]	1947-1948	1969	2,838,750	(750,000)
241-TX-117[b]	1947-1948	1969	2,838,750	(750,000)
241-TX-118	1947-1948	1980	2,838,750	(750,000)
241-TY-101[b]	1951-1952	1973	2,838,750	(750,000)
241-TY-102	1951-1952	1979	2,838,750	(750,000)
241-TY-103[b]	1951-1952	1973	2,838,750	(750,000)
241-TY-104[b]	1951-1952	1974	2,838,750	(750,000)
241-TY-105[b]	1951-1952	1980	2,838,750	(750,000)
241-TY-106[b]	1951-1952	1959	2,838,750	(750,000)
Waste Management Area U				
241-U-101[b]	1943-1944	1960	1,892,500	(500,000)
241-U-102	1943-1944	1979	1,892,500	(500,000)
241-U-103	1943-1944	1978	1,892,500	(500,000)
241-U-104[b]	1943-1944	1951	1,892,500	(500,000)
241-U-105	1943-1944	1978	1,892,500	(500,000)
241-U-106	1943-1944	1977	1,892,500	(500,000)
241-U-107	1943-1944	1980	1,892,500	(500,000)
241-U-108	1943-1944	1979	1,892,500	(500,000)
241-U-109	1943-1944	1978	1,892,500	(500,000)
241-U-110[b]	1943-1944	1975	1,892,500	(500,000)
241-U-111	1943-1944	1980	1,892,500	(500,000)
241-U-112[b]	1943-1944	1970	1,892,500	(500,000)
241-U-201	1943-1944	1977	208,175	(55,000)
241-U-202	1943-1944	1977	208,175	(55,000)
241-U-203	1943-1944	1977	208,175	(55,000)
241-U-204	1943-1944	1977	208,175	(55,000)

[a] The last year the tank was capable of receiving waste; the actual date of last waste receipt may have been earlier.

[b] Assumed leaking tank (HNF-EP-0182). The year removed date is the date (from Waste Information Data System [WIDS]) when tank was taken out of service, which may be long before the tank was officially declared as a confirmed or assumed leaking tank.

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2.0 MISCELLANEOUS TANKS

Table 2 lists tanks other than the SSTs listed in Table 1. Miscellaneous tanks are radioactively contaminated, inactive, and abandoned underground storage tanks. Many of these miscellaneous underground storage tanks (MUSTs) are buried directly in the ground; others are installed in underground vaults. Most, but not all, of the tanks are catch tanks. Many of the tanks contain sludge and process materials.

Table 2. Miscellaneous Tanks. (2 Pages)

Facility Number	Description	Facility Number	Description
241-A-302A[a,b]	Catch tank	241-SX-302 (aka 241-SX-304) [b]	Catch tank
241-A-302B[a,b]	Catch tank	241-S-304[a]	Catch tank
244-A-TK/SMP[a]	Tank/sump	241-T-301B (aka 241-T-301) [b]	Catch tank
241-A-350[a]	Catch tank	242-T-135[b]	Storage tank
A-417[a]	Misc. tank	242-TA-R1[b]	Receiver tank
241-AX-151-CT[b]	Catch tank	241-TX-302A[b]	Catch tank
241-AX-152[a]	Catch Tank	241-TX-302B[b]	Catch tank
241-B-301B (aka 241-B-301) [b]	Catch tank	241-TX-302BR[b]	Catch tank
241-B-302B[b]	Catch tank	241-TX-302C[b]	Catch tank
241-BX-302A[b]	Catch tank	241-TX-302XB (aka 241-TX-302X) [b]	Catch tank
241-BX-302B[b]	Catch tank	244-TX-TK/SMP[a]	Tank/sump
241-BX-302C[b]	Catch tank	244-TXR-TK/SMP-001[b]	Tank/sump
244-BX-TK/SMP[a]	Tank/sump	244-TXR-TK/SMP-002[b]	Tank/sump
241-BY-ITS2-Tank 2	Catch tank	244-TXR-TK/SMP-003[b]	Tank/sump
241-C-301 (aka 241-C-301C) [b]	Catch tank	241-TY-302A[b]	Catch tank
CR-003-TK/SMP	Tank/sump	241-TY-302B[b]	Catch tank
241-ER-311[a]	Catch tank	241-U-301B[a]	Catch tank
241-ER-311A (aka 241-ER-311) [b]	Catch tank	241-UX-302A[a,b]	Catch tank
241-EW-151[a]	Catch Tank	244-U-TK/SMP[a]	Tank/sump
240-S-302[b]	Catch tank	200-W-7 (aka 243-S-TK-1; aka 246-L) [b]	Catch tank

Table 2. Miscellaneous Tanks. (2 Pages)

Facility Number	Description	Facility Number	Description
241-S-302A[a,c]	Catch tank	231-W-151-001[c]	Receiver tank
241-S-302B[b]	Catch tank	231-W-151-002[c]	Receiver tank
244-S-TK/SMP[a]	Tank/sump	241-Z-8[c]	Settling tank

Source: Adapted from RPP-10466 (2002).

Note: Facility designations generally identify the farm that the MUST serviced.

[a] Listed on “Table of Disposition of Double-Shell Tank System Components Not In Use Beyond June 30, 2005,” Administrative Order NWPKW-1250 and 1251, Corrective Measure 5 as Double-Shell Tank (DST) system equipment that will be closed under the *Single-Shell Tank System Closure Plan*.

[b] RCRA Past Practice Unit.

[c] CERCLA Past Practice Unit.

aka = Also known as.

3.0 ANCILLARY EQUIPMENT

This section tabulates SST ancillary equipment, essentially consisting of equipment listed (such as diversion boxes) and not listed (such as transfer lines) in the Part A permit. The ancillary equipment identified represents the best information currently available. This list will be updated in future revisions of the closure work plan to incorporate changes identified during the resolution of the Hanford Federal Facility Agreement and Consent Order [HFFACO] M-23 series of milestones (Ecology et al. 1989) and will be finalized prior to developing the *SST System Closure Plan*. The following paragraphs provide definitions for the ancillary equipment listed in Tables 3-1 through 3-7.

Table 3-1. Diversion Boxes – Diversion boxes are belowgrade, reinforced concrete structures that provide a flexible method of directing liquid waste from a given point to any other given point. The top of the diversion box is a concrete cover block that usually extends abovegrade. Cover blocks vary in thickness from box to box. Some diversion boxes are lined with steel. Transfer lines are connected in the diversion box by installing a jumper between the connecting nozzles. Jumpers either can be fixed or flexible. Jumper installation or removal can be a complex operation requiring a crane to remove and handle the cover block and to install the jumper.

Table 3-2. Miscellaneous Structures – These are special structures that support SST functions and do not fit into other listing categories.

Table 3-3. Valve Pits – Valve pits are reinforced concrete structures located below ground that contain valve and jumper assemblies to route the liquid waste through the connected pipelines within a tank farm. Heavy, thick, grade-level blocks cover each of the valve pits. When several tanks are undergoing simultaneous pumping to a single receiver tank, the flow is routed to a valve pit. In the valve pit, the transfer lines of the sending tank are manifolded to the receiver tank line by means of a series of valves and jumper connections. Two- and three-way valves are built into each rigid jumper assembly to divert the flow in the required direction. Waste also can be routed through the valve pit with stainless steel flex jumpers. Each valve pit is equipped with a leak detection that is interlocked to shut down pumps. Each valve pit also has a flush line connected to a flush pit or a drain line connected to an underground storage tank.

Table 3-4. Flush Pits – The components for pipeline back flushing and decontamination operations are located in flush pits. In-line backflow preventers protect the flush pit system from contamination from mixed waste backflowing into the flushing system.

Table 3-5. Single-Shell Tank Pits – SST pits are located atop the tanks and provide a pathway into the tanks for pumps and monitoring equipment.

Table 3-6. Waste Transfer Vaults – These vaults are shielded enclosures used to collect, clarify, and allow physical and chemical modification of contents before such contents are transferred elsewhere.

Table 3-7. Transfer Lines – Piping used to transfer waste from one location to another.

Table 3-1. Diversion Boxes (2 Pages)

Facility Number	Description	Facility Number	Description
241-A-151[a]	200-PO-2 Operable unit	240-S-151[a]	Diversion box
241-A-152	Diversion box	240-S-152	Diversion box
241-A-153	Diversion box	241-S-151[a]	Diversion box
241-AX-151[a]	Diversion box	241-S-152	Diversion box
241-AX-152[a]	Diversion box	241-SX-151	Diversion box
241-AX-153	Diversion box	241-SX-152	Diversion box
241-AX-155[a]	Diversion box	241-T-151	Diversion box
241-AR-151[a]	Diversion box	241-T-152	Diversion box
241-B-151	Diversion box	241-T-153	Diversion box
241-B-152	Diversion box	241-T-252	Diversion box
241-B-153	Diversion box	242-T-151	Diversion box
241-B-154	Diversion box	241-TR-152	Diversion box
241-B-252	Diversion box	241-TR-153	Diversion box
242-B-151	Diversion box	241-TX-152[a]	Diversion box
241-BR-152	Diversion box	241-TX-153	Diversion box
241-BX-153	Diversion box	241-TX-154[a]	Diversion box
241-BX-154	Diversion box	241-TX-155[a]	Diversion box
241-BX-155	Diversion box	241-TXR-151	Diversion box
241-BXR-151	Diversion box	241-TXR-152	Diversion box
241-BXR-152	Diversion box	241-TXR-153	Diversion box
241-BXR-153	Diversion box	241-TXR-244	Diversion box
241-BYR-152	Diversion box	241-TY-153	Diversion box
241-BYR-153	Diversion box	241-U-151[a]	Diversion box
241-BYR-154	Diversion box	241-U-152[a]	Diversion box
241-C-151	Diversion box	241-U-153	Diversion box
241-C-152	Diversion box	241-U-252	Diversion box
241-C-153	Diversion box	241-UR-151	Diversion box
241-C-154	Diversion box	241-UR-152	Diversion box
241-C-252	Diversion box	241-UR-153	Diversion box
241-CR-151	Diversion box	241-UR-154	Diversion box
241-CR-152	Diversion box	241-UR-244	Diversion box
241-CR-153	Diversion box	241-UX-154[a]	Diversion box
241-ER-151[a]	Diversion box		
241-ER-152[a]	Diversion box		

Table 3-1. Diversion Boxes (2 Pages)

Facility Number	Description	Facility Number	Description
241-ER-153[a]	Diversion box		

Source: Adapted from RPP-10466 (2002).

[a] Listed on "Table of Disposition of Double-Shell Tank System Components Not In Use Beyond June 30, 2005," Administrative Order NWPKW-1250 and 1251, Corrective Measure 5 as Double-Shell Tank (DST) system equipment that will be closed under the *Single-Shell Tank System Closure Plan*.

Table 3-2. Miscellaneous Structures

Facility Number	Description
241-A-431[a]	Ventilation building
241-C-801[a]	Cesium loadout facility
241-SX-401[a]	Condenser shielding building
241-SX-402[a]	Condenser shielding building
242-S[a]	Evaporator
242-T[a]	Evaporator
241-EW-151[b]	Vent station

Source: Adapted from RPP-10466 (2002).

[a] RCRA Past Practice Unit.

[b] Listed on "Table of Disposition of Double-Shell Tank System Components Not In Use Beyond June 30, 2005," Administrative Order NWPKW-1250 and 1251, Corrective Measure 5 as Double-Shell Tank (DST) system equipment that will be closed under the Single-Shell Tank System Closure Plan.

Table 3-3. Valve Pits

Facility Number	Description
241-A-A[a]	Valve pit
241-A-B[a]	Valve pit
241-AX-A[a]	Valve pit
241-AX-B[a]	Valve pit
241-AX-501[a]	Valve pit, with fabric cover
241-S-A[a]	Valve pit
241-S-B[a]	Valve pit
241-S-C	Valve pit
241-S-D	Valve pit
241-SX-A	Valve pit
241-SX-B	Valve pit
241-U-A	Valve pit
241-U-B	Valve pit

Table 3-3. Valve Pits

241-U-C	Valve pit
241-U-D	Valve pit
241-BY-109	Valve pit
241-C	Valve pit
241-WS-3	209-E-WS-3 critical mass laboratory valve pit

Source: Adapted from RPP-10466 (2002).

[a] Listed on “Table of Disposition of Double-Shell Tank System Components Not In Use Beyond June 30, 2005,” Administrative Order NWPKW-1250 and 1251, Corrective Measure 5 as Double-Shell Tank (DST) system equipment that will be closed under the *Single-Shell Tank System Closure Plan*.

Table 3-4. Flush Pit

Facility Number	**Description**
241-WR	Flush pit

Source: Adapted from RPP-10466 (2002).

Table 3-5. Single-Shell Tank Pits (5 Pages)

Facility Number	**Description**	**Facility Number**	**Description**
241-A-01A	Pump Pit	241-C-02C	Sluice Pit
241-A-01B	Pump Pit	241-C-03A	Pump Pit
241-A-01C	Sluice Pit	241-C-03C	Sluice Pit
241-A-02A	Pump Pit	241-C-05A	Pump Pit
241-A-02B	Pump Pit	241-C-05B	Heel Pit
241-A-02C	Receiving Pit	241-C-05C	Sluice Pit
241-A-02D	Distribution Pit	241-C-07	No pit, covered saltwell caisson
241-A-03A	Pump Pit	241-C-08	No pit, covered saltwell caisson
241-A-03B	Pump Pit	241-C-09	No pit, covered saltwell caisson
241-A-03C	Pump Pit	241-C-110	No pit, covered saltwell caisson
241-A-03D	Distribution Pit	241-C-111	No pit, covered saltwell caisson
241-A-04A	Pump Pit	241-C-112	No pit, covered saltwell caisson
241-A-04B	Sluice Pit	241-S-02A	Pump Pit
241-A-04C	Sluice Pit	241-S-03A	Pump Pit
241-A-05A	Pump Pit	241-S-04A	Pump Pit

Table 3-5. Single-Shell Tank Pits (5 Pages)

Facility Number	Description	Facility Number	Description
241-A-05B	Sluice Pit	241-S-05A	Pump Pit
241-A-05C	Pump Pit	241-S-06A	Pump Pit
241-A-05D	Sluice Pit	241-S-08A	Pump Pit
241-A-06A	Pump Pit	241-SX-03A	Pump Pit
241-A-06B	Sluice Pit	241-SX-04A	Pump Pit
241-A-06C	Pump Pit	241-SX-05B	Heel Pit
241-A-06D	Distribution Pit	241-SX-06A	Pump Pit
241-AX-01B	Pump Pit	241-SX-07A	Pump Pit
241-AX-01C	Sluice Pit	241-SX-08A	Pump Pit
241-AX-01D	Sluice Pit	241-SX-09A	Pump Pit
241-AX-02A	Distribution Pit	241-SX-10A	Pump Pit
241-AX-02B	Pump Pit	241-SX-11A	Pump Pit
241-AX-02C	Sluice Pit	241-SX-12A	Pump Pit
241-AX-02D	Pump Pit	241-SX-13A	Pump Pit
241-AX-03A	Distribution Pit	241-SX-14A	Pump Pit
241-AX-03B	Pump Pit	241-SX-15A	Pump Pit
241-AX-03C	Sluice Pit	241-T-01A	Pump Pit
241-AX-03D	Pump Pit	241-T-01B	Heel Pit
241-AX-04A	Distribution Pit	241-T-01C	Sluice Pit
241-AX-04B	Pump Pit	241-T-02A	Pump Pit
241-AX-04C	Sluice Pit	241-T-02B	Heel Pit
241-AX-04D	Sluice Pit	241-T-02C	Sluice Pit
241-B-01A	Pump Pit	241-T-03A	Pump Pit
241-B-01B	Heel Pit	241-T-03B	Heel Pit
241-B-01C	Sluice Pit	241-T-04	No pit, covered saltwell caisson
241-B-02A	Pump Pit	241-T-05	No pit, covered saltwell caisson
241-B-02B	Heel Pit	241-T-06	No Pit, covered saltwell caisson
241-B-02C	Sluice Pit	241-T-07	No Pit, covered saltwell caisson
241-B-03A	Pump Pit	241-T-08	No Pit, covered saltwell caisson
241-B-03B	Heel Pit	241-T-09	No Pit, covered saltwell caisson
241-B-03C	Sluice Pit	241-T-111	No pit, covered saltwell caisson
241-B-04	No pit, covered saltwell	241-T-112	No Pit, covered saltwell

Table 3-5. Single-Shell Tank Pits (5 Pages)

Facility Number	Description	Facility Number	Description
	caisson		caisson
241-B-05	No pit, covered saltwell caisson	241-T-201	No Pit, covered saltwell caisson
241-B-06A	Pump Pit	241-T-202	No Pit, covered saltwell caisson
241-B-07	No pit, covered saltwell caisson	241-T-203	No Pit, covered saltwell caisson
241-B-08A	Pump Pit	241-T-204	No Pit, covered saltwell caisson
241-B-09A	Pump Pit	241-TX-01A	Pump Pit
241-B-104	Pump Pit	241-TX-01C	Sluice Pit
241-B-105	Pump Pit	241-TX-01D	Sluice Pit
241-B-107	Pump Pit	241-TX-02A	Pump Pit
241-B-109	Pump Pit	241-TX-02C	Sluice Pit
241-B-110	No pit, covered saltwell caisson	241-TX-02D	Sluice Pit
241-B-111	No pit, covered saltwell caisson	241-TX-03A	Pump Pit
241-B-112A	Pump Pit	241-TX-03C	Sluice Pit
241-B-201	Condenser Vent	241-TX-03D	Sluice Pit
241-B-202	Condenser Vent	241-TX-04A	Pump Pit
241-B-203	Condenser Vent	241-TX-04C	Sluice Pit
241-B-204	Condenser Vent	241-TX-04D	Sluice Pit
241-BX-01A	Pump Pit	241-TX-05A	Pump Pit
241-BX-01B	Heel Pit	241-TX-05C	Sluice Pit
241-BX-01C	Sluice Pit	241-TX-05D	Sluice Pit
241-BX-02A	Pump Pit	241-TX-06A	Pump Pit
241-BX-02B	Heel Pit	241-TX-06C	Sluice Pit
241-BX-02C	Sluice Pit	241-TX-06D	Sluice Pit
241-BX-03A	Pump Pit	241-TX-07A	Pump Pit
241-BX-03B	Heel Pit	241-TX-07C	Sluice Pit
241-BX-03C	Sluice Pit	241-TX-07D	Sluice Pit
241-BX-04A	Pump Pit	241-TX-08A	Pump Pit
241-BX-04B	Heel Pit	241-TX-08C	Sluice Pit
241-BX-04C	Sluice Pit	241-TX-08D	Sluice Pit
241-BX-05A	Pump Pit	241-TX-09A	Pump Pit
241-BX-05B	Heel Pit	241-TX-10A	Pump Pit
241-BX-05C	Sluice Pit	241-TX-11A	Pump Pit
241-BX-06A	Pump Pit	241-TX-12A	Pump Pit

Table 3-5. Single-Shell Tank Pits (5 Pages)

Facility Number	Description	Facility Number	Description
241-BX-06B	Heel Pit	241-TX-13A	Pump Pit
241-BX-06C	Sluice Pit	241-TX-14A	Pump Pit
241-BX-07	No pit, covered saltwell caisson	241-TX-15A	Sluice Pit
241-BX-08A	Pump Pit	241-TX-15B	Pump Pit
241-BX-09	No pit, covered saltwell caisson	241-TX-16A	Pump Pit
241-BX-107	Pump Pit	241-TX-17A	Pump Pit
241-BX-109	Pump Pit	241-TX-18A	Pump Pit
241-BX-110A	Pump Pit	241-TY-01A	Pump Pit
241-BX-111A	Pump Pit	241-TY-02A	Pump Pit
241-BX-112A	Pump Pit	241-TY-03A	Pump Pit
241-BY-01A	Pump Pit	241-TY-04A	Pump Pit
241-BY-01C	Sluice Pit	241-TY-05	No pit, covered saltwell caisson
241-BY-01D	Sluice Pit	241-TY-06	No pit, covered saltwell caisson
241-BY-02A	Pump Pit	241-U-01A	Pump Pit
241-BY-02B	Heel Pit	241-U-01B	Heel Pit
241-BY-02C	Sluice Pit	241-U-01C	Sluice Pit
241-BY-02D	Sluice Pit	241-U-02A	Pump Pit
241-BY-03A	Pump Pit	241-U-03A	Pump Pit
241-BY-03C	Sluice Pit	241-U-03B	Heel Pit
241-BY-03D	Sluice Pit	241-U-03C	Sluice Pit
241-BY-04A	Pump Pit	241-U-04A	Pump Pit
241-BY-04C	Sluice Pit	241-U-04B	Heel Pit
241-BY-04D	Sluice Pit	241-U-04C	Sluice Pit
241-BY-05C	Sluice Pit	241-U-05A	Pump Pit
241-BY-05D	Sluice Pit	241-U-05B	Heel Pit
241-BY-06C	Sluice Pit	241-U-05C	Sluice Pit
241-BY-06D	Sluice Pit	241-U-06A	Pump Pit
241-BY-07A	Pump Pit	241-U-06B	Heel Pit
241-BY-08A	Pump Pit	241-U-06C	Sluice Pit
241-BY-09A	Pump Pit	241-U-07A	Pump Pit
241-BY-110A	Pump Pit	241-U-07C	Sluice Pit
241-BY-111A	Pump Pit	241-U-08A	Pump Pit
241-BY-111B	Heel Pit	241-U-08C	Sluice Pit
241-BY-111C	Sluice Pit	241-U-09C	Sluice Pit

Table 3-5. Single-Shell Tank Pits (5 Pages)

Facility Number	Description	Facility Number	Description
241-BY-111D	Sluice Pit	241-U-10A	Pump Pit
241-BY-112A	Pump Pit	241-U-10B	Distributor Pit
241-BY-112C	Sluice Pit	241-U-11B	Distributor Pit
241-BY-112D	Sluice Pit	241-U-12	No pit, covered saltwell caisson
241-C-01A	Pump Pit	241-U-201	No pit
241-C-01B	Heel Pit	241-U-202	No Pit
241-C-01C	Sluice Pit	241-U-203	No Pit
241-C-02A	Pump Pit	241-U-204	No Pit
241-A-01A	Pump Pit	241-C-02C	Sluice Pit
241-A-01B	Pump Pit	241-C-03A	Pump Pit
241-A-01C	Sluice Pit	241-C-03C	Sluice Pit
241-A-02A	Pump Pit	241-C-05A	Pump Pit
241-A-02B	Pump Pit	241-C-05B	Heel Pit
241-A-02C	Receiving Pit	241-C-05C	Sluice Pit
241-A-02D	Distribution Pit	241-C-07	No pit, covered saltwell caisson
241-A-03A	Pump Pit	241-C-08	No pit, covered saltwell caisson
241-A-03B	Pump Pit	241-C-09	No pit, covered saltwell caisson
241-A-03C	Pump Pit	241-C-110	No pit, covered saltwell caisson
241-A-03D	Distribution Pit	241-C-111	No pit, covered saltwell caisson
241-A-04A	Pump Pit	241-C-112	No pit, covered saltwell caisson
241-A-04B	Sluice Pit	241-S-02A	Pump Pit
241-A-04C	Sluice Pit	241-S-03A	Pump Pit
241-A-05A	Pump Pit	241-S-04A	Pump Pit
241-A-05B	Sluice Pit	241-S-05A	Pump Pit
241-A-05C	Pump Pit		

Table 3-6. Waste Transfer Vaults

Facility Number	Description
244-AR Vault	Contains four tanks (244-AR-001, -002, -003, -004)

244-CR Vault	Contains four tanks (244-CR-001, -002, -003, 244-CR-011)
241-W-151	Contains two tanks (241-W-151-001, 241-W-151-002)
244-BXR Vault	Contains four tanks (244-BXR-001, -002, -003, 244-BXR-011)
244-TXR Vault	Contains three tanks (244-TXR-001, -002, -003)
244-UR Vault	Contains four tanks (244-UR-001, -002, -003, -004)

Table 3-7. Transfer Lines (34 Pages)

Line Number	**Connecting Facility**	**Connecting Facility**
103	241-SX-103-03-A	Capped
105	241-SX-105	241-SX-152
107	241-SX-107-07A-1	241-SX-152
108	241-SX-108-08A-1	241-SX-152
109	241-SX-109-09A-1	241-SX-152
110	241-SX-110-10A-1	241-SX-152
111	241-SX-111-11A-1	241-SX-152
112	241-SX-112-12A-1	241-SX-152
113	241-SX-113-13A-1	241-SX-152
114	241-SX-114-14A-1	241-SX-152
115	241-SX-115-15A-1	241-SX-152
234	241-S-102-02A-A	Unknown
235	241-S-102-02A-AA	Unknown
312	241-SX-102	Clean Out Boxes-15 Through -22
318	241-SX-102	241-SX-A, 241-SX-B-Flush Pit
456	241-SX-152	Capped
540	241-S-107-07A	241-S-151-L18
703	241-TX-109-09A-A	241-T-151-U3
704	SN-249	241-TX-109-09A-D
704	SN-249	241-TY-103-A
704	SN-249	241-TY-102
704	SN-249	241-TY-105
706	241-TX-105-05A-C	704
707	241-TX-06A-A	241-TX-02A-C
708	241-TX-102-02A-D	241-TX-103-03A-A
709	241-TX-103-03A-C	241-TX-104-04A-A
710	241-TX-108-08A-A	241-TX-104-04A-C

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
711	241-TX-107-07A-A	241-TX-108-08A-C
714	241-TX-110-10A-C	241-TX-111-11A-A
715	241-TX-111-11A-C	241-TX-112-12A-A
717	241-TX-118	241-TX-112-012A-C/15B-Valve Pit
718	241-TX-113-13A	241-TX-115
720	241-TX-114	241-15B-Valve Pit
721	241-TX-114-14A	241-TX-115
723	241-TX-118-18A	242-T
724	241-TX-111	241-TX-14B-Valve Pit
724	241-TX-118	242-T
724	241-TY-101-01A-A	241-TY-103-03A-A
726	241-TY-01A-C	241-TY-102-02A-A
727	241-TY-102-02A-C	241-TY-104-04A-C
728	241-TX-118	241-TY-104-04A-C
730	241-TX-110	241-TX-14B-Valve Pit
731	241-TX-117-17A	241-TX-118
750	241-TX-118-18A	241-TX-TX-115-15A-U2
800	241-BY-112-012D-U6	241-BY-111-011D-U6
801	241-BY-112-012D-U7	241-BY-111-011D-U7
801	244-AR-T-6	241-A-153-A
802	244-AR-Vault-T4	241-AY-152-B
804	241-BY-110-010-A	241-BY-111-A
805	241-BY-107-07A-A	241-BY-110-010A-C
805	244-AR-T-13	241-A-153-B
806	241-BY-102-02A-U8	241-BY-111-011D-U4
806	241-BY-104-04D-A	241-BY-107-07A-D
806	244-AR-Vault-T11	241-AY-152-A
807	241-BY-105-05D-A	241-BY-104-04D-C
808	241-BY-102	241-BY-105-05D-D
809	241-BY-103-03C-A	241-BY-105-05D-C
810	241-BY-103-03C-C	241-BY-106-06D-A
813	241-BY-108-08A-A	241-BY-107-07A-C
814	241-BY-102-02B	241-BY-111-011D-U8
815	241-BY-110-010A-D	241-BX-112-012-A-A
816	241-BX-112-012A-C	241-BX-111-011A-A
816	241-BX-111-011A-A	241-BX-112-012A-C
817	241-BX-111-011A-C	241-BX-110-010A-A

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
817	241-BX-110-010A-A	241-BX-111-011A-C
819	244-AR-Tank-001-T5	244-AR-Tank-003-T14
820	241-BX-106-06A-C	241-BX-105-05A-A
820	241-TX-152-U5	To Drain
821	241-BY-101-01C-A	241-BX-105-05A-C
822	241-BX-105-05A	241-B-109-09A-C
822	241-BY-101-01C-C	241-BY-104-04D
823	241-BX-105-05A-E	241-B-112-012A-A
824	241-B-112-012A-C	241-B-108-08A-A
826	241-B-109-09A-D	241-B-108-08A-D
827	241-B-103-03A-UA	241-B-102-02A-U4
829	241-B-106-06A-C	241-B-109-09A-A
837	244-AR-Tank-001,-002,-003,-004	244-AR-Tank-001,-002,-003,-004
1006	205-S	240-S-152-U2
1045	240-S-152-U1	204-S
1115	240-S-151-U6	202-S
1140	240-S-151-U15	202-S
1145	240-S-151-U9	202-S
1238	202-S	240-S-151-U10
1540	240-S-151-U14	202-S
1541	240-S-151-U5	202-S
3130	240-S-151-U1	202-S
3591	240-S-151-U18	202-S
3592	240-S-151-U19	202-S
3603	240-S-151-U7	Capped
3610	240-S-151-U16	202-S
3635	240-S-151-U11	202-S
3658	240-S-151-U4	202-S
3666	240-S-151-U2	202-S
4001	241-AX-151	Capped
4002	241-AX-151	None Identified
4003	241-AX-151	None Identified
4004	241-AX-151	Capped
4006	241-AX-151	Capped
4006	241-AX-151-E Cell	Capped
4007	244-AR Vault-T8A	241-AX-151
4009	241-AX-151	None Identified

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
4010	241-AX-151-Catch Tank	241-AX-151-F-Cell
4011	241-AX-151-Catch Tank	241-AX-151-E-Cell
4012	241-CR-153	241-AX-151 D-Cell
4013	241-AX-151-D-Cell	241-CR-152-U3A
4014	241-AX-151	Capped
4016	241-AX-151-Catch Tank Pit	241-AX-151-E-Cell
4017	241-AX-151-Washdown	Capped
4018	241-AX-151-Washdown	Capped
4019	241-AX-151	Capped
4020	241-AX-151	Capped
4021	241-AX-151-G-Cell	241-AY-151
4021	241-AY-151-Nozzle-3	241-AX-152-L2
4021	241-AY-151	Jumper Box 153-AX
4022	241-AX-151-D-Cell	241-AX-152-Pump Pit
4024	241-AX-152-B	Capped
4026	Jumper Box 153-AX-1	241-AX-101-01A-2
4026	Jumper Box 153-AX-1	241-AX-102-02A-2
4026	Jumper Box 153-AX-1	241-AX-103-03A-2
4026	Jumper Box 153-AX-1	241-AX-104-04A-2
4026	241-AX-101-01A-2	Leak Detection Pits-01E,-02E -03E, -04E
4026	241-AX-152	Jumper Box 153-AX-2
4030	241-AX-152	241-AX-152-B
4044	241-AX-151-G-Cell	Capped
4101	241-AX-151	241-A-101
4102	241-AX-151	241-A-102
4103	241-AX-151	241-A-103
4104	241-AX-151	241-A-104
4105	241-AX-151	241-A-105
4106	241-AX-151	241-A-106
4242	240-S-151-U13	202-S
4530	241-AY-151-U4	241-A-153-U1
4702	241-UX-154-L-6	241-WR
4851	241-UX-154-L-4	241-TX-155-U3
4878	241-UX-154-L-2	241-WR
4977	241-UX-152-U4	241-WR
5002	241-U-103-03A-U1	241-UR-152-L13

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
5006	241-U-102-02A-U1	241-UR-152-L12
5012	241-UR-152-U9,-U11,-U12	241-UR-151-U9
5014	241-U-103-03C-U1	241-UR-152-L10
5025	241-UR-152-U10	241-UR-151-U17
5032	241-U-103-03A-U2	241-UR-152-U6
5035	241-U-103-03C-U2	241-UR-152-U5
5037	241-U-102-02A-U3	241-UR-152-L15
5038	241-U-102-02A-U2	241-UR-152-U4
5041	241-U-102-02C-U2	241-UR-152-U3
5053	241-U-102-02C-U1	241-UR-152-Drain
5076	241-UR-Tank-001	U-103,-109,-108,-105,-107,-102
5185	241-TX-15A-U3	241-TXR-151-U11
5185	242-T-151-U2	242-T
5191	241-TX-115-15A-U1	15-X
5193	241-TX-115-15A-U6	15-B-Valve Pit
5202	251-U-106-06A-U1	241-UR-153-L13
5206	241-U-105-05A-U1	241-UR-153-L12
5212	241-UR-153-U9,-U11,-U12	241-UR-151-U8
5214	241-U-106-06C-U1	241-UR-153-L10
5225	241-UR-151-U16	241-UR-153-U10
5232	241-U-106-06A-U2	241-UR-153-U6
5235	241-U-106-06C-U2	241-UR-153-U5
5237	241-U-105-05A-U3	241-UR-153-L15
5238	241-U-105-05A-U2	241-UR-153-U4
5241	241-U-105-05C-U2	241-UR-153-U3
5307	241-UR-153-L8	5107/V573-UR152
5402	241-U-109-09A-U1	241-UR-154-L13
5406	241-U-108-08A-U1	241-UR-154-L12
5410	241-U-107-07A-U1	251-UR-154-L11
5412	241-UR-151-U6	241-UR-154-U9,-U11,-U12
5414	241-U-109-09C-U1	241-UR-154-L10
5417	241-U-108-08C-U1	241-UR-154-L7
5420	241-U-107-07C-U1	241-UR-154-L9
5425	241-UR-151-U15	241-UR-154-U10
5431	241-U-107-07A-U3	241-UR-154-L14
5432	241-U-109-09A-U2	241-UR-154-U6
5435	241-U-109-09C-U2	241-UR-154-U5

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
5437	241-U-108-08A-U3	241-UR-154-L15
5438	241-U-108-08A-U2	241-UR-154-U4
5441	241-U-108-08C-U2	241-UR-154-U3
5444	241-U-107-07A-U2	241-U-154-U2
5447	241-U-107-07C-U2	241-U-UR-154-1
5507	241-UR-154-L8	241-U-153-L8
5507	241-UR-154-L8	5107/V473-UR152
5601	244-UR-Tank-001	241-U4-151-L5
5609	244-UR-Tank-002-U2	251-U4-151-L3
5613	244-UR-Tank-001-U2	241-UR-151-L1
5622	244-UR-Tank-001-U3	241-UR-151-L7
5624	241-UR-152-L8	241-UR-151-U12
5625	241-UR-153-U8	241-UR-151-U11
5626	241-UR-151-U7	241-UR-154-U8
5630	241-UR-152-L1,-L2,-L3,-L4,-L5,-L6	241-UR-151-U14
5631	241-UR-153-L1,-L2,-L3,-L4,-L5,-L6	241-UR-151-U13
5632	241-UR-151-U10	241-UR-154-L1,-L2,-L3,-L4,-L5,-L6
5644	241-UR-151-U18,-U19,-U21	241-UR-151-U18,-U19,-U21
5647	244-UR-U1-Tank-001	241-UR-151-L8
5648	244-UR-U1-Tank-002	241-UR-151-L10
5653	244-UR-Tank-004	241-U4-151-L4
6002	241-T-103-03A-U1	241-TR-152-L13
6006	241-T-102-02A-U1	241-TR-152-L12
6010	241-T-101-01A-U1	241-TR-152-L11
6012	241-TR-153-U13	Capped
6012	241-TXR-151-U10	Capped
6012	241-T-104	244-TX-H
6014	241-T-103-03C-U1	241-TR-152-L10
6017	241-T-102-02C-U1	241-TR-152-L7
6020	241-T-101-01C-U1	241-TR-152-U2
6025	241-TXR-151-U20	241-TR-152-U10
6031	241-T-101-01A-U3	241-TR-152-L14
6032	241-T-103-03A-U2	241-TR-152-U6
6035	241-T-103-03C-U2	241-TR-152-U5
6037	241-T-02A-U3	241-TR-152-L15
6038	241-T-102-02A-U2	241-TR-152-U4
6041	241-T-102-02C-U2	241-TR-152-U3

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
6044	241-T-101-01A-U2	241-TR-152-U2
6047	241-T-101-01C-U2	241-TR-152-U1
6053	241-T-101-01C	241-TR-152-Drain
6160	241-TR-152-U9,-U11,-U12	241-TR-153-U2
6165	241-TR-153-U6	241-TR-152-L1,-L2,-L3,-L4,-L5,-L6
6170	241-TR-152-U8	241-TR-153-U1
6202	241-BY-103-03A-U1	241-BYR-152-L13
6206	241-BY-102-02A-U1	241-BYR-152-L12
6210	241-BY-101-01A-U1	241-BYR-152-L11
6214	241-BY-103-03C-U1	241-BYR-152-L10
6217	241-BY-102-02C-U1	241-BYR-152-L7
6220	241-BY-101-01C-U1	241-BYR-152-L9
6232	241-BY-103-03D-U2	241-BYR-152-U6
6235	241-BY-103-03C-U2	241-BYR-152-U5
6238	241-BY-102-02D-U2	241-BYR-152-U4
6241	241-BY-102-02C-U2	241-BYR-152-U3
6244	241-BY-101-01D-U2	241-BYR-152-U2
6247	241-BY-101-01C-U2	241-BYR-152-U1
6249	241-BYR-152-U14	241-BXR-152-U13
6253	241-BYR-152/241-BXR-152	241-B-302A
6402	241-BYR-153-L13	241-BY-106-06A-U1
6406	241-BYR-153-L12	241-BY-105-05A-U1
6410	241-BYR-153-L11	241-BY-104-04A-U1
6414	241-BYR-153-L10	241-BY-106-06C-U1
6417	241-BYR-153-L7	241-BY-105-05C-U1
6420	241-BYR-153-L9	241-BY-104-04C-U1
6432	241-BYR-153-U6	241-BY-106-06D-U2
6435	241-BYR-153-U5	241-BY-106-06C-U2
6438	241-BYR-153-U4	241-BY-105-05D-U2
6441	241-BYR-153-U3	241-BY-105-05C-U2
6444	241-BYR-153-U2	241-BY-104-04D-U2
6447	241-BYR-153-U1	241-BY-104-04C-U2
6449	241-BYR-153-U14	241-BXR-153-U13
7002	241-TX-103-03A-U1	241-TXR-152-L16
7006	241-TX-102-02A-U1	241-TXR-152-L15
7010	241-TX-101-01A-U1	241-TXR-152-L14
7012	241-TXR-152-U10,-U12,-U13	241-TXR-151-U8

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
7014	241-TX-103-03C-U1	241-TXR-152-L13
7017	241-TX-102-02C-U1	241-TXR-152-L9
7020	241-TX-101-01C-U1	241-TXR-152-L12
7025	241-TXR-152-U11	241-TXR-151-U19
7031	241-TX-101-01D-U1	241-TR-152-L18
7032	241-TX-103-03D-U2	241-TXR-152-U6
7035	241-TX-103-03C-U2	241-TXR-152-U5
7037	241-TX-102-02D-U1	241-TSR-152-L19
7038	241-TX-102-02D-U2	241-TXR-152-U4
7041	241-TX-102-02C-U2	241-TXR-152-U3
7044	241-TX-101-01D-U2	241-TXR-152-U2
7047	241-TX-101-01C-U2	241-TXR-152-U1
7159	241-TX-104-04A-U1	241-TXR-152-L17
7162	241-TX-104-04C-U1	241-TXR-152-L11
7164	241-TX-104-04C-U2	241-TXR-152-U7
7166	241-TX-104-04D-U2	241-TXR-152-U8
7202	241-TX-107-07A-U1	241-TXR-153-L16
7206	241-TX-106-06A-U1	241-TXR-153-L15
7210	241-TX-105-05A-U1	241-TXR-153-L14
7212	241-TXR-151-U6	241-TXR-153-U10,-U12,-U13
7214	241-TX-107-07C-U1	241-TXR-153-L13
7217	241-TX-106-06C-U1	241-TXR-153-L9
7220	241-TX-105-05C-U1	241-TXR-153-L12
7225	241-TXR-151-U18	241-TXR-153-U11
7231	241-TX-105-05D-U1	241-TXR-153-L18
7232	241-TX-107-07D-U2	241-TXR-153-U6
7235	241-TX-107-07C-U2	241-TXR-153-U5
7237	241-TX-106-06D-U1	241-TXR-153-L19
7238	241-TX-106-06D-U2	241-TXR-153-U4
7241	241-TX-106-06C-U2	241-TXR-153-U3
7244	241-TX-105-05D-U2	241-TXR-153-U2
7247	241-TX-105-05C	241-TXR-153-U1
7359	241-TX-115-015A-U4	241-TXR-153-L17
7362	241-TX-108-08C-U1	241-TXR-153-L11
7364	241-TX-108-08C-U2	241-TXR-153-U7
7366	241-TX-108-08D-U2	241-TXR-153-U8
7410	241-BY-111-011A-U1	241-BYR-154-L11

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
7412	241-BYR-154-U9,11,12	241-BXR-151-U4
7417	241-BY-112-012C-U1	241-BYR-154-L10
7420	241-BY-111-011C-U1	241-BYR-154-L9
7425	241-BYR-154-U10	241-BXR-151-U20
7431	241-BY-111-011D-U1	241-BYR-154-L14
7437	241-BY-112-012D-U1	241-BYR-154-L15
7438	241-BY-112-012D-U2	241-BYR-154-U4
7441	241-BY-112-012C-U2	241-BYR-154-U3
7444	241-BY-111-011D-U2	241-BYR-154-U2
7447	241-BY-111-011C-U2	241-BYR-154-U2
7601	241-TXR-244-Tank-001	241-TXR-151-L5
7609	241-TXR-151-L3	241-TXR-244-Tank-002-U2
7613	241-TXR-244-U2-Tank-003	241-TXR-151-L1
7616	241-TX-155-L1	241-TXR-151-U2,-U3
7622	241-TXR-244-U3-Tank-001	241-TXR-151-L7
7624	241-TR-153-U14	Capped
7624	241-TXR-151-U14	Capped
7624	244-TX-I	241-T-111
7624	244-TX-I	244-T-109
7625	241-TXR-151-U13	241-TXR-153-U9
7626	241-TXR-152-U9	241-TXR-151-U7
7630	241-TXR-151-U17	241-TR-153-U9
7631	241-TXR-151-U15	241-TXR-153-L1,-L2,-L3,-L4,-L5, -L6,-L7,-L8
7632	241-TXR-152-L1,-L2,-L3,-L4,-L5, -L6,-L7,-L8	241-TXR-151-U12
7636	241-TXR-151-U5	241-TX-153-L5
7644	241-TXR-151-U21, 23, 25	241-TXR-151-U21,-U23,-U25
7647	241-TXR-244-U1-Tank-003	241-TXR-151-L8
7648	241-TXR-244-U1-Tank-002	241-TXR-151-L10
7765	244-UR-Tank-002	241-UR-151-Drain
8002	241-C-103-03A-U1	241-CR-152-L13
8006	241-C-102-02A-U1	241-CR-152-L12
8010	241-C-101-01A-U1	241-CR-152-L11
8012	241-CR-152-U9,-U11,-U12	241-CR-151-U4
8014	241-C-103-03C-U1	241-CR-152-L10
8017	241-C-102-02C-U1	241-CR-152-L7
8020	241-C-101-01C-U1	241-CR-152-L9

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
8021	241-AY-152-U10	241-AX-103-03D-U3
8022	241-AY-152-U11	241-AX-103-03C-U5
8023	241-AY-152-U14	241-AX-102-02C-U3
8024	241-AY-152-U15	241-AX-102-02D-U5
8025	241-AY-152-U12	241-AX-101-01D-U3
8026	241-AY-152-U13	241-AX-101-01C-U5
8027	241-AY-152-U16	241-AX-104-04C-U3
8028	241-AY-152-U17	241-AX-104-04D-U5
8029	241-AX-103-03A-U4	241-AX-103-03C-U3
8030	241-AX-103-03B-U3	241-AX-103-03D-U5
8031	241-AX-103-03A-U9	241-AX-103-03B-U5
8031	241-C-101-01A-U3	241-CR-152-L14
8032	241-AX-104-04D-U3	241-AX-104-04B-U5
8032	241-C-103-03A-U2	241-CR-152-U6
8033	241-AX-104-04A-U4	241-AX-104-04B-U3
8034	241-AX-104-04C-U5	241-AX-104-04A-U4A
8035	241-AX-102-02C-U4	241-AX-102-02A-U7
8035	241-C-103-03C-U2	241-CR-152-U5
8036	241-AX-102-02A-U4	241-AX-102-02B-U3
8037	241-AX-102-02B-U5	241-AX-102-02D-U3
8037	241-C-102-02A-U3	241-CR-152-L15
8038	241-AX-101-01AU4	241-AX-101-01C-U3
8038	241-C-102-02A-U2	241-CR-152-U4
8039	241-AX-101-01A-U9	241-AX-101-01B-U5
8040	241-AX-101-01B-U3	241-AX-101-01D-U5
8041	241-AX-101-01A-U6	241-AX-101-01C-U4
8041	241-C-102-02C-U2	241-CR-152-U3
8042	241-AX-102-02C-U5	241-AX-102-02A-U9
8043	241-AX-103-03A-U6	241-AX-103-03C-U4
8044	241-AX-104-04C-U4	241-AX-104-04A-U7
8044	241-C-101-01A-U2	241-CR-152-U2
8047	241-C-101-01C-U2	241-CR-152-U1
8061	241-AY-152-L7	241-AX-104-04A-U5
8062	241-AX-102-02A-U5	241-AY-152-L6
8063	241-AY-152-L5	241-AX-101-01A-U8
8064	241-AY-152-L4	241-AX-102/241-AX-103
8107	241-CR-152-L8	V844/241-CR-151-L8

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
8202	241-C-106-06A-U1	241-CR-153-L13
8206	241-C-105-05A-U1	241-CR-153-L12
8210	241-C-104-04A-U1	241-CR-153-L11
8214	241-C-106-06C-U1	241-CR-153-L10
8217	241-C-105-05C-U1	241-CR-153-L7
8220	241-C-104-04C-U1	241-CR-153-L9
8225	241-CR-153-U10	241-CR-151-U10
8231	241-C-104-04A-U3	241-CR-153-L14
8232	241-C-106-06A-U2	241-CR-153-U6
8235	241-C-106-06C-U2	241-CR-153-U5
8237	241-C-105-05A-U3	241-CR-153-L15
8238	241-C-105-05A-U2	241-CR-153-U4
8241	241-C-105-05C-U2	241-CR-153-U3
8244	241-C-104-04A-U2	241-CR-153-U2
8247	241-C-104-04C-U2	241-CR-153-U1
8552	241-C-201,-202,-203,-204-U2	241-CR-151-U2
8555	241-CR-151-U5	241-C-201,-202,-203,-204-U2
8601	241-CR-151-L1	244-CR-Tank-001
8616	241-CR-151-L5	244-CR-Tank-011-U1
8624	241-CR-152-U8	241-CR-151-U7
8625	241-CR-153-U8	241-CR-151-U6
8630	241-CR-152-L1,-L2,-L3,-L4,-L5,-L6	241-CR-151-U9
8631	241-CR-153-L (1-6)	241-CR-151-U8
8644	241-CR-151-U12,-U13,-U15	241-CR-151-U12,-U13,-U15
8647	241-CR-151-L4	244-CR-Tank-003-U1
8648	241-CR-151-L6	244-CR-Tank-002-U1
8656	241-AX-151	244-CR DCRT-Tank-003
8900	201-C-Valve Box	244-CR-Tank-003-U10
9002	241-B-103-03A-U1,-03B-U2	241-BR-152-L13
9006	241-B-102-02A-U1,-02B-U2	241-BR-152-L12
9010	241-B-101-01A-U1,-01B-U2	241-BR-152-L11
9012	241-BXR-151-U8	241-BR-152-U9
9014	241-B-103-03C-U1	241-BR-152-L10
9017	241-B-102-02C-U1	241-BR-152-L7
9020	241-B-101-01C-U1	241-BR-152-L9
9025	241-BXR-151-U19	241-BR-152-U10
9031	241-B-101-01A-U3	241-BR-152-L14

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
9032	241-B-103-03A-U2	241-BR-152-U6
9035	241-B-103-03C-U2	241-BR-152-U5
9037	241-B-102-02A-U3	241-BR-152-L15
9038	241-B-102-02A-U2	241-BR-152-U4
9041	241-B-102-02C-U2	241-BR-152-U3
9044	241-B-101-01A-U2	241-BR-152-U2
9047	241-B-101-01C-U2	241-BR-152-U1
9202	241-BX-103-03A-U1	241-BXR-152-L13
9206	241-BX-102-02A-U1	241-BXR-152-L12
9212	241-BYR-152-U9,-U11,-U12	241-BXR-151-U6
9212	241-BYR-152-U9,-U11,-U12	241-BXR-152-U9,-U11,-U12
9214	241-BX-103-03C-U2	241-BXR-152-L10
9217	241-BX-102-02C-U1	241-BXR-152-L7
9225	241-BYR-152-U10	241-BXR-151-U18
9225	241-BYR-152-U10	241-BXR-152-U10
9231	241-BX-101-01A-U3	241-BXR-152-L14
9232	241-BX-103-03A-U2	241-BXR-152-U6
9235	241-BX-103-03C-U1	241-BXR-152-U5
9237	241-BX-102-02A-U3	241-BXR-152-L15
9238	241-BX-102-02A-U2	241-BXR-152-U4
9241	241-BX-102-02C-U2	241-BXR-152-U3
9244	241-BX-101-01A-U2	241-BXR-152-U2
9247	241-BX-101-01C-U2	241-BXR-152-U1
9249	241-BYR-152-U13	241-BXR-152-U14
9256	241-BX-103-03B-U2	241-BX-103-03A-U1
9263	241-BX-102-02B-U2	241-BX-102-02A-U1
9270	241-BX-101-01B-U2	241-BX-101-01A-U1
9412	241-BYR-153-U9,-U11,-U12	241-BXR-151-U3
9414	241-BX-106-06C-U1	241-BXR-153-L10
9417	241-BX-105-05C-U1	241-BXR-153-L7
9420	241-BX-104-04C-U1	241-BXR-153-L9
9425	241-BYR-153-U10	241-BXR-151-U17
9425	241-BYR-153-U10	241-BXR-153-U10
9431	241-BX-104-04A-U3	241-BXR-153-L14
9432	241-BX-106-06A-U2	241-BXR-153-U6
9435	241-BX-106-06C-U2	241-BXR-153-U5
9437	241-BX-105-05A-U3	241-BXR-153-L15

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
9438	241-BX-105-05A-U2	241-BXR-153-U4
9441	241-BX-105-05C-U2	241-BXR-153-U3
9444	241-BX-104-04A-U2	241-BXR-153-U2
9447	241-BX-104-04C-U2	241-BXR-153-U1
9449	241-BYR-153-U13	241-BXR-153-U14
9463	241-BX-105-05B-U2	9406/9463/241-BX-105-05A-U1
9465	241-BX-106-06B-U2	9402/9456/241-BX-106-06A-U1
9601	244-BXR-Tank-001	241-BXR-151-L1
9604	244-BXR-Tank-003	244-BXR Tank-O01-U2
9613	244-BXR-Tank-003-U2	244-BXR Tank 011
9616	244-BXR-011-U1	241-BXR-151-L5
9622	244-BXR-Tank-001-U3	241-BXR-151-L3
9623	241-BYR-154-U8	241-BXR-151-U15
9624	241-BXR-151-U12	241-BR-152-U8
9626	241-BYR-153-U8	241-BXR-151-U5
9626	241-BYR-153-U8	241-BXR-153-U8
9630	241-BXR-151-U15	241-BR-152-L1
9631	241-BXR-151-U13	241-BXR-152-L1,-L2,-L3,-L4,-L5,-L6
9631	241-BXR-151-U13	241-BYR-152-L1,-L2,-L3,-L4,-L5,-L6
9632	241-BXR-151-U10	241-BYR-151-L1,-L2,-L3,-L4,-L5,-L6
9632	241-BXR-151-U10	241-BXR-153-L1,-L2,-L3,-L4,-L5,-L6
9633	241-BYR-154-L1,-L2,-L3,-L4,-L5,-L6	241-BXR-151-U9
9636	241-BXR-151-U2	241-B-252-U8
9644	241-BXR-151-U21,-U23,-U25	241-BXR-151-U21,-U23,-U25
9647	244-BXR-Tank-003-U1	241-BXR-151-L4
9648	244-BXR-Tank-002-U1	241-BXR-151-L6
9719	241-BXR-151-U24	241-ER-151-L3
9765	241-BXR-151-Drain	244-BXR-Vault
01A	241-A-101-01A-U7	241-A-153-U5
01B	241-A-101-01B-U1	241-A-153-L10
01C	241-A-101-01C-U1	241-A-153-L9
02A	241-A-102-02A-U7	241-A-153-U4
02B	241-A-102-02B-U1	241-A-153-L11

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
03A	241-A-103-03A-U7	241-A-153-U6
03B	241-A-103-03B-U1	241-A-153-L12
03C	241-A-103-03C-U1	241-A-153-L7
04B	241-A-104-04B-U1	241-A-153-L4
04C	241-A-104-04C-U1	241-A-153-L3
05B	241-A-105-05B-U1	241-A-103-03A-U4
05B	241-A-105-05B-U1	241-A-153-L6
05C	241-A-105-05C-B	241-A-103-03D, 241-A-153-U2
05D	241-A-105-05D-U1	241-A-153-L2
06A	241-A-106-06A-U7	241-A-153-U3
06B	241-A-106-06B-U1	241-A-153-L5
06C	241-A-106-06C-U1	241-A-153-L1
108/837/8649/8901	221-B	244-CR-DCRT
153A	241-A-101	241-A-153-Drain
223/224/225/226	244-BX-Vault	241-B-106,-105,-109
223/Unk	244-BX-Vault	241-B-103
227/228	244-BX-Vault	241-B-108,-111
231/232/233/234	244-BX-Vault	241-B-104,-107,-110
4001/T029	PUREX	241-A-B-R12
4001/T029	202A	241-A-B VP-R12
4002/T031/G026/402A	PUREX	244-AR
4003/T037/4017	PUREX	241-AX-152
4003/T037/4017	202-A	241-AX-152-B
4004/G341/V029	PUREX	241-A-A-L12
4005/810	241-AX-151-D-Cell	244-AR Vault-T9
4006/4018	244-AR Vault-T9A	241-AX-152-A
4044/V029/4004/G341/ 4029	202A	241-A-B VP-L12
4107VO33	241-AX-151-D-Cell	241-A-152-U11
4510/A107	241-AX-152-7	Capped
4703/4859	241-UX-154-L5	241-TX-155-U2
4859/4703	241-TX-155-U2	241-UX-154-L5
5107/V473	241-UR-152-L8	241-U-153-L11
6307/V336	241-BYR-152-L8	241-BX-153-U2
6443/9453	241-BYR-153-Drain, 241-BXR-153 Drain	241-BX-104-04C
7406/9394	241-BY-109-09A-U4	241-BYR-154-L12
7406/9394	241-BY-112-012A-U1	241-BY-109-09A-U4

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
7435/9385/V304	241-BYR-154-U5,-L13	241-B-252-L15
7507/9712	241-BYR-154-L8	B-Swamp
814/4002/4028/G026/4001/T031	244-AR Vault-TK-001	PUREX
814/4015	241-AX-151	Capped
819/818	241-BX-106-06A-U4	241-BX-110010C-C
833/8618/8612/809	221-B	244-AR Vault-T16A
834/8615/8653/818	221-B	244-AR Vault-T10
8636/V105	241-CR-151-U1	241-C-151-L6
8653/8618	241-ER-151-L9	241-CR-151-U14
9210/9270	241-BX-101-01B-U2	241-BXR-152-L11
9406/9463	241-BX-105-05A-U1	241-BXR-153-L12
9456/9402	241-BX-106-06A-U1	241-BXR-153-L13
9470/9410	241-BX-104-04B-U2,-04A-U1	241-BX-104-04A, 241-BXR-153-L11
9625/9212	241-BXR-151-L11	241-BYR-152-U8
9625/9212	241-BXR-151-L11	241-BXR-152-U8
9653/141	221-B	Capped
9653/243	221-B	241-ER-151-L7
A101	241-AX-101	241-AX-152
A102	241-AX-102	241-AX-152
A-103	241-AX-103	241-AX-152
A-104	241-AX-104	241-AX-152
A4013	241-CR-152-3A	241-AX-151-Washdown
B101	241-AX-101	241-AX-152
B102	241-AX-102	241-AX-152
B-103	241-AX-103	241-AX-152
B-104	241-AX-104	241-AX-152
BWCTL	241-B-103-03A-C	241-B-106-06A-A
BWCTL-M2	241-B-102-02A-A	241-B-108-08A-C
C101	241-AX-101	241-AY-501
C102	241-AX-102	241-AY-501
C-103	241-AX-103	241-AY-501
C-104	241-AX-104	241-AY-501
D020	PUREX	241-A-151-U19
D040	PUREX	241-A-151-U27
D070	PUREX	241-A-151-U26
D088	PUREX	241-A-151-U-25
D149	PUREX	241-A-151-U18

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
D186	PUREX	241-A-151-U5
D601D505	241-AZ-152	241-AY-152
Drain	241-TX-101	241-TXR-152
Drain	241-TX-105-05D	241-TXR-153
Drain	241-TX-302A	241-TX-153
Drain	241-TX-302A	Crib
Drain	241-TX-302B	Encasement Drain
Drain	241-TX-302B	241-TX-155
Drain	241-TX-302C	241-TX-154
Drain	241-TXR-244-002-Sump	241-TXR-151
Drain	241-TY-302A	241-TY-153
Drain	241-U-102-02A	P19 K1-Exhauster
Drain	241-U-102-02A-C	Clean Out Boxes-U32,-U33,-U34,-U35
Drain	241-U-105-05C-B	241-UA, 241-UB-Flush Pits
Drain	241-U-105-05C-U1	241-UR-153
Drain	241-U-107-07A-B	Clean Out Box-U30,-U31
Drain	241-U-107-07C	241-UR-154
Drain	241-U-108-08A-B	P-20-Exhauster
Drain	241-U-108-08A-C	Clean Out Box-U29
Drain	241-U-105-05C-C	241-U-A-Flush Pit, 241-U-B-Flush Pit
Drain	241-U-111-11A-E	241-U-C-Flush Pit, 241-U-D-Flush Pit
Drain	241-U-301-B	241-U-152
Drain	241-UX-302A	241-UX-154
Drain	241-BX-153-Drain	241-B-302A
Drain (BX-302B)	241-BX-155	241-BX-302C
Drain Line	241-B-302B	241-B-154
Drain Line	241-BX-302B	241-BX-154
Drain Line	241-BYR-154	244-BXR-Vault-002
Drain Line	241-C-102-02B-U3	241-C-Valve Pit-L1
Drain Line	241-C-103	241-C-Valve Pit
Drain Line	241-C-104-04C	241-CR-153
Drain Line	241-C-104-04B-U3	241-C-Valve Pit-L2
Drain Line	241-C-107-U1	241-C-Valve Pit-L3
Drain Line	241-C-252	Unknown Catch Tank
Drain Line	241-C-153, 241-C-151	Unknown Catch Tank
Drain Line	241-S-102-02A-F	241-S-152

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
Drain Line	241-S-107	241-S-B-Flush Pit
Drain Line	241-S-107	241-S-C-Flush Pit
Drain Line	241-S-107	241-S-D-Flush Pit
Drain Line	241-S-302-B	241-S-302-A
Drain Line	244-CR-Tank-002	241-CR-151
Drain-301	241-C-106-06C-U8	Metal Filter Drain
Drain-301	241-A Farm-COBS	241-A-350
Drain-302	241-C-106-06C-U9	Process Building Floor Drain
Drain-302	COB-A-2	DR-301/241-A-350
Drain-303	COB-A-5	DR-301/241-A-350
Drain-304	COB-A-9	DR-301/241-A-350
Drain-305	241-A-B-Flush Pit	DR-307/241-A-350
Drain-306	241-A-A-Flush Pit	DR-307/241-A-350
Drain-307	241-A-A-Flush Pit, -A-B-Flush Pit	241-A-350
Drain-308	COB-A-3	DR-301/241-A-350
Drain-309	COB-A-4	DR-301/241-A-350
Drain-314	241-AX-COBs	DR-301/241-A-350
Drain-315	COB A-10	DR-317/DR-301/241-A-350
Drain-316	COB A-8	DR-301/241-A-350
Drain-318	COB AX-12	DR314/241-AX-102-Riser-24
Drain-319	COB AX-14	DR314/241-AX-102-Riser-24
Drain-320	COB AX-15	DR314/241-AX-102-Riser-24
Drain-321	COB AX-16	DR314/241-AX-102-Riser-24
Drain-322	COB AX-17	DR314/241-AX-102-Riser-24
Drain-323	COB AX-18	DR314/DR370/241-AX-102-Riser-24
Drain-324	COB AX-21	DR314/DR370/241-AX-102-Riser-24
Drain-329	COB AX-19	DR314/DR370/241-AX-102-Riser-24
Drain-330	COB AX-24	DR325/241-AX-104-Riser-7C
Drain-331	COB AX-22	DR314/DR370/241-AX-102-Riser-24
Drain-332	COB AX-23	DR314/DR370/241-AX-102-Riser-24
Drain-341	C0B A-1	DR-301/241-A-350
Drain-342	C0B AX-26	DR333/DR325/241-AX-107–Riser-7C
Drain-347	C0B AX-20	DR325/DR307/241-AX-107-Riser-7C
Drain-348	C0B AX-25	DR333/DR325/241-AX-107-Riser-7C
Drain-349	COB AX-13	DR314/241-AX-102-Riser-24
E006	PUREX	241-A-151-U24
E167	PUREX	241-A-151-U23

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
EFD-02	241-A-401-Condensate Bldg	241-AN-101-01D-A
EFD-92	241-A-401-Condensate Bldg	241-AN-101-01D-B
F241	PUREX	241-A-151-U21
F274	PUREX	241-A-151-U9
F377	PUREX	241-A-151-U14
F429	PUREX	241-A-151-U13
F719	PUREX	241-A-151-20
F791	PUREX	241-A-151-U8
Flush	241-UA-L6,-L8,-L17	241-UA-Flush Pit
Flush	241-UB-R17,-R8,-R6	241-UB-Flush Pit
Flush	241-UC-L6,-L8,-L17	241-UC-Flush Pit
Flush	241-UD-R6,-R8,-R17,-R21	241-UD-Flush Pit, 241-UD-R8
Flush Line	241-A-A-Flush Pit	241-A-A-L6,-L8,-L17
Flush line	241-A-B-Flush Pit	241-A-102-02B-4
Flush Line	241-A-B-R6,-R8,-R17	241-A-B-Flush Pit
Flush Line	241-AX-A-L6,-L8,-L17	241-AX-A-Flush Pit
Flush Line	241-AX-B-R6,-R8,-R17	241-AX-B-Flush Pit
Flush Line	241-S-A-L8/L17	241-S-A-Flush Pit
Flush Line	241-S-B-R6,-R8,-R17	241-S-B-Flush Pit
Flush Line	241-S-C-L8,-L17	241-S-C-Flush Pit
Flush Line	241-S-D-R6,-R8,-R17	241-S-D-Flush Pit
Flush Line	241-SX-A-L6,-L17	241-SX-A-Flush Pit
Flush Line	241-SX-A-R6,-R17	241-SX-B-Flush Pit
G057	PUREX	241-A-151-U17
G180	PUREX	241-A-151-U11
G212	PUREX	241-A-151-U16
M044	PUREX	241-A-151-U10
M045	PUREX	241-A-151-U22
No number	241-UA-L18,-L19	241-UB-R18,R19
Overflow	241-A-106-Sidewall	241-A-350-Sidewall
PL2021	242-B	241-B-106
PLP11	241-BY-112-012D-5A	241-BY-109-09A-U6
PLP22	241-BY-109	241-BY-108-08A-C
R165	PUREX	241-A-151-U12
R345	PUREX-R8	241-A-151-U15
SL101	241-S-152-Nozzle 1	Blocked
SL101	241-UD-R3	Blocked

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
SL102	241-UC-L10	241-UA-L3
SL102	241-A-106-06D-A	241-A-B-R7, COB-A8,-A9
SL103	241-U-B	241-U-D
SL103	241-UD-R10	241-UB-R3
SL104	241-U-109-09B-A	241-UC-L7
SL105	241-U-108-08B-A	241-UC-L9
SL105	241-A-103-03D-A	241-A-B-R5
SL106	241-A-B-R10	241-A-102-02D-A
SL107	241-A-01H	241-A-A
SL108	241-U-107-07B-A	241-UD-R9
SL108	241-U-110-10B-A	241-UD-R7
SL108	241-AX-01A	241-AX-A
SL109	241-U-103	241-U-B
SL110	241-U-06B	241-UA-L9
SL111	241-AX-103-03A-A	241-AX-A-L7
SL111	241-U-02B	241-U-B
SL112	241-AX-104-04A-A	241-AX-B-R9
SL112	241-U-105-05B-A	241-U-A-L7
SL113	241-U-C	241-U-D
SL113	242-Evaporator	241-A-B
SL114	241-U-B	241-U-A
SL115	241-S-A	241-S-C
SL116	211-S-B-R10	241-S-D-R3
SL117	241-S-C	241-SX-A
SL118	241-S-D	241-SX-B
SL119	241-S-103-03A-B	241-S-A-L7
SL120	241-S-106-B	241-S-A-L9
SL121	241-S-101-01A-B	241-S-B-R5
SL122	241-S-105-05A	241-S-B-R9
SL123	241-S-109-09A-B	241-S-C-L7
SL124	241-S-108-08A-B	241-S-C-L5
SL125	241-S-112-12A-B	241-S-C-L9
SL126	241-S-D	None Identified
SL127	241-S-110-10A	241-S-D-R7
SL128	241-S-111-11A-B	241-S-D-R9
SL129	241-SX-103	241-SX-A
SL130	241-SX-102-02B-B	241-SX-A-L5

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
SL131	241-SX-106-06A-B	241-SX-151-L9
SL132	241-SX-105	241-SX-B-R9
SL133	241-SX-104-04A-B	241-SX-B-R7
SL134	241-S-A-L18	241-S-D-R18
SL137	241-SX-101-01A	241-SX-B-R5
SL138	241-S-152	242-S-Evaporator
SL138	241-S	SL-175
SL139	241-S-152-4	Capped
SL139/SL114	242-S-Evaporator	241-S-B
SL140	241-S-102	241-S-A
SL175	241-S-152-8	Failed
SL175	SL-138	241-SY-A
SL175/S138	241-SY-A-L3	242-S Evaporator
SL204	241-U-109-09A-A	241-UC-L14
SL219	241-S-103-03A-A	241-S-A-L15
SN200	241-S-102	241-S-152-5
SN200	241-TX-116	244-TX-E
SN200	241-BY-102-02A-U2	SN-200/Capped
SN201	241-S-102	241-S-152-7
SN201	241-TX-113-13A	SN206
SN201	241-BY-103-U2	SN-200/Capped
SN202	241-UC-L12	241-UA-L1
SN202	241-A-B-R11	241-A-106-06C-Nozzle A
SN202	241-BY-105-05A-U2	SN-200/Capped
SN203	SN206	241-TX-105-05A
SN203	241-BY-106-06A-U2	SN200/Capped
SN203	241-UC-R12	241-UB-R2
SN204	244-TX-D	241-TX-117-017A
SN204	241-U-09A	241-U-C
SN204	241-BY-108-08A-U1	SN207/Capped
SN205	241-U-108-08A-A	241-UC-L15
SN205	SN204	241-TX-114-014A
SN205	241-A-103-03C-A	241-A-B-R14
SN205	241-BY-109-09A-U5	SN207/Capped
SN206	SN204	241-TX-110-01A
SN206	241-U-107-07A-A	241-UD-R14
SN206	241-A-102-02C-3	241-A-102-02B-3

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
SN206	241-BY-111-011A-U2	Capped
SN207	241-TX-106-06A	SN204
SN207	251-U-111-11A-A	241-UD-R20
SN207	241-A-A-L14	241-A-101-01B-A
SN207	241-BY-103-03A	244-BX-D
SN207	241-BY-112-012A	801
SN208	241-TX-118-18A	244-TX-C
SN208	241-AX-101-01B-A	241-AX-A-L15
SN209	241-TX-115-15A	SN208
SN209	241-U-103-03A-A	241-UB-R-15
SN209	241-AX-102-02D-A	241-AX-B-R14
SN210	241-TX-111-11A	SN208
SN210	241-U-106-06C-A	241-UA-L16
SN210	241-AX-A-L19	241-AX-B-R19
SN211	241-AX-103-03D-A	241-AX-A-L14
SN211	241-TX-112-012A	244-TX-B
SN211	241-BY-110-010-A, 241-BY-104-04-U2	244-BX-Nozzle B
SN211	241-U-102-02A-A	241-UB-R14
SN212	241-AX-104-04B-A	241-AX-B-R15
SN212	241-U-105-05C-A	241-UA-L14
SN212	241-TX-108-08A	SN211
SN213	241-S-102	241-S-A-L1
SN213	241-U-111-11A-C	241-UC-L15
SN213	241-TX-101-01A	SN211
SN214	241-TX-102-02A	SN211
SN214	241-S-102	241-SB-R1
SN215	241-U-111-11A-B	241-UD-R15
SN215	241-TX-103-03A	SN211
SN215	241-S-A-L14	241-S-C-L1
SN216	241-S-152-9	Capped
SN216	241-S-B-R12	241-S-D-R1
SN216/217	241-BX-107, 241-BX-110	244 BX-Nozzle E
SN216/282	241-U-D	241-SY-B
SN217	241-S-C-L12	241-SX-A-L1
SN218	241-S-D-R12	241-SX-B-R1
SN220	241-S-106-06A-A	241-S-A-L16

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
SN221	241-S-101-01A-A	241-S-B-R14
SN222	241-S-105-05A	241-S-B-R16
SN223	241-S-109-09A-A	241-S-C-L15
SN224	241-S-108-08A-A	241-S-C-L14
SN225	241-S-112-12A-A	241-S-C-L16
SN226	241-S-107-07A-A	241-S-D-R14
SN227	241-S-110-10A	241-S-D-R15
SN228	241-S-111-11A-A	241-S-D-R16
SN229	241-SX-103-03B-A	241-SX-A-L15
SN230	241-SX-102-02B-A	241-SX-A-L14
SN230/215/214/213	241-BX-104-04B-U1	244-BX-Nozzle A
SN231	241-SX-106-06A-A	241-SX-A-L16
SN233	241-SX-104-04A-A	241-SX-B-R15
SN-235	241-A-102-02B-2	Capped
SN239	241-S-C-L19	241-S-D-R19
SN241	241-SX-101-01A-A	241-SX-B-R14
SN242	241-S-102-02A-U6	241-S-A-L12
SN244	244-CR-Vault	241-ER-153
SN245	241-S-107-07A	244-S-18
SN246	241-S-107-07A	244-S-17
SN246	241-S-107-07A-B	241-S-D-R2
SN247	241-S-107-07A	244-S-16
SN248	241-S-107-07A	244-S-15
SN249	241-S-107-07A	244-S-14
SN249	244-TX-A	704
SN264	241-UD-R5	244-U-A
SN265	241-UD-R4	244-U-B
SN266	244-U-C	Capped
SN275	241-C-VP-U1,-U2,-U3,-U4,-U5,-U6	244-CR-U15
SN275	241-SY-A	241-S-A
SN276	241-SY-B	241-S-B
SN281	241-S-152-10	Failed
SN282	241-S-152-11	Failed
U039	PUREX	241-A-151-U6
U136	PUREX	241-A-151-U7
Unknown	241-A-102-02C-U1	241-A-153-L8
Unknown	244-AR-Tank-001-T15	244-AR-Tank-004-T4

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
Unknown	COB-A-11	DR-317/DR-301/241-A-350
Unknown	241-A-104-04A-U1	241-A-101-01A-U1
Unknown	241-A-104-04A-U2	241-A-105-05C-A
Unknown	241-A-105-05A-U1	241-A-102-02A-U1
Unknown	241-A-106-06A-U1	241-A-103-03A-U1
Unknown	241-B-111	241-B-110
Unknown	241-B-112	241-B-111
Unknown	241-B-201	241-B-109
Unknown	241-BX-102	241-BX-101
Unknown	241-BX-103	241-BX-102
Unknown	241-BY-106-06D,-C	241-BY-109
Unknown	241-BY-112	241-BY-111
Unknown	241-C-101	241-C-102
Unknown	241-C-102	241-C-103
Unknown	241-C-101-01B-U1	8010
Unknown	241-C-102-02B-U2	Line 8006
Unknown	241-C-103-03B-U1	241-C-Valve Pit-L6
Unknown	241-C-103-03B-U2	Line 8002
Unknown	241-C-104-04B-U2	Line 8210
Unknown	241-C-104-04B-U3	241-C-Valve Pit-L2
Unknown	241-C-10505B-U3	Capped
Unknown	241-C-105-05B-U2	Line 8206
Unknown	241-C-106-06B-U2	Line 8202
Unknown	241-C-108	241-C-107
Unknown	241-C-109	241-C-108
Unknown	241-C-110-U1	241-C-Valve Pit-L3
Unknown	241-C-111	241-C-110
Unknown	241-C-112	241-C-111
Unknown	241-C-112	241-C-Valve Pit-L5
Unknown	241-S-102-BB/B	Flush Pit
Unknown	241-S-103	Clean Out Boxes-9,-10
Unknown	241-S-109	Clean Out Boxes-13,-14
Unknown	241-S-A-L19	241-S-B-R19
Unknown	241-S-C-L18	241-S-D-R18
Unknown	241-SX-106	Clean Out Boxes-24,-25
Unknown	241-SX-A-L18	241-SX-B-R18
Unknown	241-SX-A-L19	241-SX-B-R19

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
Unknown	241-T-101	241-T-102
Unknown	241-T-101	241-T-102-02B-U3
Unknown	241-T-101-01B-U2	6010
Unknown	241-T-101-01B-U3	241-T-105
Unknown	241-T-102	241-T-103
Unknown	241-T-102-02B-U2	6006
Unknown	241-T-103-03B-U2	6002
Unknown	241-T-104	241-T-105
Unknown	241-T-105	241-T-106
Unknown	241-T-107	241-T-108
Unknown	241-T-108	241-T-109
Unknown	241-T-110	241-T-111
Unknown	241-T-111	241-T-112
Unknown	241-TX-117	241-TX-118
Unknown	241-T-201	241-T-101
Unknown	241-T-202	241-T-101
Unknown	241-T-203	241-T-101
Unknown	241-T-204	241-T-101
Unknown	241-TX-105	241-TX-106
Unknown	241-TX-106-06A-D	241-TX-107-07A-C
Unknown	241-TX-107	241-TX-108
Unknown	241-TX-109	241-TX-110
Unknown	241-TX-109-09A-C	241-TX-05A-A
Unknown	241-TX-110	241-TX-111
Unknown	241-TX-110A-A	241-TX-106-06A-C
Unknown	241-TX-111	241-TX-112
Unknown	241-TX-113	241-TX-114-14A
Unknown	241-TX-113	241-TX-114
Unknown	241-TX-114	241-TX-115
Unknown	241-TX-115	15-X (V615)
Unknown	241-TX-116	241-TX-117
Unknown	241-TX-117	241-TX-118
Unknown	241-TXR-244-Tank-002	241-TXR-244-U1-Tank-001
Unknown	241-TXR-244-Tank-003	241-TXR-244-U2-Tank-001
Unknown	241-TY-101	241-TY-102
Unknown	241-TY-103	241-TY-104
Unknown	241-TY-103-03A-A	241-TY-103-C

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
Unknown	241-TY-105	241-TY-106
Unknown	242-TA	242-T
Unknown	241-UA-L18	241-UB-R-18
Unknown	241-UA-L19	241-UB-R19
Unknown	241-UC-L18	241-UD-R18
Unknown	241-UC-L19	241-UD-R19
Unknown	241-UX-302A	291-U Stack
Unknown	242-B	241-B-106
Unknown	242-S-Evaporator	241-S-103
Unknown	244-BXR-Tank-002-U2	244-BXR-011
Unknown (02C)	241-A-102-02C-U1	241-A-153-L8
V004	241-A-152-U2	241-A-151-L22
V005	241-A-152-U8	241-A-151-L21
V006	241-A-152-U4	241-A-151-L20
V007	241-A-152-U6	241-A-151-L17,-L18,-L19
V008	241-A-152-U10	241-A-151-L14,-L15,-L16
V-011	241-A-151-L7,-L9	Crib
V-014	241-A-151-L5,-L6,-L11,-L12	Tank-216A
V-016	241-A-151-L3,-L4,-L10	Crib
V021	241-A-151-L25	241-AW-A-L12
V022	241-A-151-L-24	241-AW-B-R12
V029	241-A-151-UC	241-A-151-UD
V031	241-A-151-UA	241-A-151-UF
V032	241-A-106-A-U1, 241-A-103-03A-U1	241-A-152-U7
V038	241-A-152-L6	241-A-101
V039	241-A-152-L5	241-A-101
V040	241-A-152-L4	241-A-102
V041	241-A-152-L3	241-A-102
V042	241-A-103	241-A-152-L2
V043	241-A-103	241-A-152-L1
V044	241-A-152-L10	241-A-104
V045	241-A-152-L11	241-A-104
V046	241-A-152-L12	241-A-105
V047	241-A-152-L13	241-A-105
V048	241-A-106	241-A-152-L14
V049	241-A-106	241-A-152-L15
V050	241-A-152-L7	241-C-104

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V051	241-A-152-L8	241-C-104
V052	241-A-152-L9	Capped
V058	241-A-152-A	241-A-152-A
V059	241-A-152-B	241-A-152-B
V060	241-A-152-C	241-A-302B, 241-A-152-C
V061	241-A-152-L16	Capped
V100	241-C-151-L1	241-C-153-U9
V1000	241-CR-152	244-CR-Vault-U14
V1001	241-CR-152-U4A	241-CR-153-U3A
V1002	241-CR-152-U6A	241-CR-153-U1A
V101	241-C-153	Capped
V101	241-C-151-L2	241-C-104-04A-U4
V102	241-C-101	241-C-151-L4
V103	241-C-105	241-C-151-L3
V104	241-C-101	241-C-151-L5
V105/8636	241-C-151-L6	241-CR-151-U1
V107	241-C-252-U4	241-C-151-L8
V108/812	241-C-151-U1	244-AR-Tank-002-T9
V109	241-C-151-U2	241-A-101
V110	241-C-151-U3	244-CR Vault-U12
V113	241-C-151	241-AX-101-01A
V113	241-C-151	241-AX-103-03A-1
V115	241-C-105-05A-U8	241-C-152-L1
V118	241-C-152-L4	241-C-153-U6
V119	241-C-152-L5	241-C-153-U5
V120	241-C-152-L6	241-C-153-U4
V121	241-C-152	Capped
V122	241-C-105-05A-U4	241-C-152-L8
V130	241-B-154-L8	241-C-152-U4
V136	241-C-153-L1	None Identified
V137	241-C-153-L2	241-C-110
V138	241-C-110	241-C-153-L3
V139	241-C-110	241-C-153-L4
V140	241-C-110	241-C-153-L5
V141	241-C-153-L6	Capped
V142	241-C-153-L7	Capped
V143	241-C-107	241-C-153-L8

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V144	241-C-107	241-C-153-L9
V145	241-C-107	241-C-153-L10
V147	241-C-153-L1`2	None Identified
V148	241-C-104	241-C-153-L13
V149	241-C-104	241-C-153-L14
V150	241-C-104	241-C-153-L15
V156	241-C-201	241-C-252-L1
V157	241-C-201	241-C-252-L2
V158	241-C-202	241-C-252-L3
V159	241-C-202	241-C-252-L4
V160	241-C-203	241-C-252-L5
V161	241-C-203	241-C-252-L6
V162	241-C-204	241-C-252-L7
V163	241-C-204	241-C-252-L8
V172	241-C-252-U1	241-C-109/241-C-112
V175	241-C-252-U5	201-C-Hot Semi Works
V200	241-B-154-U7	221-B
V2000	241-BXR-152-U1A	241-BX-155-L9
V2001	241-BX-155-L10	241-BR-152-U1A
V201	241-B-154-U8	241-B-302B-Catch Tank
V203	241-A-151-L23	241-AW-B-R11
V203	241-B-154-L2	Crib
V204	241-B-154-L3	Sump
V208	241-B-154-L7	241-B-152-U6
V209	241-B-154-L9	241-B-152-U5
V210/V111	241-B-154-L10	241-C-151-U4
V211	241-B-154-L11	241-B-152-U4
V213	241-B-154-L13	241-B-151-U4
V214/8902	241-B-154-L14	221-B
V215	241-B-154-L15	241-B-151-U3
V219	241-ER-151-L2	Capped
V225	241-B-151-U1	241-ER-151-L10
V228	241-CR-153-U6A	241-ER-153-7
V230	241-B-153-U1	241-B-151-L1
V231	241-B-153-U8	241-B-151-L2
V233	241-B-151-L4	241-B-101
V234	241-B-151-L5	241-B-101

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V235	241-BX-153-U3	241-B-151-L6
V236	241-BX-153-U11	241-B-151-L7
V237	241-B-151-L8	241-BX-101
V238	241-B-151,/-153,/-252-Drains	241-B-301B-Catch Tank
V240	241-B-152-U3	241-B-151-U5
V242	241-BX-153-U4	241-B-152-L1
V243	241-V-252-U6	241-B-152-L2
V245	241-B-153-U6	241-B-153-L4
V246	241-B-153-U5	241-B-152-L5
V247	241-B-153-U4	241-B-153-L6
V250	241-B-152-L11	241-B-106
V252	241-BX-153-U6	241-B-152-L11
V253	241-BX-153-U5	241-B-152
V260	241-B-153-L2	241-B-111
V261	241-B-153-L3	241-B-110
V262	241-B-153-L4	241-B-110
V263	241-B-153-L5	241-B-110
V266	241-B-153-L8	241-B-107
V267	241-B-153-L9	241-B-107
V268	241-B-153-L10	241-B-107
V271	241-B-153-L13	241-B-104
V272	241-B-153-L14	241-B-104
V273	241-B-153-L15	241-B-104
V282	241-BX-155-U2	241-BX-154-L3
V283	241-BX-155-U3	241-BX-154-L4
V284	241-BX-155-U4	241-BX-154-L5
V285	241-BX-154-L6	241-B-252-U5
V289	241-BX-154-U9	241-BX-302B
V290	241-BX-201	241-B-252-L1
V291	241-BX-201	241-B-252-L2
V292	241-BX-202	241-B-252-L3
V293	241-BX-202	241-B-252-L4
V294	241-BX-203	241-B-252-L5
V295	241-BX-203	241-B-252-L6
V296	241-BX-204	241-B-252-L7
V297	241-BX-204	241-B-252-L8
V305	241-B-252-L16	241-BY-109

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V307	242-B-151-L1	241-B-108
V308	242-B-151-L2	241-B-109
V309	242-B-151-L3	241-B-107
V310	242-B-151-L4	241-B-105
V311	242-B-151-L5	241-B-104
V312	241-B-104	241-B-151-Drain
V313	242-B-151-U1	242-B-Evaporator
V314	242-B-Evaporator	Cut and Capped
V315	241-BX-155-L2	241-B-151-U6
V316	241-BX-153-U9	241-BX-155-L3
V317	241-BX-153-U8	241-BX-155-L4
V318	241-BX-153-U7	241-BX-155-L5
V319	241-BX-155-L6	241-B-152-U2
V323	241-BX-155-U7	241-BX-302C
V329	241-B-154-U1	221-B
V330	241-B-154-U2	221-B
V331	241-B-154-U3	221-B
V332	241-B-154-U4	221-B
V333	241-B-154-U5	221-B
V334	241-B-154-U6	221-B
V335	221-B	241-BX-154-U1
V336	241-BX-154-U2	221-B
V337	241-BX-154-U3	221-B
V338	241-BX-153-U12	241-B-302A
V339	241-BX-154-U5	221-B
V340	241-BX-154-U6	221-B
V341	241-BX-154-U7	221-B
V342	241-BX-110	241-BX-153-L4
V342	241-BX-154-U8	221-B
V343	241-BX-110	241-BX-153-L5
V344	241-BX-110	241-BX-153-L6
V345	241-BX-109	241-BX-153-L11
V346	241-BX-107	241-BX-153-L8
V347	241-BX-107	241-BX-153-L9
V348	241-BX-107	241-BX-153-L10
V349	241-BY-104	241-BX-153-L12
V350	241-BX-112	241-BX-153-L7

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V351	241-BX-104	241-BX-153-L13
V352	241-BX-104	241-BX-153-L14
V353	241-BX-104	241-BX-153-L15
V355	241-BX-101	241-BX-153-L17
V360	241-UX-154	241-EW-151
V361	241-UX-154	241-EW-151
V362	241-UX-154-U11	241-ER-151-U4
V363	241-UX-154-U7	241-ER-151-U6
V364	241-UX-154-L8	241-ER-151-U7
V365	241-ER-151-U8	Flow Meter Box
V366	241-UX-154-U13	241-ER-151-U9
V374	241-UX-154-U6	221-U
V375	241-UX-154-U9	241-TX-155-U17
V376	241-UX-154-U10	241-TX-155-U15
V379	241-UX-302	241-UX-154
V382	241-UX-154-L3	241-TX-155-U11
V383	241-TX-154-L7	Capped
V384	241-TX-154-7	Capped
V385	241-TX-154-L7	Capped
V386	241-TX-155-L8	Capped
V387	241-TX-154-L5	241-TX-152-U1
V388	241-TX-154-L4	241-TX-152-U3
V388	241-TX-155-U12	Capped
V391	241-TX-154-L3	241-TX-155-U16
V392	241-TX-154-L2	241-TX-155-U18
V393	241-TX-302B	241-TX-155-U19
V394	241-TX-155-A1	241-TX-155-A2
V395	241-TX-155-B1	241-TX-155-B2
V396	241-TX-155-L2	241-TX-153-U15
V397	241-TX-155-L4	241-TX-153-U14
V398	241-U-152-U4	241-TX-152-U7
V399	241-T-152-U7	241-TX-155-U6
V401	241-TX-155-L8	241-TX-153-U12
V402	3241-TX-155-L9	Capped
V403	241-TX-155-L10	241-TX-153-U11
V404	241-U-152-U2	241-TX-152-U8
V405	241-T-152-U3	241-TX-155-L12

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V406	241-TX-155-L13	Capped
V407	241-TX-155-L14	241-TX-153-U6
V408	241-TX-155-L15	Capped
V408	244-TX-0	241-TX-152-Drain
V409	241-TX-155-L16	241-TX-153-U4
V410	241-TX-155-L17	Capped
V410	241-U-151-U2	241-TX-155-L17
V411	241-T-151-U2	241-TX-155-L18
V412	241-TX-155-L19	Blocked
V413	241-TX-155-L20	241-TX-153-U3
V416	241-U-152-U1	241-TX-153-U10
V426	241-U-152-L4	241-U-153-U6
V427	241-U-152-L5	241-U-153-U5
V428/V461	241-U-152-L6	241-U-153-U4
V445	241-U-151-U1	241-T-151-L6
V450	241-U-153-U9	241-U-151-L1
V452/V422	241-U-151-L3	241-U-152-L9
V453/V421	241-U-151-L4	241-U-152-L8
V455	241-U-151-L8	241-S-151-U13
V458	241-U-153-U1	240-S-151-L9
V459	241-U-153-U2	240-S-151-L15
V460	241-U-153-U3	240-S-151
V465	241-U-153-L3	241-U-110
V466	241-U-153-L4	241-U-110
V467	241-U-153-L5	241-U-110
V470	241-U-153-L8	241-U-107
V471	241-U-153-L9	241-U-107
V472	241-U-153-L10	241-U-107
V473/5107/5507/5307	241-U-153-L11	241-UR-154-L8, 241-UR-153-L8 241-UR-152-L8
V487	241-U-201	241-U-252-L1
V488	241-U-201	241-U-252-L2
V489	241-U-202	241-U-252-L3
V490	241-U-202	241-U-252-L4
V491	241-U-203	241-U-252-L5
V492	241-U-203	241-U-252-L6
V493	241-U-204	241-U-252-L7

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V494	241-U-204	241-U-252-L8
V5006	241-S-104-04A	241-S-107-07A
V508	240-S-151-L17	241-S-151-U6
V509	240-S-151-L16	241-S-151-U7
V510	241-S-151-U8	241-S-304-13
V512	240-S-151-L13	241-S-151-U10
V513	240-S-151-L12	241-S-151-U11
V514	240-S-151-L6	Capped
V515	240-S-151-L9	241-S-151-U14
V516	240-S-151-L7	241-S-151-U15
V517	240-S-151	Capped
V517	202-S	241-S-151
V519	240-S-151-L2	241-S-151-U18
V521	241-S-151-B2	241-S-151-B1
V526	241-SX-151-U13	241-S-151-L4
V527	241-SX-151-U10	241-S-151-L5
V528	241-SX-151-U8	241-S-151-L6
V529	241-SX-151-U6	241-S-151-L7
V530	241-SX-151-U4	241-S-151-L5
V533	241-S-151-L11	Crib
V534	241-S-110	241-S-151-L12
V535	241-S-110	241-S-151-L13
V536	241-S-107	241-S-151-L14
V537	241-S-107	241-S-151-L15
V538	241-S-104	241-S-151-L16
V539	241-S-104	241-S-151-L17
V541	241-S-101/101-S-Caisson	241-S-151-L19
V542	241-S-304	241-S-151
V543	241-S-304	241-S-151
V544	240-S-151-L1	216-S-Swamp
V547	240-S-151-L8	216-S-Crib
V548	240-S-151-L10	V544/216-S-Swamp
V550	240-S-151	V544/216-S-Swamp
V552	240-S-151-U3	240-S-152-L2
V553	240-S-151-U8	240-S-142-L3
V554	240-S-151-L12	241-S-302-CT
V555	240-S-152-L1	240-S-151-U17

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V563	241-SX-151-U1	241S-302A
V564	241-SX-151-U11	241-SX-151-U2
V566	241-SX-151-U9	241-SX-151-U5
V567/V581	241-SX-151-U7	241-SX-152
V569	241-SX-302-A	241-SX-151-L1
V570	241-SX-110	241-SX-151-L2
V571	241-SX-111	241-SX-151-L2
V572	241-SX-112	241-SX-151-L4
V574	241-SX-109	241-SX-151-L6
V575	241-SX-108	241-SX-151-L7
V576	241-SX-107	241-SX-151-L8
V577	241-SX-151-L9	241-SX-152
V578	241-SX-101	241-SX-151-L10
V579	241-SX-102	241-SX-151-L11
V580	241-SX-103-03	241-SX-151-L12
V582	241-SX-106	241-SX-151-L14
V583	241-SX-105	241-SX-151-L15
V584	241-SX-104	241-SX-151-L16
V591	241-SX-114	241-SX-151-L23
V595	241-SX-302-A	241-SX-152
V596	241-TX-153-U1	241-TX-302A
V597	241-TY-153-L1	241-TX-153-U2
V600	241-TXR-152-U14	241-TXR-153-U14, 241-TX-153-U8
V6002	241-TR-152-U13	241-T-103-03A-U1
V6006	241-TR-152-U12	241-T-102-02A-U1
V601	241-T-152-L10	241-TX-153-U9
V6010	241-TR-152-L11	241-T-101-01A-U1
V603	241-TX-153-A1	241-TX-153-A2
V604	241-TX-153-B1	241-TX-153-B2
V606	241-TX-153-C2	219-1-Crib
V608	241-TX-101	241-TX-153-L2
V609	241-TX-101	241-TX-153-L3
V610	241-TX-153-L4	242-T-Evaporator
V612	241-TX-105	241-TX-153-L6
V613	241-TX-105	241-TX-153-L7
V615	241-TX-115/15-X	241-TX-153-L9
V616	241-TX-118	241-TX-153-L10

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V617	241-TX-107	241-TX-153-L11
V618	241-TX-109	241-TX-153-L12
V619	241-TX-109	241-TX-153-L13
V621	241-TX-113	241-TX-153-L15
V622	241-TX-113	241-TX-153-L16
V625	241-TX-116	241-TX-153-L19
V644	241-TY-103	241-TY-153-L7
V645	241-TY-103	241-TY-153-L8
V648	241-TY-101	241-TY-153-L11
V649	241-TY-101	241-TY-153-L12
V653	241-T-151-U3	221-T
V654	241-T-151-U4	221-T
V657	241-T-151-L1	241-T-153-U1
V658	241-T-151-L2	241-T-153-U8
V660	241-T-101	241-T-151-L4
V661	241-T-101	241-T-151-L5
V663	241-T-151-L8	Crib
V664	241-T-151, 241-T-152, 241-T-153	241-T-302B
V667	241-T-152-U4	221-T
V668	241-T-152-U5	221-T
V669	241-T-152-U6	221-T
V671	241-T-152-U9	224-T
V675	241-T-153-U5	241-T-152-U4
V676	241-T-153-U6	241-T-152-U5
V677	241-T-152-L6	241-T-153-U4
V690	241-T-110	241-T-153-L2
V691	241-T-110	241-T-153-L4
V692	241-T-110	241-T-153-L5
V695	241-T-107	241-T-153-L8
V696	241-T-107	241-T-153-L9
V697	241-T-107	241-T-153-L10
V698	241-T-106	241-T-153-L11
V699	241-T-105	241-T-153-L12
V700	241-T-104	241-T-153-L13
V701	241-T-104	241-T-153-L14
V702	241-T-104	241-T-153-L15
V707	221-T-Section 10	Unknown

Table 3-7. Transfer Lines (34 Pages)

Line Number	Connecting Facility	Connecting Facility
V711	241-T-201	241-T-252-L1
V712	241-T-201	241-T-252-L2
V713	241-T-202	241-T-252-L3
V714	241-AX-155-10,-11	241-AR-151-1
V714	241-T-202	241-T-252-L4
V714	PUREX-F16	241-AR-151-2
V715	241-T-203	241-T-252-L5
V716	241-T-203	241-T-252-L6
V716	241-U-301-B	244-U-E-Vault
V717	241-T-204	241-T-252-L7
V718	241-T-204	241-T-252-L8

Table 3-8. Overground Transfer Lines as of April 23, 2002

From	To	Status
BY-105 Pump Pit	244-BX DCRT	Active
BY-106 Pump Pit	BY-105 Pump Pit	Active
S-111-11A Pit	S-C Valve Pit	Active
S-109-09A Pit	S-A Valve Pit	Active
S-A Valve Pit	S-C Valve Pit	Active
S-C Valve Pit	SX-A Valve Pit	Inactive
SX-101-01A Pit	SX-A Valve Pit	Active
SX-102-02B Pit	SX-A Valve Pit	Active
SX-103-03B Pit	SX-A Valve Pit	Active
SX-105-05A Pit	SX-A Valve Pit	Active
U-107-07B Pit	UD Valve Pit	Active
U-108-08B Pit	UD Valve Pit	Active
U-109-09B Pit	U-109-09A Pit	Inactive
U-111-11B Pit	UD Valve Pit	Active

4.0 REFERENCES

DOE/ORP-2001-18, 2002, *Single-Shell Tank System Closure Work Plan*, Jacobs Engineering Group, Inc., Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

HNF-EP-0182, 2002, *Waste Tank Summary Report for Month Ending November 30, 2001*, Rev. 164, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-10466, 2002, *Status of Facilities and Waste Transfer Lines Within SST Farms*, CH2M HILL Hanford Group, Inc., Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Public Law 96-150, 94 Stat. 2767, Title 26, 42 USC 9601 et seq.

Resource Conservation and Recovery Act of 1976 (RCRA), Public Law 94-580, 90 Stat. 2795, 42 USC 901 et seq.

APPENDIX C

WMA C CLOSURE ACTION PLAN

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CONTENTS

FIGURES

TABLES

ADDENDUMS

ATTACHMENT

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LIST OF TERMS

AEA	*Atomic Energy Act of 1954*
ARAR	applicable or relevant and appropriate requirement
BBI	Best Basis Inventory
bgs	below ground surface
C-106	single-shell tank 241-C-106
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
CPP	CERCLA Past Practice
CY	calendar year
DOE	U.S. Department of Energy
DQO	data quality objective
DST	double-shell tank
DWS	drinking water standards
Ecology	Washington State Department of Ecology
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
Framework Plan	*Framework Plan for Single-Shell Tank System Closure*
FY	fiscal year
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HSRAM	*Hanford Site Risk Assessment Methodology*
HWTOS	*Hanford Tank Waste Operation Simulator*
HWMA	"Hazardous Waste Management Act"
HWIS	Hanford Well Information System database
ILCR	incremental lifetime cancer risk
IP	intrusion prevention
IS	interim stabilized
LCF	latent cancer fatality
MCL	maximum contaminant limit
PI	partial interim isolation
PNNL	Pacific Northwest National Laboratory
PUREX	plutonium-uranium extraction
R	retrieval
RFI	RCRA Facility Investigation
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	*Revised Code of Washington*
ROD	record of decision
RMIS	Hanford Records Management Information System
RPP	RCRA Past Practice
SAC	system assessment capability
SPR	selected phase removal

SST	single-shell tank
TSD	treatment, storage, and disposal
TWINS	Tank Waste Information Network System
UPR	unplanned release
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System
WMA	waste management area

C1.0 INTRODUCTION

The waste management area C (WMA C) is a dangerous waste management unit within the single-shell tank (SST) system. For the purposes of closure, the WMA C components include numerous tanks, pits, transfer piping, diversion boxes, and vaults as well as soil and groundwater contaminated by WMA C operations. The boundary of the WMA C is generally coincident with the 241-C tank farm area (C farm) fenceline. While most WMA C components are physically located within this boundary, some components extend beyond the boundary (e.g., pipelines and groundwater) or are located outside the boundary (e.g., 241-C-154 diversion box). Section 2.0 describes the WMA and its associated components.

U.S. Department of Energy (DOE) will conduct closure activities for single components or groups of components within WMA C. In accordance with Section 173-303-610 of the *Washington Administrative Code* (WAC) "Dangerous Waste Regulations" (WAC 173-303) and the *Hanford Federal Facility Agreement and Consent Order* (HFFACO, Ecology et al. 1989), it is the intent of the DOE to close WMA C after all associated component closure activities have been completed. Closure of WMA C will include disposition of all components including any corrective or remedial actions determined to be necessary to meet performance objectives for soil or groundwater contaminated with dangerous waste or dangerous waste constituents.

This WMA C Closure Action Plan includes both the requirements associated with clean closure of WMA C as a tank system (WAC 173-303-640[8](a)), and closure and postclosure actions associated with landfills (WAC 173-303-640[8](b) and WAC 173-303-665[6]). In accordance with WAC 173-303-640(8)(c), a closure and postclosure plan consistent with landfill requirements is required to be included in a closure plan for a tank system that does not comply with secondary containment (such as the SST system). Landfill closure will only occur if approved by Ecology through modifications to the Site-Wide Permit. These landfill closure and postclosure plans must provide contingent actions should the removal and decontamination activities that are to be performed for WMA C components leave dangerous waste or dangerous waste constituents in excess of those identified in WAC 173-303-610(2)(b). Contingent actions will include design and installation of an engineered surface barrier in compliance with WAC 173-303-665(6)(a) performance standards (described in Sections C4.2.7 and C4.3, herein) and performance of postclosure care requirements in compliance with WAC 173-303-665(6)(b) (described in Section C8.0, herein).

C1.1 WMA C CLOSURE ACTION PLAN RATIONALE

DOE submits this closure action plan to support the following:

- Closure in accordance with WAC 173-303-610 treatment, storage and disposal (TSD) closure and postclosure requirements.

- The concurrent closure activity for the tank 241-C-106 (C-106)

- HFFACO Milestone M-45-06, which directs closure of all WMAs (tank farms) by September 30, 2024
- HFFACO Milestone M-45-06-T03, which directs closure actions to proceed on a WMA (tank farm) basis
- HFFACO Milestone M-24-00, which specifies groundwater monitoring, will occur in relation to the SSTs.

This WMA C Closure Action Plan describes waste characterization, removal, decontamination, treatment, and other such closure activities for the tanks, pits, piping, diversion boxes, vaults, soil and groundwater of the WMA. It also describes actions that will be taken to support closure of the entire WMA such as risk assessment, groundwater monitoring, planning for design of a final cover, and integration of the WMA-wide actions with adjacent and site-wide remediation and closure strategies. The WMA C Closure Action Plan identifies specific activities, schedules, plans, documentation, and integration needs that can be identified at the present time, as well as the information gaps. DOE expects that information gaps will be filled by successive revisions of this closure action plan as component closure activities generate data and reduce the uncertainties. DOE will not propose closure of WMA C until all associated components have been addressed pursuant to component closure activity plans or alternative documentation (such as corrective measures, *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) Action Memoranda or Records of Decision [ROD] upon approval), through incorporation into the Site-Wide Permit.

A relative sequence for completion of component closure activities, including contingent closure activities for landfills, leading to closure of the WMA, as well as contingent postclosure activities for completion is described in Section C4.0.

C1.2 REGULATORY SETTING

A complete discussion of applicable statutes and regulations is presented in the *Framework Plan for Single-Shell Tank System Closure* (Framework Plan). With respect to closure of WMA C, the driving factors are the State of Washington *Hazardous Waste Management Act of 1976* (HWMA, *Revised Code of Washington* [RCW] 70.105) and the HFFACO.

The HFFACO establishes that WMA C and the balance of the SST system will be closed in accordance with WAC 173-303-610, WAC 173-303-645, and the HFFACO Milestone M-45 series.

Closure will be carried out at the WMA level. Thus, the requirements for certification of closure and, potentially, postclosure care, will apply to WMA C and will be addressed in this closure action plan.

As specified in Section 6 of the HFFACO, the *SST System Closure Plan* will address all waste constituents that could potentially affect human health and/or the environment. Where information regarding treatment, management, and disposal of the radioactive source, byproduct

material, and/or special nuclear components of mixed waste (as defined by the *Atomic Energy Act of 1954* [AEA]) has been incorporated into the Site-Wide Permit, it is not incorporated for the purpose of regulating such components under the authority of the Site-Wide Permit and the HWMA. To the extent that *Resource Conservation and Recovery Act of 1976* (RCRA)/HWMA requirements are inconsistent with requirements under the AEA, Section 1006 of RCRA provides that the inconsistent RCRA requirements yield to those of the AEA.

C1.3 THE WMA C CLOSURE ACTION PLAN

DOE is establishing a system for dispositioning individual components and the WMA, as contributory actions in closing the SST system. DOE has developed a tiered structure of documentation to integrate the various component closure activity plans and closure action plans into the Site-Wide Permit, as shown in Figure C1-1. The following sections describe how the WMA C Closure Action Plan (tier 2) relates to each of the tiers.

C1.3.1 Relationship to Framework Plan

The Framework Plan (Tier 1) describes the systemic and sitewide integrated approach for closing the entire SST system through closure of the seven WMAs (A-AX, B-BX-BY, C, S-SX, T, TX-TY, U). The approved Framework Plan will be incorporated into Part V of the Site-Wide Permit. The WMA C Closure Action Plan (Tier 2) is an appendix to the Framework Plan.

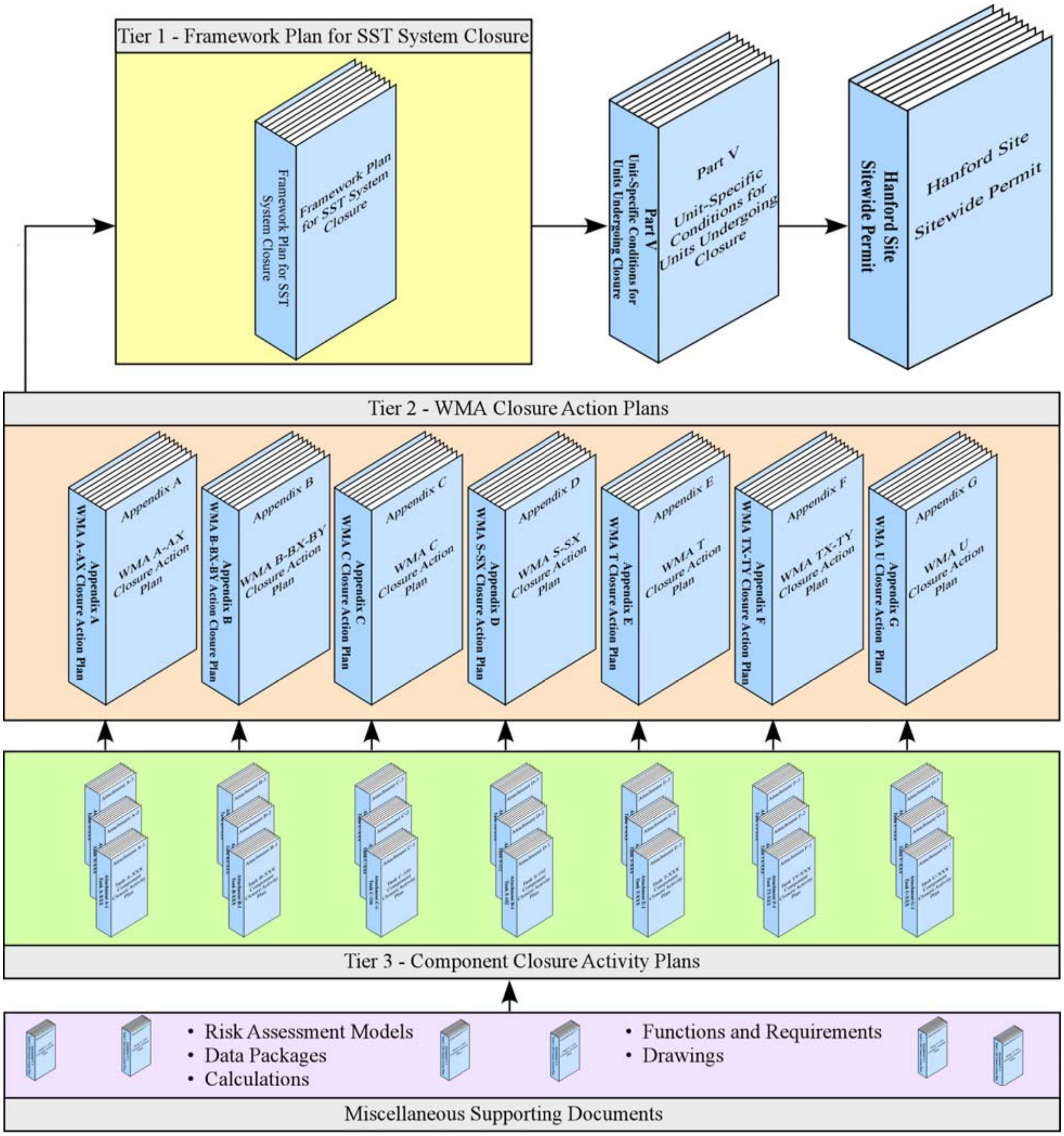
C1.3.2 Relationship to Component Closure Activity Plans

DOE intends to submit component closure activity plans (Tier 3) for the various components of WMA C, such as individual or groups of tanks, ancillary equipment, soil, and groundwater. The component closure activity plans, or equivalent decision documents, will be developed to be consistent with the overall WMA strategy for closure. Each approved component closure activity plan will become an attachment to this WMA C Closure Action Plan. If equivalent documents are used they will be approved through incorporation into the Site-Wide Permit.

C1.3.3 Relationship to Site-Wide Permit

All WMA closure action plans and component closure activity plans, including contingent plans for landfills in accordance with WAC 173-303-640(8)(c), will be incorporated through the permit modification process into Part V, "Unit-Specific Conditions for Units Undergoing Closure," of the Dangerous Waste Portion of the Site-Wide Permit as they are approved. At that time, they will become subject to the terms and conditions of the permit. Should postclosure activities that are consistent with landfill requirements be required for WMA C, the postclosure requirements will be incorporated into Part VI, "Unit-Specific Conditions for Units in Postclosure," of the Site-Wide Permit.

Figure C1-1. *Single-Shell Tank System Closure Plan* Document Structure.



C2.0 WMA C DESCRIPTION

WMA C encompasses the C farm located in the east central portion of the 200 East Area (Figures C2-1 and C2-2) including soil and groundwater contaminated by C farm operations. In general, the WMA C boundary is represented by the fenceline surrounding the C tank farm.

The C farm 100-series tanks are 23 m (75 ft) in diameter, have a 5-m (15 ft) operating depth, and have an operating capacity of 1,892,700 L (530,000 gal) each. The 200-series tanks are 6 m (20 ft) in diameter with a 5-m (17 ft) operating depth and an operating capacity of 208,000 L (55,000 gal) each. Typical tank configuration and dimensions are shown in Figure C2-3. The tanks sit below grade with at least 2 m (7 ft) of soil cover to provide shielding from radiation exposure to operating personnel. Tank pits are located on top of the tanks and provide access to the tank, pumps, and monitoring equipment.

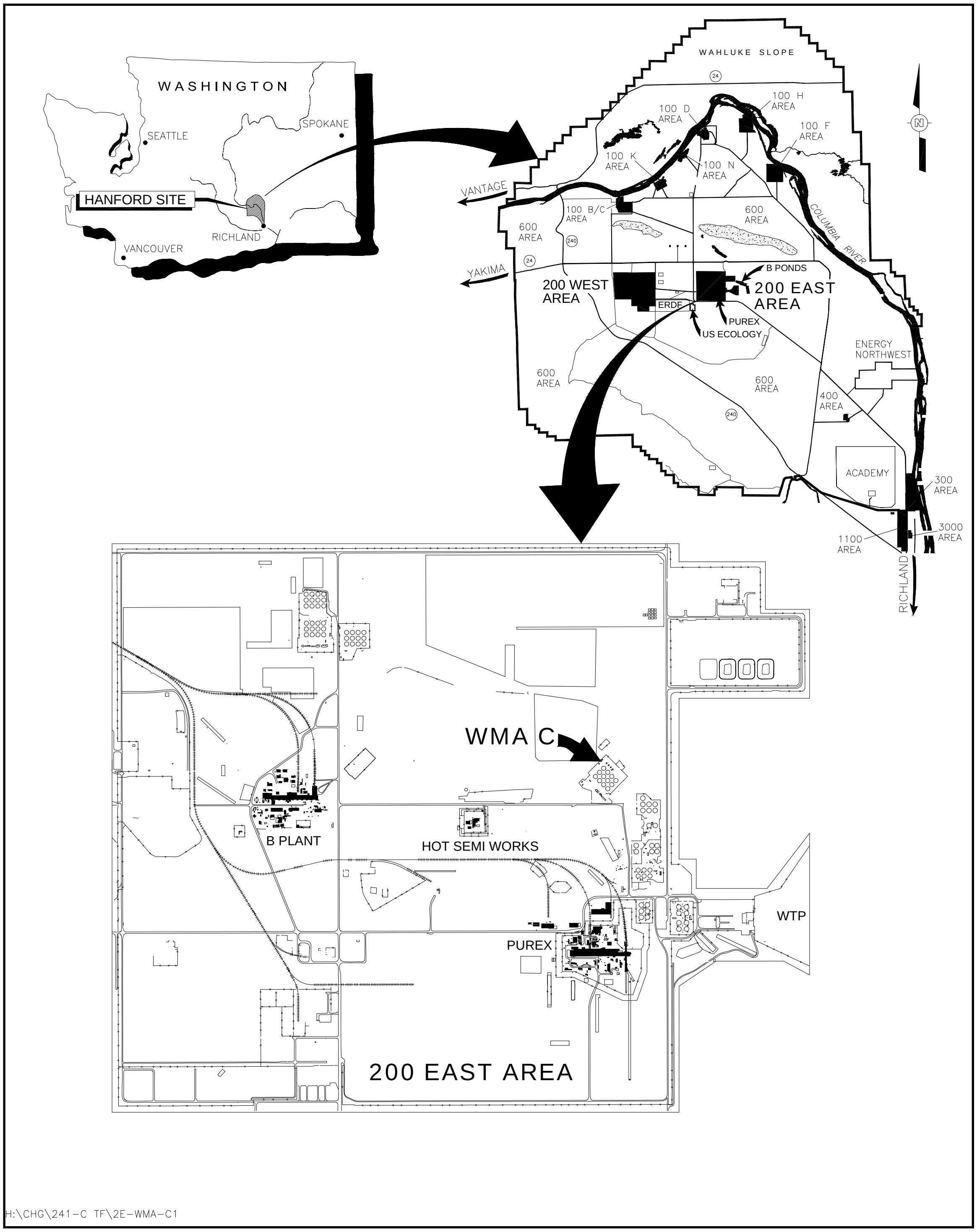
The SSTs were constructed in place with carbon steel (ASTM A283 Grade C) lining the bottom and sides of a reinforced concrete shell. The tanks have concave bottoms (center of tanks lower than the perimeter) and a curving intersection of the sides and bottom. The inlet and outlet lines are located near the top of the liners (Figure C2-3). These lines are also referred to as “cascade” lines since they allowed transfer of fluids between tanks using gravity flow. The SSTs in WMA C were used to store waste primarily from the bismuth phosphate, the plutonium-uranium extraction (PUREX), and the uranium extraction processes.

To support the transfer and storage of waste within WMA C SSTs, there is a complex waste transfer system of pipelines (transfer lines), diversion boxes, vaults, valve pits, and other miscellaneous structures. Collectively, these are referred to as ancillary equipment.

The 244-CR vault is located south of the tanks. The vault is a two level, multi-cell, reinforced concrete structure constructed below grade (DOE/RL-92-04), which contains four underground tanks along with overhead piping and equipment. Two tanks have a capacity of 170,343 L (45,000 gal) each. The other two tanks have capacities of 55,494 L (14,700 gal) each. This vault was constructed in 1946 and ceased operating in 1988. It was last used to transfer waste solutions from processing and decontamination operations (DOE/RL-92-04). A schematic of the 244-CR vault is shown in Figure C2-4.

The routing of liquid waste from the operations buildings to the tank farms was accomplished using underground transfer lines, diversion boxes, and valve pits. The diversion boxes housed the switching facilities where waste could be routed from one transfer line to another. The diversion boxes are below-ground, reinforced concrete boxes that were designed to contain any waste that leaked from the high-level waste transfer line connections. Diversion boxes generally drained by gravity to nearby catch tanks where any spilled waste was stored and then pumped to SSTs (DOE/RL-92-04). Figure C2-5 shows a schematic of a typical diversion box.

Figure C2-1. Location Map of WMA C in the 200 East Area at the DOE Hanford Site.



1 Figure C2-2. Location Map of WMA C and Surrounding Area.

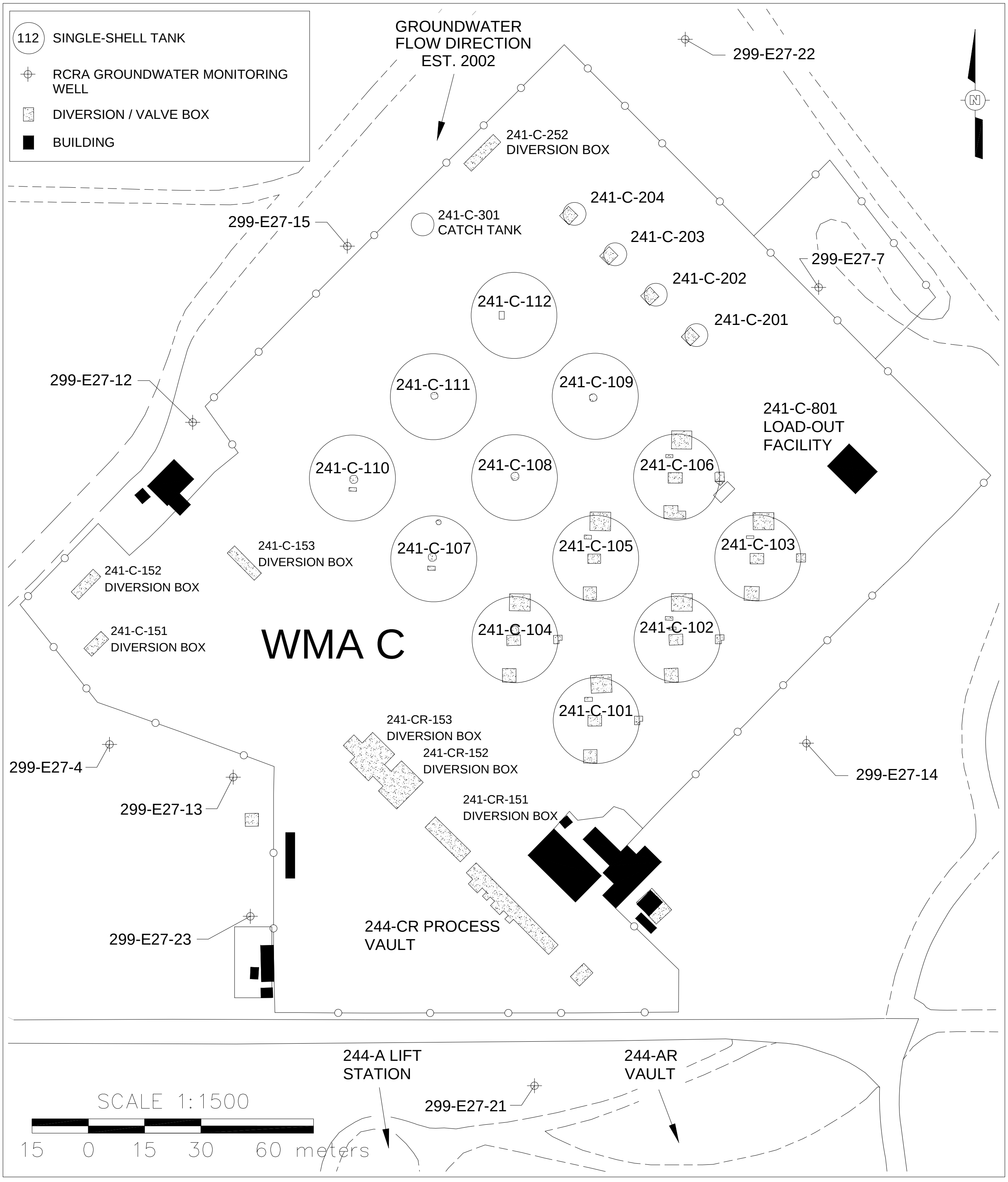


Figure C2-3. Typical Configuration and Dimensions of SSTs in WMA C.

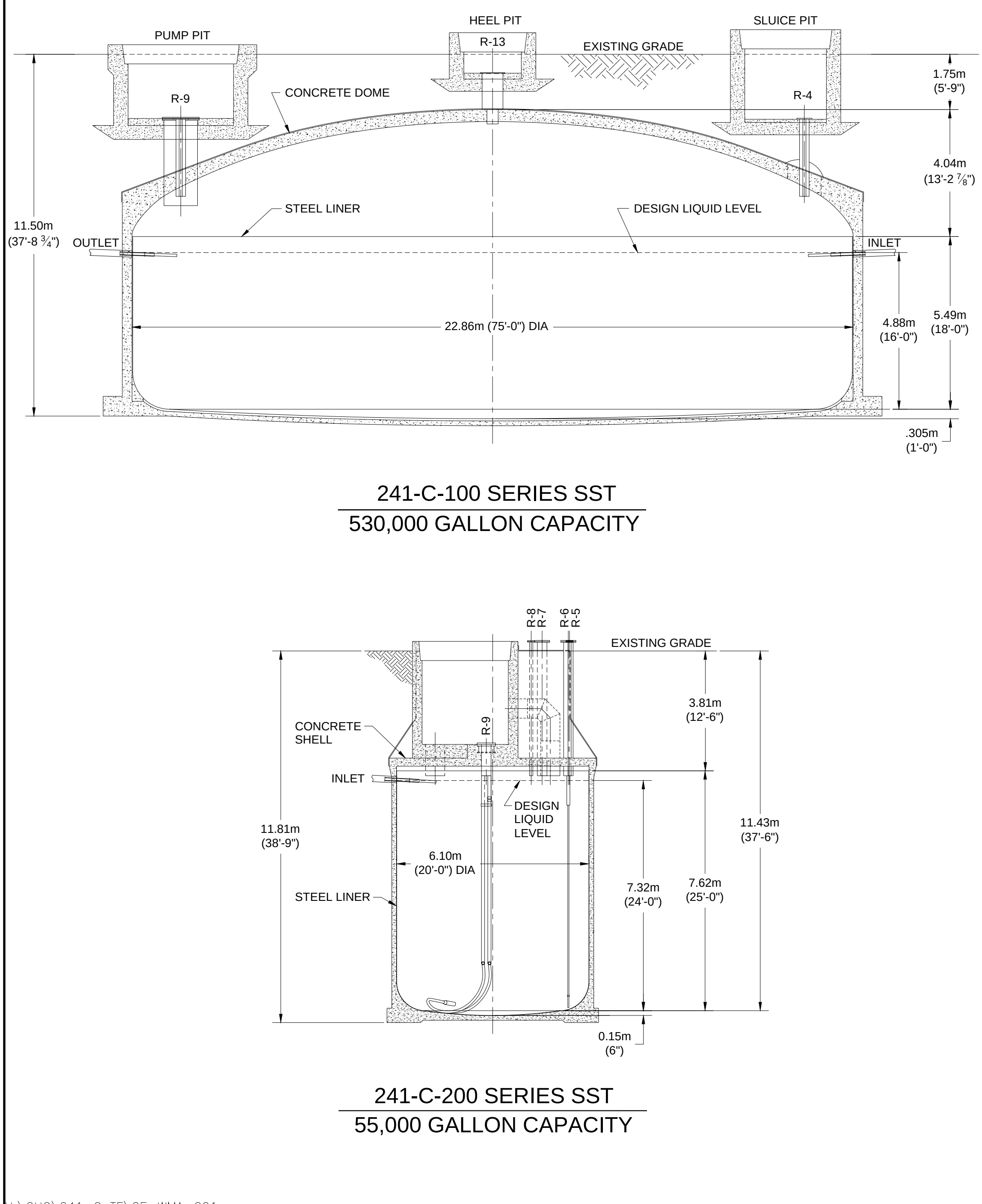


Figure C2-4. Schematic of the 244-CR Vault in WMA C.

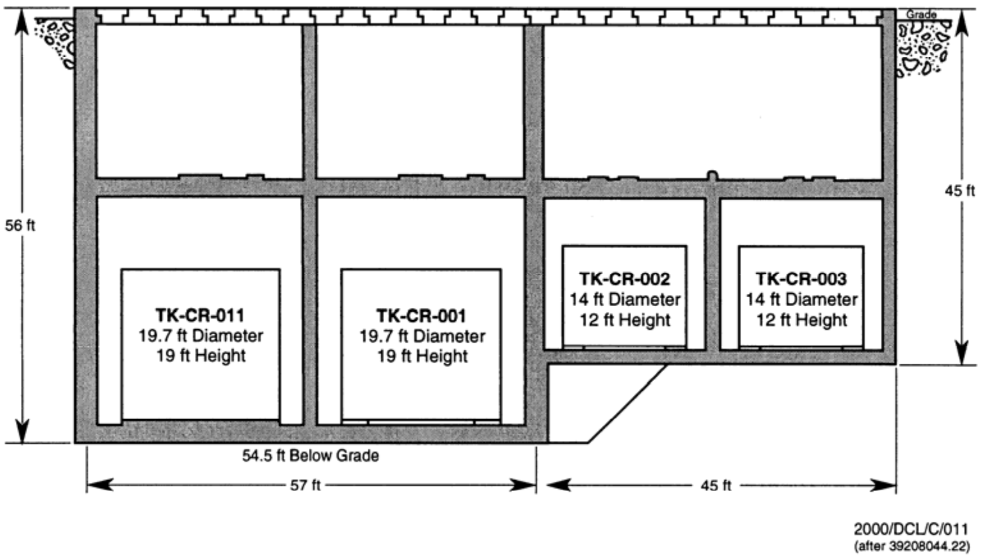
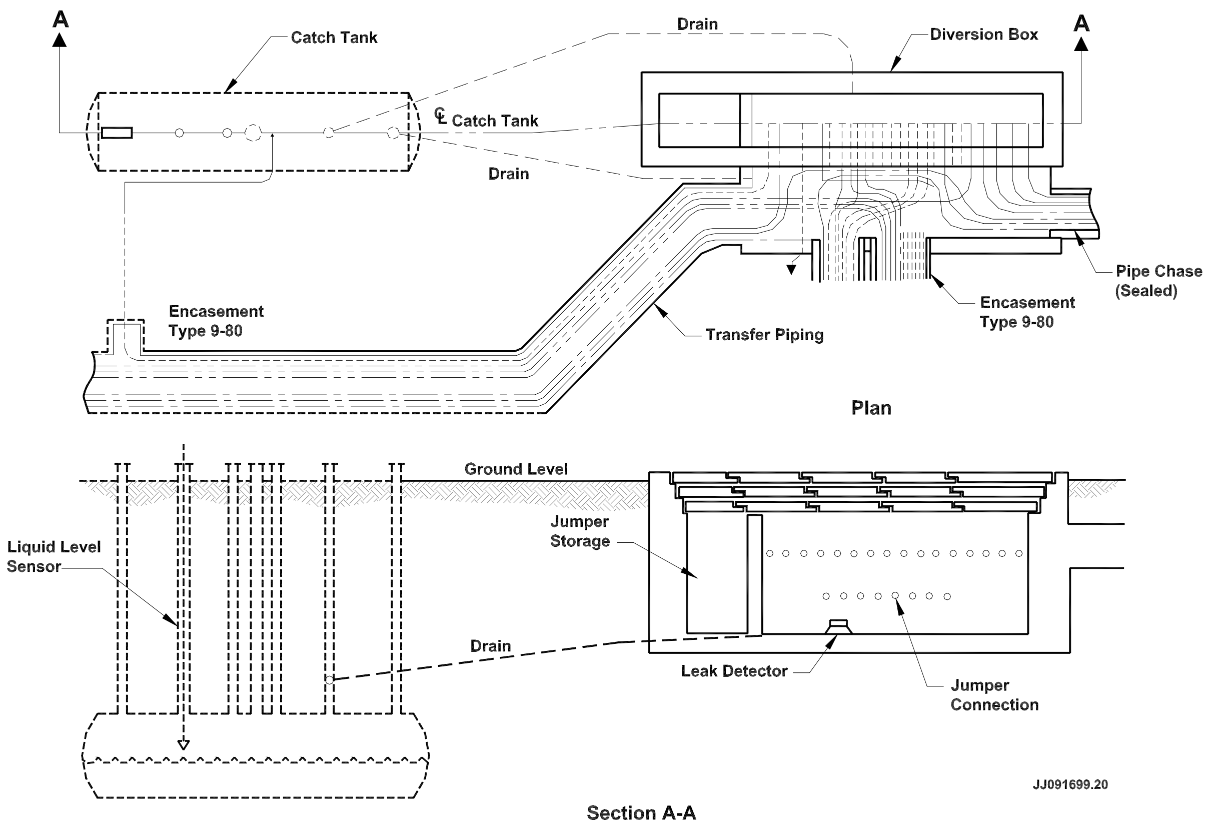


Figure C2-5. Schematic of a Typical Diversion Box Transfer System.



Valve pits are below-ground, reinforced concrete structures that contain valve and jumper assemblies that were used for routing the liquid waste through the transfer lines. Liquid waste was routed to valve pits when several tanks were undergoing simultaneous pumping to a single receiver tank. Each valve pit has a flush line connected to a flush pit or drain line connected to an underground tank.

Waste management practices in WMA C have included efforts to reduce the liquid content in tanks and to perform preliminary isolation of the tank systems. Table C2-1 provides the waste volume and stabilization/isolation status of the SSTs in WMA C. Waste volumes are updated on a quarterly basis. The values included in the table are from the December 2002 Best Basis Inventory (BBI) for tank contents as maintained on the Tank Waste Information Network System (TWINS) website. The risk assessment in Section C5.0 addresses uncertainty in input values. Most of the pumpable liquids have been removed from the SSTs and transferred to double-shell tanks (DST) as part of interim stabilization.

Intrusion prevention (IP) is the administrative designation for the completion of the physical activities required to minimize the addition of liquids into an inactive storage tank. Electrical and other instrumentation devices are not disconnected during intrusion prevention. Partially interim isolated (PI) is an administrative designation reflecting the completion of the physical activities required to minimize the addition of liquids to an inactive storage tank. Isolation of risers and piping that are required for jet pumping or other methods of stabilization are not included in the PI process. Interim stabilized (IS) means that the tank now contains less than 189,250 L (50,000 gal) of drainable interstitial liquid and less than 18,925 L (5,000 gal) of supernatant liquid. Waste volumes are updated on a quarterly basis in the BBI, and will document changes resulting from in-tank physical and chemical processes that may cause settling, condensing, stratification, and segregation of waste components. Retrieval (R) designation is given to tanks scheduled for removal of waste to the maximum extent practical, generally focusing on the removal of solids from the tank (HNF-EP-0182 2003).

Table C2-1. Waste Volume and Stabilization/Isolation Status by Tank as of December 2002. (2 Pages)

Tank 241-	**Stabilization/ Isolation Status**[a]	**Total Waste (L [gal] x 1,000)**	**Supernatant Liquid (L [gal] x 1,000)**	**Sludge (L [gal] x 1,000)**	**Saltcake (L [gal] x 1,000)**
C-101	IS/IP	333 [88]	0 [0]	333 [88]	0 [0]
C-102	IS/IP	1,196 [316]	0 [0]	1,196 [316]	0 [0]
C-103	/PI	764 [202]	291[77]	473 [125]	0 [0]
C-104	IS/IP	980 [259]	0 [0]	980 [259]	0 [0]
C-105	IS/PI	500 [132]	0 [0]	500 [132]	0 [0]
C-106	/PI	138 [36] [a]	115 [30]	23 [6]	0 [0]
C-107	IS/IP	939 [248]	0 [0]	939 [248]	0 [0]
C-108	IS/IP	250 [66]	0 [0]	250 [66]	0 [0]
C-109	IS/IP	238 [63]	0 [0]	238 [63]	0 [0]
C-110	IS/IP	674 [178]	4 [1]	670 [177]	0 [0]

Table C2-1. Waste Volume and Stabilization/Isolation Status by Tank as of December 2002. (2 Pages)

Tank 241-	Stabilization/ Isolation Status[a]	Total Waste (L [gal] x 1,000)	Supernatant Liquid (L [gal] x 1,000)	Sludge (L [gal] x 1,000)	Saltcake (L [gal] x 1,000)
C-111	IS/IP	216 [57]	0 [0]	216 [57]	0 [0]
C-112	IS/IP	394 [104]	0 [0]	394 [104]	0 [0]
C-201	IS/R	4 [1]	0 [0]	4 [1]	0 [0]
C-202	IS/R	4 [1]	0 [0]	4 [1]	0 [0]
C-203	IS/R	11 [3]	0 [0]	11 [3]	0 [0]
C-204	IS/R	11 [3]	0 [0]	11 [3]	0 [0]

[a] HNF-EP-1082 2003
IP = intrusion prevention
IS = interim stabilized
PI = partially interim isolated
R = retrieval

C2.1 HISTORY OF WMA C

Constructed in the mid 1940s, WMA C was one of two original tank farms to receive bismuth phosphate process waste from B Plant. By the end of 1948, all tanks in the farm were filled with waste from the bismuth phosphate process.

In 1952 and 1953, metal wastes were sluiced from the SSTs in WMA C and sent to U Plant for uranium extraction. All the 100-series tanks in WMA C received the uranium recovery waste from the tributyl phosphate processing. The 200-series tanks received hot semi-works waste generated during PUREX pilot plan studies conducted in the mid 1950s. Tank C-204 received strontium semi-works waste in 1967 from the strontium recovery operations at the hot semi-works plant.

Beginning in May 1955 until December 1957, the 244-CR vault was used to mix ferrocyanide scavenging chemicals with uranium recovery waste to precipitate cesium-137 and strontium-90. Uranium recovery waste already stored in other 200 East Area tank farms was pumped to the vault for processing. The vault was used later as a receiving station, and operations ceased in 1988.

The PUREX process, along with B Plant waste fractionization processes, produced the most complicated combination of wastes at the Hanford Site. Waste types sent to WMA C included cladding wastes, organic wash wastes, and cell drainage.

Several other waste streams were routed to one or more tanks in WMA C. These include S Plant ion-exchange wastes, N Reactor complexed waste, evaporator bottom concentrate from 241-B and 241-BX farms, S Plant supernatant, process development wastes from the Hot Semi-Works (C Plant), low-level and metal waste from 241-B farm, and Hanford laboratory operations waste (DOE/RL-92-04).

Fourteen unplanned releases (UPR) have occurred within or adjacent to WMA C. The following brief descriptions of the UPRs are summarized from the Waste Information Data System (WIDS) General Summary Reports (the access page located at the Hanford intranet web site http://apweb02/cfroot/wids/) and represent the best information available on the nature and extent of releases. There exists substantial uncertainty in the volume and content of UPRs from components within the WMA C. Estimates of contaminant release volumes, inventories and location for some UPRs are included in the WMA C inventory data package associated with the risk assessment presented in Section C5.0. These estimates will be revised as new information becomes available. The UPR sites will be addressed as potentially contributing sources to the soil component and will be part of the soil component investigation and cleanup.

- Unplanned release UN-200-E-16 is a surface spill that resulted from a leak in an overground transfer pipeline between tanks C-105 and C-108. The surface spill associated with this release is located approximately 18 m (60 ft) northeast of tank C-105 and occurred in 1959. The spilled liquid was classified as coating waste from the PUREX process.

- Unplanned release UN-200-E-27 is located just east of the 244-CR vault and extends east beyond the tank farm fenceline. DOE/RL-92-04 indicates the surface contamination was deposited in 1960, but does not identify the source(s) of the contamination. Since the UN-200-E-27 release consisted of airborne particulate contamination, the impact was limited to the ground surface.

- Unplanned release UN-200-E-68 is wind-borne surface contamination spread from the 241-C-151 diversion box. The release occurred in 1985 and was subsequently decontaminated to background radiation levels or covered with clean soil for later decontamination (the source document is inconclusive). Sometime after the release, the 241-C-151 diversion box was opened, flushed, and sprayed with Turco Fabri-Film to physically fix contamination to the structure surface.

- Unplanned release UN-200-E-72 occurred in 1985 and is located south of WMA C near the 216-C-8 crib. The source of the contamination was buried contaminated waste. The waste posed little release potential because the contamination was fixed in place with Turco Fabri-Film. The source of the contamination was determined to be from the burial of previously undocumented contamination material. The area was surrounded with a chain and posted as a Surface Contamination Area; however, the site is no longer marked or posted. No information regarding the buried material was given in the WIDS report, it is assumed that the contamination extends to the depth of the buried material, but the aerial extent and depth are not known. The volume of the contamination was not specified.

- Unplanned release UN-200-E-81 is located northeast of the 244 CR vault, near the 241-CR-151 diversion box. It occurred as a result of a leak in an underground transfer pipeline in October 1969. The waste leaked from the pipeline consisted of PUREX coating waste. The site was covered with 0.5 m (18 inches) of backfill and clean gravel.

- Unplanned release UN-200-E-82 occurred in December 1969. The source was determined to be the feed line running between tank C-105 and the 221-B building. The leak was discovered near the 241-C-152 diversion box. The liquid release flowed from the vicinity of the 241-C-152 diversion box to the northeast, downgrade, until it pooled into an area, measuring approximately 0.46 m^2 (5 ft^2), outside the WMA C fence. The leak volume is unknown.The contaminated site was covered with clean gravel in 1969. The depth of the clean gravel applied in 1969 was not provided in the WIDS report; however, it states that additional decontamination of the area was done in 1985.

- Unplanned release UN-200-E-86 is a spill that resulted from a leak in a pipeline used to transfer waste from the 244-AR vault to WMA C. The depth of the leaking pipeline was approximately 2 m (8 ft) below ground surface (bgs). The release occurred in March 1971 near the southwest corner of WMA C, outside the fence. The spill consisted of 25,000 curies of cesium-137. The soils surrounding the pipeline were sampled, and it was determined the contamination had not penetrated below 6 m (20 ft). The contamination plume volume was estimated at 37 m^3 (1,300 ft^3). The surface of the release site has been stabilized with “shotcrete”. The release site is demarcated with concrete AC-540 marker posts and signs indicating “Underground Radioactive Material”.

- Unplanned release UN-200-E-91 is located approximately 30 m (100 ft) from the northeast side of the tank farm. It resulted from surface contamination that migrated from WMA C. The date of the occurrence, its areal extent, and the nature of the contamination are not specified. DOE/RL-92-04 states that the contaminated soil was removed, and the area was released from radiological controls.

- Unplanned release UN-200-E-99 is surface contamination that resulted from numerous piping changes associated with the 244-CR vault. It is located south of 7th Street, directly south of the 244-CR vault and was established as a release site in 1980, although the actual occurrence date is unknown. A radiological survey conducted in support of herbicide applications in 1981 found no detectable contamination in the release area. As a result of the radiological survey, surface contamination postings were removed on March 5, 1981 and the area was released from the radiation zone designation.

- Unplanned release UN-200-E-100 is a surface spill of unknown volume and constituents that occurred in 1986. It is located about 60 m (8 ft) south and east of WMA C and surrounds the 244-A lift station.

- Unplanned release UN-200-E-107 is a surface spill located north of the 244-CR vault, inside WMA C. DOE/RL-92-04 states that a spill occurred on November 26, 1952, when a pump discharged liquid to the ground surface during a pump installation. The spilled waste was tributyl phosphate waste from 221-U building. The volume of the spill and any cleanup measures were not documented.

- Unplanned release UN-200-E-118 is located in the northeast portion of the tank farm and extends north up to about 300 m (1,000 ft) beyond the fenceline. It was the result of an airborne release from tank C-107 that occurred in April 1957. The highest exposure rate was estimated at 50 mrem/hour at the ground surface (DOE/RL-92-04).

- Unplanned release UPR-200-E-136 is a release of 64,345 to 90,840 L (17,000 to 24,000 gal) of waste from tank C-101. Two thousand curies were released between 1946 and 1970 (DOE/RL-92-04).
- Unplanned release UPR-200-E-137 occurred when water entered tank C-203, migrated through the saltcake, and either became entrained in the saltcake or leaked out of the tank. The leak was 1,514 L (400 gal) of PUREX high-level waste.

C2.2 COMPONENTS OF WMA C

The components that will be included in the WMA C closure action are listed in Table C2-2. This list is extracted from Addendum 1 of the *Single-Shell Tank System Closure Plan* (RPP-13774) which incorporates units listed on the RCRA Part A, Form 3, Rev. 8 permit application, in addition to RCRA Past Practice (RPP), *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) Past Practice (CPP), and Miscellaneous Storage Tank units. While most WMA C components are physically located within the C farm fenceline (also the WMA C boundary), some components extend beyond the fenceline (e.g., pipelines and groundwater) or are located outside the fenceline (e.g., 241-C-154 diversion box). Closure actions for components extending outside of the WMA boundary will be addressed through modifications to the Hanford Site-Wide Permit. Section C4.2 describes closure activities for these components.

Table C2-2. WMA C Components. (7 Pages)

Single-Shell Tanks			
Tank 241-	**Constructed**	**Removed From Service**	**Constructed Operating Capacity L (gal)**
C-101	1943 – 1944	1970	2,000,000 (530,000)
C-102	1943 – 1944	1976	2,000,000 (530,000)
C-103	1943 – 1944	1979	2,000,000 (530,000)
C-104	1943 – 1944	1980	2,000,000 (530,000)
C-105	1943 – 1944	1979	2,000,000 (530,000)
C-106	1943 – 1944	1979	2,000,000 (530,000)
C-107	1943 – 1944	1978	2,000,000 (530,000)
C-108	1943 – 1944	1976	2,000,000 (530,000)
C-109	1943 – 1944	1976	2,000,000 (530,000)
C-110	1943 – 1944	1976	2,000,000 (530,000)
C-111	1943 – 1944	1978	2,000,000 (530,000)
C-112	1943 – 1944	1976	2,000,000 (530,000)
C-201	1943 – 1944	1977	210,000 (55,000)
C-202	1943 – 1944	1977	210,000 (55,000)
C-203	1943 – 1944	1977	210,000 (55,000)
C-204	1943 – 1944	1977	210,000 (55,000)

Table C2-2. WMA C Components. (7 Pages)

Diversion boxes			
Unit 241-	**Constructed**	**Removed From Service**	**Description**
C-151	1946	1985	Interconnected 241-C-152, -153, and CR-151 diversion boxes
C-152	1946	1985	Interconnected 241-B-154 and -153 and C farm, associated with 241-C-301 catch tank
C-153	1946	1985	Interconnected 241-C-151 and -152 diversion boxes
C-154	1946	1985	Interconnected B-Plant to Hot-Semi Works. Box located at Hot-Semi Works
C-252	1946	1985	Interconnected 241-C-151 diversion box and C farm
CR-151	1952	1985	Interconnected 241-C-151 and C farm
CR-152	1946	1985	Interconnected 241-C-151 diversion box and C farm
CR-153	1946	1985	Interconnected 241-CR-152 diversion box and C farm
244-CR-Vault (contains four tanks)			
Tank 244-	**Constructed**	**Removed From Service**	**Description**
CR-011	1946	1988	Transfer of waste solutions from processes and decontamination operations.
CR-001	1946	1988	
CR-002	1946	1988	
CR-003	1946	1988	

Miscellaneous Tanks	
Facility Number	**Description**
241-C-301 (aka 241-C-301C) (RPP)	Catch tank
CR-003-TK/SMP	Tank/sump
Miscellaneous Structures	
Facility Number	**Description**
241-C-801 (RPP)	Cesium loadout facility
Valve Pits	
Facility Number	**Description**
241-C	Valve pit
Tank Pits	
Facility Number	**Description**
241-C-01A	Pump Pit
241-C-01B	Heel Pit
241-C-01C	Sluice Pit
241-C-02A	Pump Pit

Table C2-2. WMA C Components. (7 Pages)

Tank Pits (continued)	
Facility Number	**Description**
241-C-02C	Sluice Pit
241-C-03A	Pump Pit
241-C-03C	Sluice Pit
241-C-05A	Pump Pit
241-C-05B	Heel Pit
241-C-05C	Sluice Pit
241-C-07	No pit, covered saltwell caisson
241-C-08	No pit, covered saltwell caisson
241-C-09	No pit, covered saltwell caisson
241-C-110	No pit, covered saltwell caisson
241-C-111	No pit, covered saltwell caisson
241-C-112	No pit, covered saltwell caisson
241-C-02C	Sluice Pit
241-C-03A	Pump Pit
241-C-03C	Sluice Pit
241-C-05A	Pump Pit
241-C-05B	Heel Pit
241-C-05C	Sluice Pit
241-C-07	No pit, covered saltwell caisson
241-C-08	No pit, covered saltwell caisson
241-C-09	No pit, covered saltwell caisson
241-C-110	No pit, covered saltwell caisson
241-C-111	No pit, covered saltwell caisson
241-C-112	No pit, covered saltwell caisson

Transfer Lines		
Line Number	**Connecting Facilities**	
4012	241-CR-153	241-AX-151-D-Cell
4013	241-AX-151-D-Cell	241-CR-152-U3A
8002	241-C-103-03A-U1	241-CR-152-L13
8006	241-C-102-02A-U1	241-CR-152-L12
8010	241-C-101-01A-U1	241-CR-152-L11
8012	241-CR-152-U9,-U11,-U12	241-CR-151-U4
8014	241-C-103-03C-U1	241-CR-152-L10
8017	241-C-102-02C-U1	241-CR-152-L7
8020	241-C-101-01C-U1	241-CR-152-L9
8031	241-C-101-01A-U3	241-CR-152-L14

Table C2-2. WMA C Components. (7 Pages)

Transfer Lines (continued)		
Line Number	**Connecting Facilities**	
8032	241-C-103-03A-U2	241-CR-152-U6
8035	241-C-103-03C-U2	241-CR-152-U5
8037	241-C-102-02A-U3	241-CR-152-L15
8038	241-C-102-02A-U2	241-CR-152-U4
8041	241-C-102-02C-U2	241-CR-152-U3
8044	241-C-101-01A-U2	241-CR-152-U2
8047	241-C-101-01C-U2	241-CR-152-U1
8107	241-CR-152-L8	V844/241-CR-151-L8
8202	241-C-106-06A-U1	241-CR-153-L13
8206	241-C-105-05A-U1	241-CR-153-L12
8210	241-C-104-04A-U1	241-CR-153-L11
8214	241-C-106-06C-U1	241-CR-153-L10
8217	241-C-105-05C-U1	241-CR-153-L7
8220	241-C-104-04C-U1	241-CR-153-L9
8225	241-CR-153-U10	241-CR-151-U10
8231	241-C-104-04A-U3	241-CR-153-L14
8232	241-C-106-06A-U2	241-CR-153-U6
8235	241-C-106-06C-U2	241-CR-153-U5
8237	241-C-105-05A-U3	241-CR-153-L15
8238	241-C-105-05A-U2	241-CR-153-U4
8241	241-C-105-05C-U2	241-CR-153-U3
8244	241-C-104-04A-U2	241-CR-153-U2
8247	241-C-104-04C-U2	241-CR-153-U1
8552	241-C-201,-202,-203,-204-U2	241-CR-151-U2
8555	241-CR-151-U5	241-C-201,-202,-203,-204-U2
8601	241-CR-151-L1	244-CR-Tank-001
8616	241-CR-151-L5	244-CR-Tank-011-U1
8624	241-CR-152-U8	241-CR-151-U7
8625	241-CR-153-U8	241-CR-151-U6
8630	241-CR-152-L1,-2,-3,-4,-5,-6	241-CR-151-U9
8631	241-CR-153- L1,-2,-3,-4,-5,-6	241-CR-151-U8
8644	241-CR-151-U12,-U13,-U15	241-CR-151-U12,-U13,-U15
8647	241-CR-151-L4	244-CR-Tank-003-U1
8648	241-CR-151-L6	244-CR-Tank-002-U1
8656	241-AX-151	244-CR-DCRT-Tank-003
8900	201-C-Valve Box	244-CR-Tank-003-U10

Table C2-2. WMA C Components. (7 Pages)

Transfer Lines (continued)		
Line Number	**Connecting Facilities**	
108/837/8649/8901	221-B	244-CR-DCRT
8636/V105	241-CR-151-U1	241-C-151-L6
8653/8618	241-ER-151-L9	241-CR-151-U14
A4013	241-CR-152-3A	241-AX-151-Washdown
Drain Line	241-C-102-02B-U3	241-C-Valve Pit-L1
Drain Line	241-C-103	241-C-Valve Pit
Drain Line	241-C-104-04C	241-CR-153
Drain Line	241-C-104-04B-U3	241-C-Valve Pit-L2
Drain Line	241-C-107-U1	241-C-Valve Pit-L3
Drain Line	241-C-252	Unknown Catch Tank
Drain Line	241-C-153 & 241-C-151	Unknown Catch Tank
Drain Line	244-CR-Tank-002	241-CR-151
Drain-301	241-C-106-06C-U8	Metal Filter Drain
Drain-302	241-C-106-06C-U9	Process Building Floor Drain
Flush Line	241-SX-A-R6,R17	241-SX-B-Flush Pit
SN244	244-CR-Vault	241-ER-153
SN275	241-C-VP-U1,-U2,-U3,-U4,-U5,-U6	244-CR-U15
Unknown	241-C-101	241-C-102
Unknown	241-C-102	241-C-103
Unknown	241-C-101-01B-U1	8010
Unknown	241-C-102-02B-U2	Line 8006
Unknown	241-C-103-03B-U1	241-C-Valve Pit-L6
Unknown	241-C-103-03B-U2	Line 8002
Unknown	241-C-104-04B-U2	Line 8210
Unknown	241-C-104-04B-U3	241-C-Valve Pit-L2
Unknown	241-C-10505B-U3	Capped
Unknown	241-C-105-05B-U2	Line 8206
Unknown	241-C-106-06B-U2	Line 8202
Unknown	241-C-108	241-C-107
Unknown	241-C-109	241-C-108
Unknown	241-C-110-U1	241-C-Valve Pit-L3
Unknown	241-C-111	241-C-110
Unknown	241-C-112	241-C-111
Unknown	241-C-112	241-C-Valve Pit-L5
V050	241-A-152-L7	241-C-104
V051	241-A-152-L8	241-C-104

Table C2-2. WMA C Components. (7 Pages)

Transfer Lines (continued)		
Line Number	**Connecting Facilities**	
V100	241-C-151-L1	241-C-153-U9
V1000	241-CR-152	244-CR Vault-U14
V1001	241-CR-152-U4A	241-CR-153-U3A
V1002	241-CR-152-U6A	241-CR-153-U1A
V101	241-C-153	Capped
V101	241-C-151-L2	241-C-104-04A-U4
V102	241-C-101	241-C-151-L4
V103	241-C-105	241-C-151-L3
V104	241-C-101	241-C-151-L5
V105/8636	241-C-151-L6	241-CR-151-U1
V107	241-C-252-U4	241-C-151-L8
V108/812	241-C-151-U1	244-AR-Tank-002-T9
V109	241-C-151-U2	241-A-101
V110	241-C-151-U3	244-CR Vault-U12
V113	241-C-151	241-AX-101-01A
V113	241-C-151	241-AX-103-03A-1
V115	241-C-105-05A-U8	241-C-152-L1
V118	241-C-152-L4	241-C-153-U6
V119	241-C-152-L5	241-C-153-U5
V120	241-C-152-L6	241-C-153-U4
V121	241-C-152	Capped
V122	241-C-105-05A-U4	241-C-152-L8
V130	241-B-154-L8	241-C-152-U4
V136	241-C-153-L1	None Identified
V137	241-C-153-L2	241-C-110
V138	241-C-110	241-C-153-L3
V139	241-C-110	241-C-153-L4
V140	241-C-110	241-C-153-L5
V141	241-C-153-L6	Capped
V142	241-C-153-L7	Capped
V143	241-C-107	241-C-153-L8
V144	241-C-107	241-C-153-L9
V145	241-C-107	241-C-153-L10
V147	241-C-153-L1,-L2	None Identified
V148	241-C-104	241-C-153-L13
V149	241-C-104	241-C-153-L14

Table C2-2. WMA C Components. (7 Pages)

Transfer Lines (continued)		
Line Number	**Connecting Facilities**	
V150	241-C-104	241-C-153-L15
V156	241-C-201	241-C-252-L1
V157	241-C-201	241-C-252-L2
V158	241-C-202	241-C-252-L3
V159	241-C-202	241-C-252-L4
V160	241-C-203	241-C-252-L5
V161	241-C-203	241-C-252-L6
V162	241-C-204	241-C-252-L7
V163	241-C-204	241-C-252-L8
V172	241-C-252-U1	241-C-109/241-C-112
V175	241-C-252-U5	201-C-Hot-Semi Works
V210/V111	241-B-154-L10	241-C-151-U4
V228	241-CR-153-U6A	241-ER-153-7

C3.0 GROUNDWATER MONITORING

In accordance with closure requirements outlined in WAC 173-303-610(3)(a)(vi) and the HFFACO, this section describes groundwater monitoring requirements and activities associated with WMA C. To provide context to the groundwater monitoring discussion, the description includes:

- The regulatory basis for groundwater monitoring at WMA C
- A summary of the hydrogeologic conditions in the vicinity of WMA C
- The extent of known contamination in the vadose zone beneath WMA C and plans for future vadose zone characterization
- Current monitoring network configuration and management
- Groundwater sampling results
- Plans for modifications to the groundwater monitoring network.

C3.1 REGULATORY BASIS FOR GROUNDWATER MONITORING ACTIVITIES

DOE monitors groundwater at the Hanford Site pursuant to the HFFACO and to fulfill a variety of state and federal regulations, including the AEA, RCRA, CERCLA, and WAC regulations. DOE manages groundwater monitoring activities through the Hanford groundwater monitoring project.

U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), and DOE agreed to implement a RCRA groundwater monitoring system in accordance with the HFFACO Milestone M-24 and M-45 series. The primary objectives of RCRA groundwater monitoring are to comply with regulatory requirements and agreements, assess the potential impact of facilities on groundwater quality, and identify near-term corrective measures, if feasible, for the protection of human health and the environment. In conformance with interim-status standards contained in 40 *Code of Federal Regulations* (CFR) 265 Subpart F (which was incorporated by reference into WAC 173-303-400), RCRA projects are monitored according to three levels of effort:

- Background monitoring
- Indicator evaluation
- Groundwater quality assessment.

As shown on Figure C2-2, nine RCRA groundwater monitoring wells are located outside the WMA C fenceline. The wells are intended to monitor groundwater contamination attributable to the entire WMA rather than individual components. The initial background-monitoring program for WMA C is complete and monitoring is currently conducted under an interim status indicator evaluation program (PNNL-13024 , PNNL-13024-ICN-1). Monitoring under the indicator evaluation program will continue until the entire WMA is closed or at such time there is a shift to assessment monitoring as a result of statistically significant changes in indicator parameter concentrations in groundwater. Changes in the monitoring program status will be documented in modifications to the WMA C RCRA groundwater monitoring plan (PNNL-13024, PNNL-13024 ICN-1).

Prior to closure of WMA C, a postclosure groundwater-monitoring plan will be developed. Postclosure groundwater monitoring, in compliance with WAC 173-303-645, will be integrated with the Central Plateau regional groundwater monitoring system. At that time, a description of the planned groundwater monitoring activities, frequencies at which they will be performed, and reporting requirements as required by WAC 173-303-645 and -665 will be included. The plan must be approved by Ecology and modified through the WAC 173-303-830 process.

C3.2 HYDROGEOLOGIC CONDITIONS IN THE VICINITY OF WMA C

The site stratigraphy, aquifer characteristics, and vadose zone characteristics described in this section are based on information presented in the *RCRA Groundwater Monitoring Plan for Single-Shell Tank Waste Management Area C at the Hanford Site* (PNNL-13024) and the corresponding interim change notice (PNNL-13024-ICN-1). Characterization information in these references was compiled principally using wells outside the WMA C fenceline. Geologic and hydrologic data obtained from these wells are used for inferring generalized stratigraphy and groundwater conditions below WMA C, but do not provide site-specific detail regarding hydrogeologic conditions that affect potential distribution and movement of contaminants directly below the individual components of WMA facilities. Elevation values contained in Section C3.2.1 are based on the North American vertical datum of 1988.

C3.2.1 Site-Specific Stratigraphy

The geology beneath WMA C was first described in ARH-LD-132 and later in WHC-SD-EN-AP-012, WHC-SD-EN-TA-004, and HNF-2603. WMA C geology was recently updated based on examination of gross gamma-ray and neutron moisture logs, archived drill cuttings, and analysis of laboratory moisture and particle size distribution data (PNNL-13024, PNNL-13024-ICN-1).

The geology beneath WMA C consists of basalt basement overlain by five sedimentary sequences distinguished by texture or particle size and stratigraphic position. These sequences are (oldest to youngest):

- Hanford formation lower gravel sequence

- Hanford formation sand sequence
- Hanford formation upper gravel sequence
- Holocene eolian surficial deposits
- Backfill material

Table C3-1 summarizes the stratigraphic information for selected wells associated with WMA C. Much of the information used in Table C3-1 was taken directly from Table 2.4 in the WMA C groundwater monitoring plan (PNNL-13024). Top of basalt elevations and elevations of units beneath drywells 30-04-12 (aka 299-E27-65) and 30-06-02 (aka 299-E27-72) were interpolated from geologic surface maps and geologic cross sections (PNNL-12261, PNNL-13024). These interpolated data should only be used as estimates until refined through possible future characterization activities.

Table C3-1. Stratigraphic Data.

Well ID	Total depth[b] m (ft)	Elevations[a]						
		Surface[c] m (ft)	Top of eolian surficial deposits[d] m (ft)	Top of backfill material[d] m (ft)	Top of Hanford formation upper gravel sequence[b] m (ft)	Top of Hanford formation sand sequence[b,e] m (ft)	Top of Hanford formation lower gravel sequence[b,e] m (ft)	Top of basalt[f] m (ft)
299-E27-7	86 (281)	194 (636)	NE	NE	194 (636)	182 (596)	130 (426)	107 (351)
299-E27-12	83 (270)	202 (661)	NE	NE	202 (661)	191 (626)	133 (436)	105 (345)
299-E27-13	85 (280)	204 (669)	NE	NE	204 (669)	192 (629)	131 (431)	104 (342)
299-E27-14	81 (267)	201 (658)	201 (658)	NE	198 (650)	187 (613)	131 (428)	105 (344)
299-E27-15	80 (263)	199 (653)	199 (653)	NE	197 (645)	193 (633)	129 (423)	107 (351)
30-04-12 (299-E27-65)	41 (135)	199 (651)	NE	199 (651)	NE	186 (609)	131 (428)	105 (344)
30-06-02 (299-E27-72)	38 (125)	198 (648)	NE	198 (648)	NE	186 (609)	130 (427)	107 (350)

[a] Elevations rounded to nearest whole number – North American vertical datum of 1988 surveyed in 1994.
[b] From Table 2.4 of PNNL-13024.
[c] Surface elevations based on brass marker elevations minus a 0.2 m (0.5-ft) correction factor for approximate thickness of concrete pad. For wells 299-E27-65 and 299-E27-72 surface elevation based on top of casing survey.
[d] Interpreted from geologists logs in Appendix C of PNNL-13024.
[e] For wells 299-E27-65 and -72 geologic contacts interpolated from geologic cross sections (Plates 1-3) in PNNL-13024. Assumes 12 m (40 ft) of backfill material inside tank farm boundary.
[f] Interpolated from top of basalt map (Plate 4) in PNNL-12261 .
NE = Unit not encountered during drilling of borehole.

The Elephant Mountain Member of the Saddle Mountains Basalt Formation forms the bedrock base below WMA C. Drywells associated with the WMA C are not deep enough to encounter the Elephant Mountain Member basalt. A 200 East Area basalt surface map published in PNNL-12261 depicts the top basalt below WMA C at approximately 104.3 to 107.0 m (342 to 351 ft) elevation. The apparent dip of the basalt surface is south-southwest.

Directly overlying the basalt beneath WMA C is a sedimentary sequence characterized as cobble to pebble gravels, sandy gravels, and gravelly sands with lesser amounts of silty sandy gravel, and sand with occasional silt lenses. The gravels are subangular to well rounded and generally uncemented, although some local calcium carbonate consolidation is present. The age and stratigraphic nomenclature associated with this lower gravel sequence are variably described by WHC-SD-EN-AP-012, HNF-2603, and PNNL-12261. However, for this closure plan, the sequence is referred to as the Hanford formation lower gravel sequence, which is consistent with nomenclature used in the WMA C groundwater monitoring plan (PNNL-13024, PNNL-13024-ICN-1). The elevation of the top of the Hanford formation lower- gravel sequence ranges from 129.0 to 132.9 m (423 to 436 ft). Below the tank farm proper, the depth to the unit is approximately 67.7 m (222) or 56.4 m (185 ft) below the bottom of the SSTs. The estimated thickness of this undifferentiated sequence ranges from 22.0 to 27.7 m (72 to 91 ft) with an apparent thinning toward the basalt high.

The Hanford formation sand sequence overlies the Hanford formation lower gravel sequence beneath WMA C. This sequence is the thickest sedimentary unit underlying WMA C. The sequence is characterized as variably bedded silty sand, sand, and slightly gravelly to gravelly sand. The sandy beds exhibit a “salt and pepper” coloration due to the basaltic and felsic-mineral composition. The sequence is not cemented but does contain zones with calcium carbonate as small concretions and as coatings on sediment grains. The elevation of the top of the Hanford formation sand sequence ranges from 181.7 to 193.0 m (596 to 633 ft). Below the tank farm proper, the sequence occurs at approximately 12.2 m (40 ft) bgs or about 0.9 m (3 ft) below the bottom of the SSTs. The estimated thickness of the sequence ranges from 51.8 to 64.0 m (170 to 210 ft).

The Hanford formation upper gravel sequence overlies the sand sequence. The Hanford formation upper gravel sequence is described on borehole logs of cuttings as consisting of interbedded sandy gravels, gravelly sands, and sands. The upper gravel sequence consists of the gravel-dominated facies and was deposited by high-energy, glacial flood waters.

The elevation of the top of the Hanford formation upper gravel sequence ranges from 193.9 to 204.0 m (636 to 669 ft). The sequence varies from 3.7 to 12.2 m (12 to 40 ft) thick in the WMA C vicinity. This unit was removed from most, if not all, of the tank farm proper during construction and replaced as backfill after construction was complete. Outside WMA C, the sequence occurs at ground surface except at wells 299-E27-14 and 299-E27-15 where approximately 2.4 m (8 ft) of Holocene eolian sands cap the surface.

Within WMA C, the uppermost 12.2 m (40 ft) of material is backfill consisting of mixed gravel, sand and silt excavated from the Hanford formation during construction of the tank farm (WHC-SD-EN-TA-004). Excavated soils were used as backfill around the tanks.

C3.2.2 Aquifer Identification and Hydrogeologic Description

Depth-to-groundwater measurements collected from the five of the WMA C groundwater monitoring wells on June 25, 2002, indicate that the elevation of the uppermost aquifer beneath WMA C occurs at 122.3 m (401 ft) (PNNL HydroDat Database 2002). Details on the nature of the unconfined, uppermost aquifer are provided in PNNL-13024 and PNNL-13024-ICN-1.

In general, aquifer materials beneath WMA C are comprised of sandy gravel or silty sandy gravel. Although there is some consolidation of sediments within the unconfined aquifer, there is little evidence of compaction or cementing. Consequently, permeability is high and relatively homogeneous within the aquifer (PNNL-13024, PNNL-13024-ICN-1).

The base of the uppermost unconfined aquifer is defined by the top of the basalt. The thickness of the uppermost unconfined aquifer in the vicinity of WMA ranges from approximately 14 to 20 m (45 to 50 ft).

Groundwater flow direction and gradient in the vicinity of WMA C historically has been influenced by the substantial groundwater mound beneath B pond, located east of the WMA. The B pond mound, when at its peak, caused groundwater to assume a west to northwest flow direction. Following discontinuation of discharges to B pond, the mound has dissipated. As a result, the groundwater flow direction beneath WMA C has begun to return to what is expected to be its natural flow direction (which is generally southeast toward the Columbia River).

The hydraulic gradient below WMA C is nearly flat making it difficult to determine groundwater flow direction from water-level elevations. In fiscal year (FY) 2001, Pacific Northwest National Laboratory (PNNL) integrated the use of colloidal borescope surveys and gyroscopically corrected water-level data to estimate groundwater flow beneath WMA C (PNNL-13788). This survey concluded that the general flow direction is southwest at approximately 214 degrees azimuth (PNNL-13024-ICN-1).

The flow direction is expected to continue to change until it ultimately assumes a southeast direction. The actual time required for return to a "normal" flow pattern beneath WMA C will be driven by the decay of the B-pond mound and potentially by continuing discharges to the Treated Effluent Discharge Facility located to the east of the 200 East Area.

The RCRA standard wells at WMA C constructed prior to 2003 have open intervals within the aquifer ranging from 2.4 to 3.4 m (7.9 to 10.6 ft) in length. Well 299-E27-7, which is a pre-RCRA well, has a 14.3 m (46.9 ft) open interval in the aquifer. The rate of water table decline beneath WMA C has increased from 9.1 cm (0.3 ft) per year in June 1997 to approximately 30.5 cm (1 ft) per year in March 1999. If this current rate continues, downgradient well 299-E27-13, with less than 3 m (10 ft) of water, may become unusable in six or seven years.

The groundwater flow rate beneath WMA C is estimated to be between 0.7 and 1.4 m (2.4 and 4.8 ft) per day, or 267 to 534 m (876 to 1,752 ft) per year (PNNL-13024, PNNL-13024-ICN-1). These estimates were derived using the groundwater gradient across WMA C from June 2000

data, estimated porosity of the saturated sediments (PNNL-12086), and various published values for hydraulic conductivities in the 200 East Area (WHC-SD-EN-TI-147, WHC-SD-WN-TI-019).

C3.2.3 Vadose Zone Description

The vadose zone beneath WMA C is approximately 71.7 to 81.7 m (235 to 268 ft) thick in the vicinity of WMA C based on June 2002 groundwater data. The vadose zone is contained within the following strata (listed oldest to youngest). A brief description of each of these strata is found in Section C3.2.1.

- Hanford formation lower gravel sequence
- Hanford formation sand sequence
- Hanford formation upper gravel sequence
- Backfill material.

Texturally, the vadose zone is largely comprised of coarse sands with some gravels and silts. Clastic dikes (see Section C3.3) also were observed in C farm during construction, but were not mapped (ARH-LD-132).

C3.3 CONCEPTUAL MODEL FOR CONTAMINANT MIGRATION

The conceptual model for WMA C is an overview that summarizes the physical characteristics and mechanisms that potentially could lead to generation and transport of contamination to the groundwater. A detailed assessment of the conceptual model for WMA C including contaminant sources, source constituents, contaminant drivers, and migration pathways is provided in the WMA C groundwater monitoring plan (PNNL-13024, PNNL-13024-ICN-1) and also elaborated in the WMA C risk assessment which includes numerical modeling (Section 5.0 and Addendum C1). The conceptual model is based upon hydrogeologic and contaminant distribution data collected to date and will be modified subsequent to further field investigations in support of the RFI/CMS process and/or closure activities.

The primary potential sources of contamination in the WMA C are:

- SSTs
- Diversion boxes, vaults, and catch tanks
- Valve pits
- Piping
- Surface spills

- Existing soil contamination.

As discussed earlier, the vadose zone beneath WMA C is approximately 71.7 to 81.7 m (235 to 268 ft) thick in the vicinity of WMA C. Consequently, contamination from a near-surface source must migrate vertically through a substantial thickness of unsaturated soils before reaching the groundwater. Because of the nature of the depositional environment associated with the Hanford formation (that is, moderate to high-energy flood deposits), a large variability exists in heterogeneity and anisotropy over vertical and horizontal scales on the order of tens of feet. Delineating a migration pathway through this thick sequence of unconsolidated sediments beneath WMA C can be complex.

The stratigraphy in the vicinity of WMA C lacks the distinct, laterally continuous, silt-rich units and paleosols (such as caliche layers) found in the suprabasalt sediments in the 200 West Area and some parts of the 200 East Area (such as B, BX, BY farms) (PNNL-13024, PNNL-13024-ICN-1). These generally low-permeability units result in perching and lateral spreading of vertically-migrating liquids, in some cases for long distances. Below WMA C, thin intercalated, silt-rich units and paleosols are present, although these thin layers are not common and generally are not laterally continuous. Consequently, vadose-zone sediments below WMA C are not expected to have much effect on retarding downward migration of fluids or cause extensive lateral spreading. Therefore, potential impacts to the groundwater from contaminant sources would likely occur near the source.

Potential preferential pathways for vertical contaminant migration are identified for the WMA C. These potential pathways include clastic dikes, poorly sealed well casings, and the tank sidewalls. In addition, leaking water and other water sources, such as stormwater runoff, may accelerate transport of contaminants.

Clastic dikes are sedimentary features that crosscut existing horizontal bedding and may provide preferential pathways for contaminants to move through the vadose zone to groundwater. The maximum vertical extent of a clastic dike is about 45.7 m (150 ft) into the subsurface. Clastic dikes have been documented in boreholes at WMA C (ARH-LD-132, BHI-01103), although the effects of clastic dikes on contaminant transport are not established.

The annular space on the outside of unsealed well casings or wells with poorly constructed annular seals potentially provides a vertical preferential pathway. WMA C has several drywells that are used for secondary leak detection and have no annular seals or are poorly sealed. These drywells extend from 15.2 to 47.2 m (50 to 155 ft) bgs.

The sidewalls of the SSTs provide a large surface for preferential contaminant migration in the upper 15.2 m (50 ft) of the soil column. As discussed in Section C3.4.1, much of the cesium-137 contamination associated with the soil column in WMA C is attributed to possible surface or near surface sources that migrated along the sidewalls of the tank structures.

Section C3.4.3 discusses the planned characterization activities for WMA C that are intended to provide understanding of migration pathways through both the vadose zone and the sediments in the unconfined aquifer. Influences from various moisture driving forces also may become better understood. This conceptual model will be revised as necessary to reflect these new findings.

C3.4 EXTENT OF VADOSE ZONE CONTAMINATION

This section describes the known extent of vadose zone contamination in the vicinity of WMA C to supplement the lack of groundwater data inside the tank farm boundary. Vadose monitoring efforts provide data from drywells located around the various waste management facilities (particularly the SSTs) within WMA C.

C3.4.1 Vadose Zone Monitoring – WMA C Drywells

Figure C3-1 shows the existing vadose zone monitoring network associated with WMA C. There are 70 vadose zone monitoring wells (drywells) associated with WMA C. The distribution of these wells is targeted primarily around the twelve 2,000,000-L (530,000-gal) SSTs. There are few drywells around the four 210,000-L (55,000-gal) SSTs (C-201, C-202, C-203, and C-204) and some of the vaults and diversion boxes.

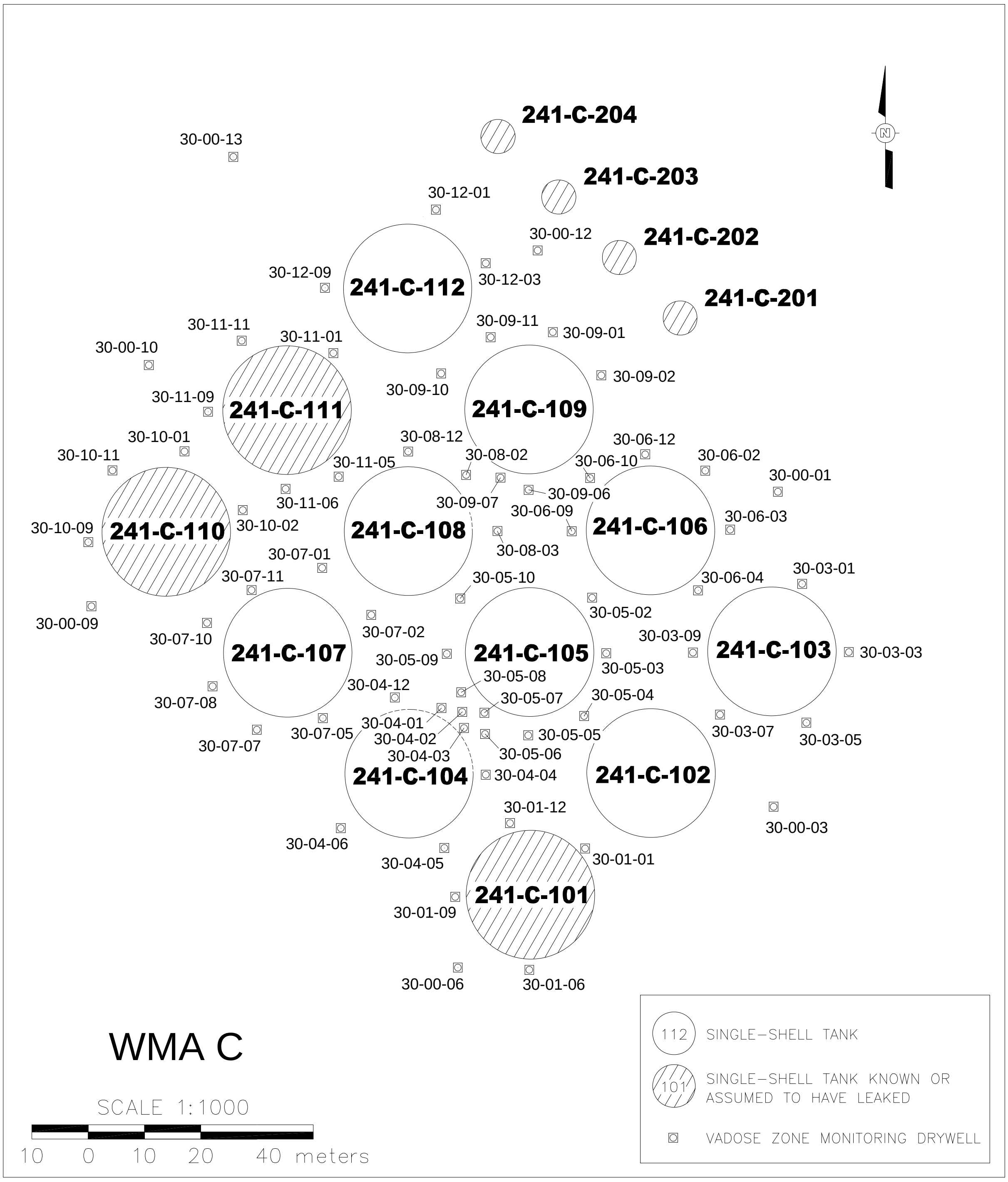
The current vadose zone monitoring program implemented at WMA C as well as other tank farms on the Hanford Site is described in *Hanford 200 Areas Spectral Gamma Baseline Characterization Project – Baseline Characterization Plan* (GJO-HGLP-1.7.1). Under this monitoring plan, drywells are monitored (logged) on a quarterly, annual, or a 5-year frequency. The order and frequency of monitoring is based on a priority score, which is calculated using tank and plume-related factors developed from the baseline characterization. The frequency of routine monitoring currently established for the wells within WMA C is documented in Appendix A of the *Hanford Tank Farms Vadose Zone Monitoring Project Baseline Monitoring Plan* (MAC-HGLP 1.8.1).

In 1997, these drywells were logged using a high resolution spectral gamma logging system. This effort was part of the baseline characterization for WMA C. The purpose of the baseline characterization was to acquire a baseline of the distribution of individual man-made gamma-emitting radioisotopes (originating from mixed-waste sources) within the vadose zone. Results of the baseline characterization for WMA C are documented in the *Vadose Zone Characterization Project at the Hanford Tank Farms C Tank Farm Report* (GJPO-HAN-18 1998) and associated addendum (GJO-HAN-18 2000) and are summarized in Section C3.4.2. Results of the radionuclide concentration logs for individual drywells were compiled and presented in 12 individual tank summary data reports (GJ-HAN-82, -83, -84, -85, -86, -87, -88, -90, -91, -92, -93, -94).

The baseline characterization and follow-up logging provided a better understanding of where gamma-emitting contamination occurs in the upper part of the vadose zone within WMA C. The major gamma-emitting contaminants associated with WMA C are cesium-137 and cobalt-60 with lesser amounts of europium-154. These contaminants are located mostly in and around areas of known or suspected tank and pipeline leaks. Logging results indicated that the contaminated zones are isolated occurrences and most probably resulted from surface spills and pipeline leaks. Although most of the drywells are deeper than the surrounding contamination, some zones of contamination extend deeper than nearby drywells. Consequently, the maximum depth of vadose zone contamination is not known in some areas of WMA C. GJO-HGLP-1.7.1

describes the tasks and organizational requirements associated with routine vadose zone monitoring operations in the SST farms. Included in the plan are the methods and procedures associated with data evaluation, selection, and prioritization of individual borehole intervals to be logged, scheduling, data acquisition procedures, and reporting.

Figure C3-1. Vadose Zone Monitoring Network for WMA C.



C3.4.2 Vadose Zone Monitoring Results

Estimates for volumes of the contaminated formation and total radioactivity for cesium-137, cobalt-60, and europium-154 were determined for WMA C using data from the 1997 baseline spectral gamma characterization system. Total activity for major gamma emitters (cesium-137, cobalt-60, and europium-154) in the vadose zone is approximately 42 curies in 26,400 m^3 (34,500 yd^3) of soil (soil volume estimate based on extent of cesium-137 contamination). Evaluation of repeat logging data indicates that cobalt-60 movement through the vadose zone has occurred in the past and appears to be continuing (GJO-HAN-18 2000).

Limitations of estimates on the extent of contamination include the following:

- No data are available from directly under the tanks.
- No data are available below the bottoms of drywells. The deepest drywell in WMA C is 47.3 m (155 ft) bgs (well 30-00-03), and the maximum logged depth is 43.6 m (143 ft) bgs in well 30-04-08.

Additional information on the derivation of these estimates is included in GJPO-HAN-18 (1998). Additional information on man-made radionuclide distribution and movement will be discussed in the field investigation report resulting from the WMA C Phase I field investigation.

C3.4.3 Planned Vadose Zone Characterization

The *Site-Specific Single-Shell Tank Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan Addendum for Waste Management Areas C, A-AX, and U* (RPP-16608) describes planned vadose zone characterization for WMA C. Additional vadose zone characterization activities are proposed for WMA C between FY 2003 and FY 2005.

Additional vadose zone characterization information obtained subsequent to preparation of this closure action plan will be documented in a RCRA Facility Investigation (RFI) report pursuant to HFFACO M-45-55. This includes data collected during the drilling and installation of the new groundwater monitoring wells discussed in Section C3.5.5. New data will be incorporated in risk assessment modeling as described in Section C4.2.5.

C3.5 INTERIM STATUS GROUNDWATER MONITORING

At WMA C, RCRA groundwater monitoring is performed according to an interim status groundwater monitoring plan (PNNL-13024, PNNL-13024-ICN-1). The current groundwater monitoring network was designed in accordance with RCRA, as presented in 40 CFR 265, Subpart F.

C3.5.1 Groundwater Monitoring Well Network

The groundwater monitoring network is shown in Figure C2-2. The original groundwater-monitoring network (wells 299-E27-7, -12, -13, -14, and –15) was designed for a flow direction from east to west (WHC-SD-EN-AP-012). Changes in groundwater flow direction necessitated the installation of four additional wells to improve upgradient and downgradient coverage of WMA C. Details of the existing groundwater monitoring network, including well construction information and monitoring efficiencies, are discussed in the WMA C groundwater monitoring plan (PNNL-13024, PNNL-13024-ICN-1). Ecology has expressed concern regarding the model parameters used to evaluate the groundwater monitoring network efficiency [Ecology Letter, October 13, 2002 D. Goswami, Ecology to K.M. Thompson DOE-RL *Monitoring Efficiency Model (MEMO) as Applied to Single-Shell Tank (SST) Farm Waste Management Areas (WMAs)*].

Table C3-2 gives well-by-well information on the position of each well with respect to flow direction, sampling objective, and sampling frequency. The cross gradient, upgradient, and downgradient designations refer to the location of the wells with respect to the southwesterly groundwater flow direction refined based on colloidal borescope measurements (PNNL-13024, PNNL-13024-ICN-1).

Table C3-2. Network Monitoring Wells.

Well Name (299-)	Completion Date	Upgradient Downgradient*	Sampling Objective and Frequency
E27-7	1982	Up	C, SA
			WL, Q
E27-12	1989	Cross	C, SA
			WL, Q
E27-13	1989	Down	C, SA
			WL, Q
E27-14	1989	Cross	C, SA
			WL, Q
E27-15	1989	Marginally up	C, SA
			WL, Q
E27-22	2003	Up	C, SA
			WL, Q
E27-4	2003	Down	C, SA
			WL, Q
E27-21	2003	Marginally Down	C, SA
			WL, Q
E27-23	2003	Down	C, SA
			WL, Q

Source: PNNL-13024, PNNL-13024-ICN-1
* Upgradient/downgradient determintations based on an average groundwater flow direction as defined in PNNL-13024-ICN-1 (2002)
C = chemistry monitoring
Q = quarterly
SA= semi-annual
WL =water level measurement

C3.5.2 Groundwater Sampling and Analysis Plan Overview

The WMA C groundwater monitoring plan (PNNL-13024, PNNL-13024-ICN-1) includes a sampling and analysis plan for the current interim-status groundwater monitoring plan. This sampling and analysis plan describes the quality assurance project plan and the field sampling plan for groundwater monitoring. Procedures for groundwater sampling, sample documentation and preservation, shipment, and chain-of-custody requirements are described in ES-SSPM-001 (1998) and in the quality assurance project plan (PNNL 1998).

C3.5.3 Groundwater Quality Monitoring Results

Results of the groundwater detection indicator evaluation program for WMA C are published annually. The contaminant indicator parameters and the statistical evaluation methodology for the groundwater indicator evaluation program are described in the WMA C groundwater monitoring plan (PNNL-13024, PNNL-13024-ICN-1).

The WMA C groundwater monitoring plan provides historic information on the results of RCRA groundwater monitoring at WMA C since the initiation of routine detection monitoring at that site in 1992. Information on recent and past contaminant issues is provided. There have been recent (1994-1999) small increases in contaminant levels across the WMA. However, the concentrations are generally low. Without a better understanding of local flow direction, it is too early to suggest sources for these small increases in contamination. The critical mean values for the indicator parameters (pH, electrical conductivity, total organic carbon, and total organic halides) have not been exceeded during this time.

Technetium-99 activity has been rising gradually in all the network wells. In well 299-E27-14, it has been increasing since 1994 or earlier (Figure C3-3). The maximum value of 709 pCi/L for this well was reached in December 1999. This concentration is below the drinking water standard (DWS) of 900 pCi/L. Increases in various anion and cation concentrations correspond to the rising technetium-99 trend (Figures C3-3 through C3-7). Until June 1999, nitrate and sodium trends correlated with the technetium-99 activity (Figure C3-8). After September 1999, the nitrate and sodium values ceased to track the technetium-99 upward trend actually decreasing in concentration. As of 2001, the nitrate concentration in this well is about 16,000 μg/L (May 2000), which is well below the DWS of 45,000 μg/L. The calcium chloride and sulfate concentrations continue to track the rising technetium-99 activity (Figures C3-5, C3-6, and C3-7). Maximum sulfate values are about 82,000 μg/L while the calcium value is about 40,000 μg/L. This change in co-contaminant chemistry may be due to chemical heterogeneities within a larger, regional plume.

Figure C3-2. Trend Plot of Technetium-99 at WMA C.

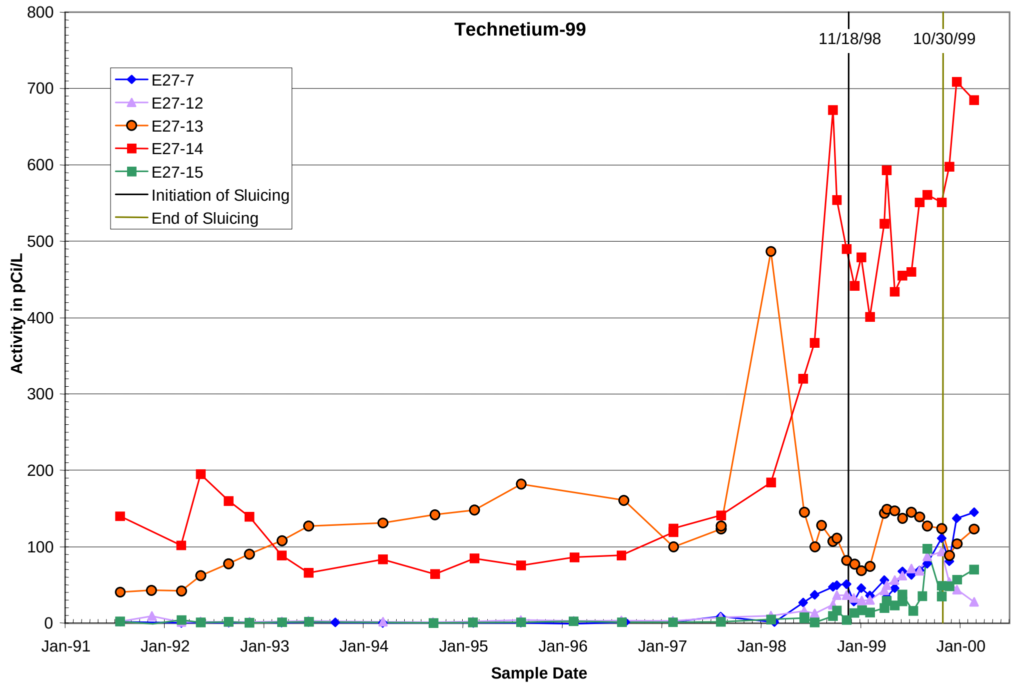


Figure C3-3. Trend Plot of Nitrate at WMA C.

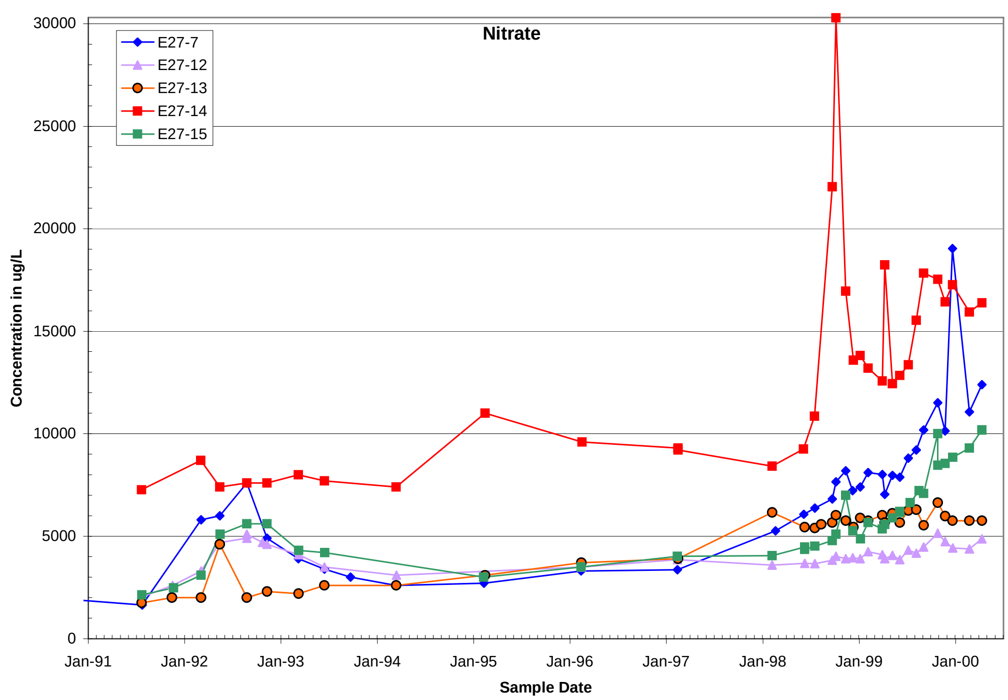


Figure C3-4. Trend Plot of Sodium at WMA C.

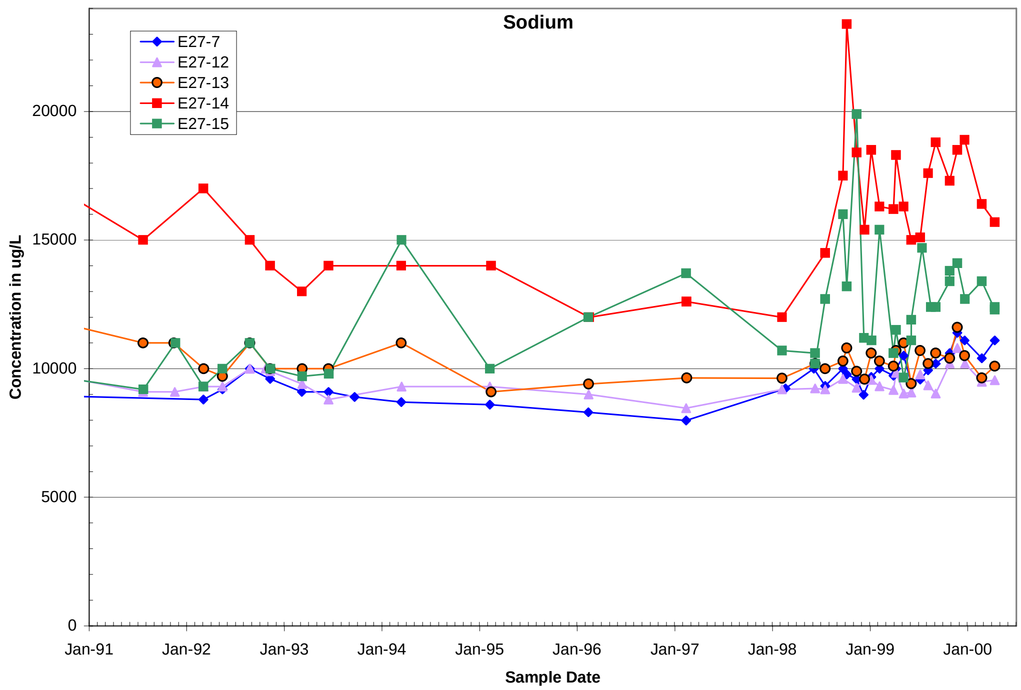


Figure C3-5. Trend Plot of Sulfate at WMA C.

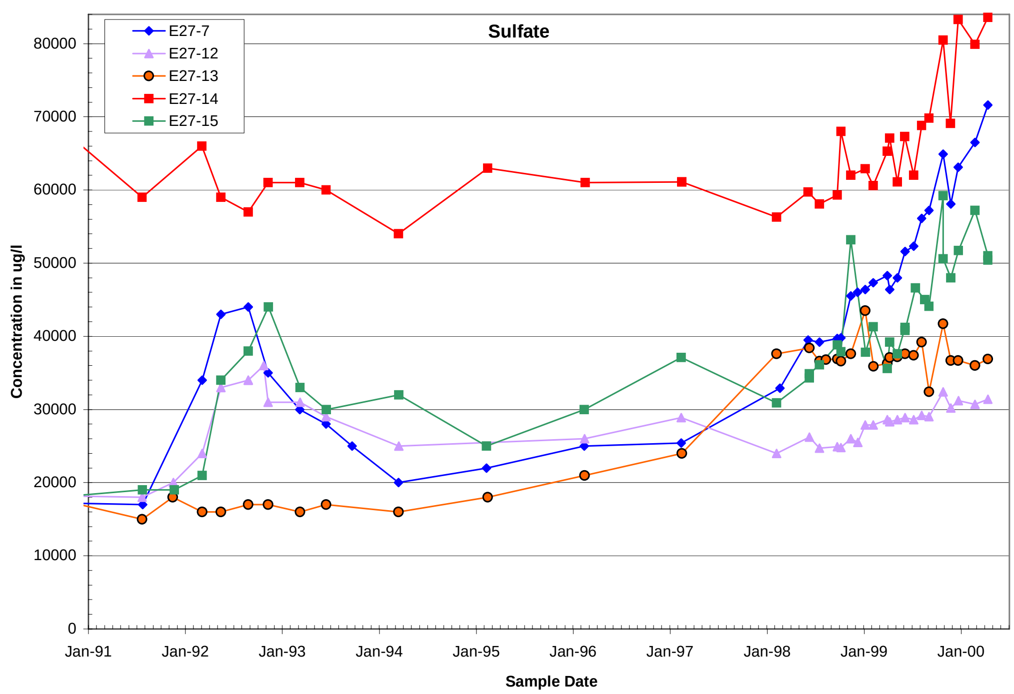


Figure C3-6. Trend Plot of Chloride at WMA C.

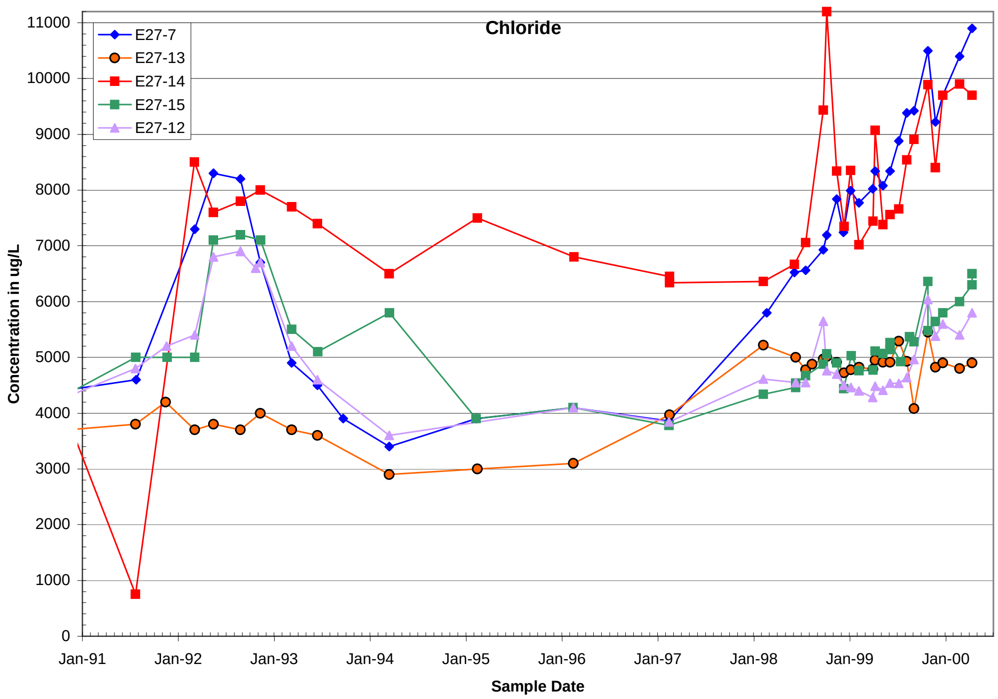


Figure C3-7. Trend Plot of Calcium at WMA C.

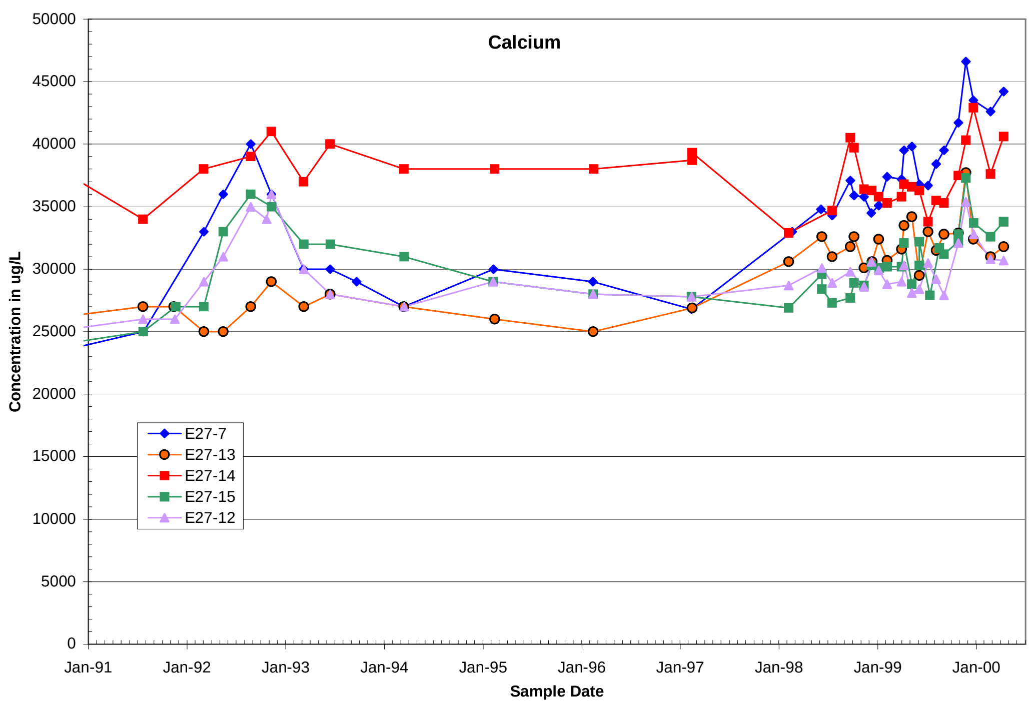
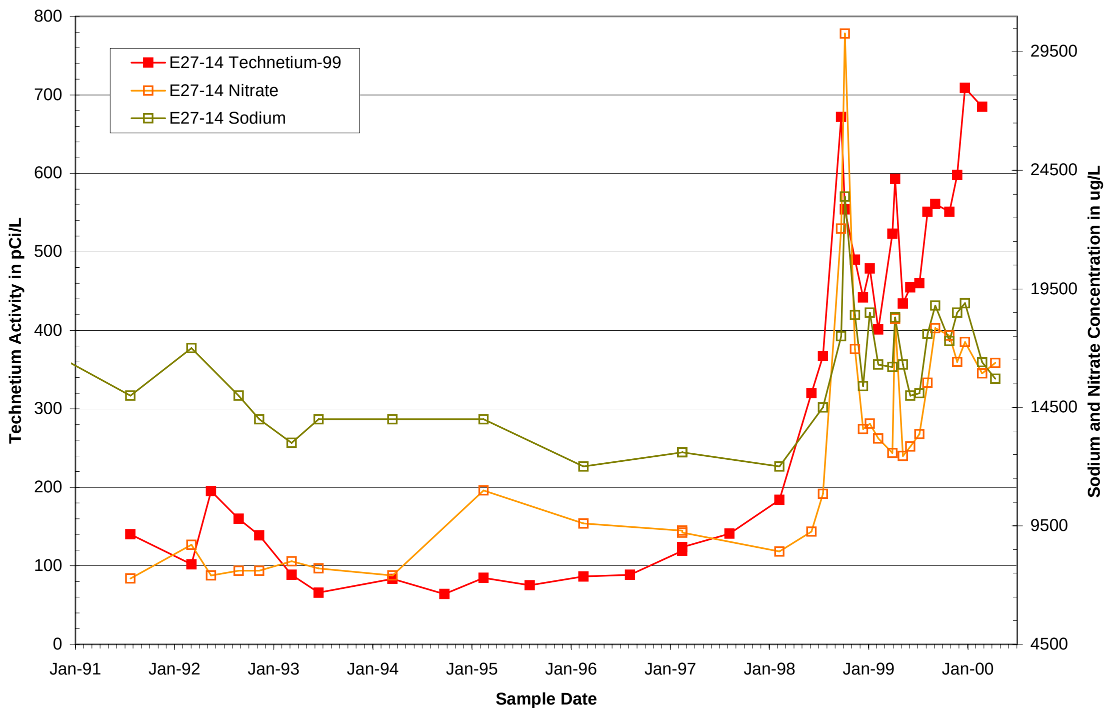


Figure 3-8. Trend Plots for Well 299-E27-14 Comparing Technetium-99 to Nitrate and Sodium.



From November 1998 to October 1999, sluicing operations were performed in C-106. The WMA was temporarily monitored monthly and then bi-monthly to provide additional coverage before, during, and after the recent in-tank sluicing event to increase the ability to detect a leak related to sluicing operations. The period of sluicing is marked in Figure 3-2 by the two vertical lines. As can be seen, the groundwater plume currently impacting the groundwater under the C Farm entered the area several years before sluicing operations began. Thus, the rising contamination in well 299-E27-14 is unlikely to be associated with active sluicing of tank 106.

Just prior to the increases in contamination observed at well 299-E27-14, a single pulse (487 pCi/L) of technetium-99 was observed at well 299-E27-13 in February 1998 (Figure 3-2). Small increases were also observed in nitrate, sulfate, chloride, and calcium at this well. In May 1998, technetium-99 activity returned to historical values of about 150 to 120 pCi/L. It is important to note there were no exceedances of indicator parameters, DWSs, or maximum contaminant levels (MCL) associated with this well. As of 2001, this well has the lowest levels of anions around the WMA except for well 299-E27-12. This elevated technetium-99, seen in 1998, may be associated with the increased contamination currently observed in all the wells around WMA C.

For example, technetium-99 values are rising in 299-E27-7, 299-E27-15, and 299-E27-12; however, activities are below 200 pCi/L. Associated with this overall increase in technetium-99, are sharp increases in sulfate, calcium, and chloride. Although there is some increase in nitrate (Figure 3-3), sulfate, calcium, and chloride are the dominant anions for this event. Since early 1999, the chloride concentration at 10,900 µG/L and the calcium concentration at 46,600 µG/L have risen higher in well 299-E27-7 than in any other network well. Located north of the WMA,

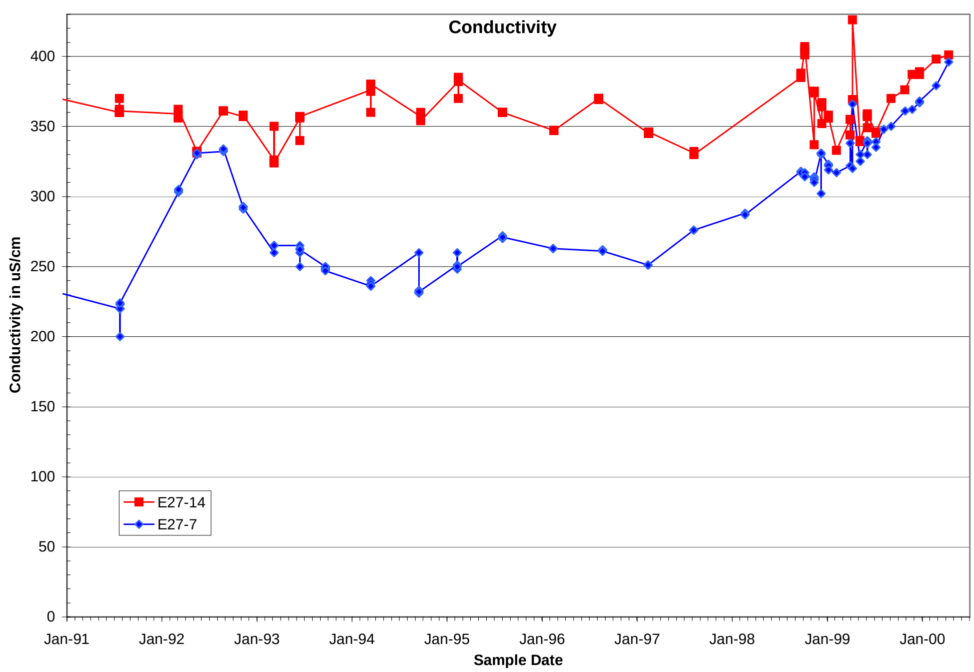
well 299-E27-15 has concentrations also rising sharply. Although sodium has shown increased levels in wells 299-E27-14 and 299-E27-15, it is not clear that sodium is rising with the technetium-99, calcium, sulfate, and chloride seen in the groundwater at the other wells. Typically, sodium is the main cation observed in groundwater contamination associated with processing waste.

Well 299-E27-7 has also recently begun to show low levels of cyanide at 15 µG/L. Cyanide has not been seen in network wells prior to this recent occurrence nor has cobalt-60 been detected in any of the wells. Tanks at WMA C were used for in-tank scavenging with ferrocyanide. The general increase in ionic chemistry is elevating conductivity values up to 400 µS/cm in wells 299-E27-7 and 299-E27-14 (Figure 3-9). Well 299-E27-7 is still considered an upgradient well while it is unclear if well 299-E27-14 is upgradient or crossgradient. It may be necessary to recalculate the critical mean for this site, which is currently 553.5 µS/cm.

Rising sulfate, calcium, and chloride have recently been observed elsewhere in the northern part of the 200 East Area. However, these wells to the north of WMA C are not sampled for technetium-99, although the dominant sulfur and calcium character is similar. Thus, there may be some regional source moving into the area from a northwesterly direction.

There does not appear to be other tank-related wastes in the groundwater. Tritium levels are low, generally less than 1,500 pCi/L, except at well 299-E27-7 where values rose from about 600 pCi/L to 2,500 pCi/L during the late 1990s. As of 2001, the trend is not increasing and remains level at 2,480 pCi/L.

Figure C3-9. Trend Plots of Conductivity for Wells 299-E27-7 and 299-E27-14.



The following summarizes WMA C water chemistry information presented in the FY2001 annual report (PNNL-13788):

- Critical mean values were not exceeded in groundwater for the indicator parameters pH, total organic carbon, and total organic halides in FY2001.
- The critical mean for specific conductance was exceeded in well 299-E27-14 at the end of FY2001. The increase is due primarily to rising concentrations of sulfate and calcium along with nitrate and chloride. Nitric acid was extensively used in chemical processing.
- Low concentrations of cyanide were noted in well 299-E27-7 in FY1999 and FY2000. Concentrations of cyanide decreased in FY2001, and currently are not detected in well 299-E27-7 or any other network monitoring well.
- For information purposes, the following radionuclide information pursuant to AEA authority is summarized.
  - Technetium-99 concentrations continue to increase in all wells at WMA C. Elevated levels of technetium-99 first appeared in well 299-E27-14 in 1997. The greatest increase in FY2001 was measured in well 299-E27-7.
  - Low tritium levels have been observed in groundwater at WMA C. Tritium concentrations in well 299-E27-7 spiked in 1990 but have since stabilized.

The sources for the contamination detected in the groundwater beneath WMA C are not defined (PNNL-13024, PNNL-13024-ICN-1).

C3.5.4 Inspection and Maintenance of Wells

Routine well inspection and maintenance is performed on groundwater monitoring wells to ensure compliance with WAC 173-160, *Minimum Standards for Construction and Maintenance of Wells*. The *Hanford Well Maintenance and Inspection Plan* (BHI-01265) describes the procedures for well maintenance and inspection on the Hanford Site. Routine well maintenance and inspections are performed at least every five years, based on the drilling completion date and the date of the last routine maintenance, whichever is the most recent. Routine well maintenance consists of 1) checking the well pump function, 2) removing the pump, 3) performing a video camera survey, 4) brushing/cleaning the screen or perforations, 5) redeveloping the well, 6) removing fill material and debris from the well bore, and 7) reinstalling the pump.

In addition to the scheduled routine maintenance activities, the well maintenance program addresses nonroutine well maintenance which is performed to keep the well operational (i.e., allow water sampling). Nonroutine well maintenance may consist of replacing sampling pumps, repairing or replacing well tubing, and removing foreign objects from wells. Problems requiring nonroutine maintenance are typically identified during well sampling activities.

Routine and non-routine well maintenance and inspection activities are documented on forms specified in the *Hanford Site Well Management Plan* (DOE/RL-2003-13). Completed forms are entered into the Hanford Records Management Information System (RMIS) and also into the Hanford Well Information System (HWIS) database.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new well should be constructed or if an existing well should be substituted.

C3.5.5 Plans for Monitoring Network Modification and Additional Groundwater Characterization

A data quality objective (DQO) scoping process is underway for the 200 East Area to assess CERCLA remediation performance monitoring, site-wide surveillance monitoring to meet the requirements of the AEA, and detection/assessment monitoring to meet the requirements of RCRA. At the completion of the scoping process, a DQO summary report for the 200 East Area will be issued. This DQO summary report will provide the number, location, and schedule for installing additional groundwater monitoring wells at WMA C. Schedules for installation of new monitoring wells will be developed and detailed per HFFACO Milestone M-24 or the Site-Wide Permit. Four additional groundwater monitoring wells were recently installed and will provide supplementary data for characterizing groundwater flow direction, stratigraphy, vadose zone properties, and groundwater chemistry in the vicinity of WMA C. Additional vadose zone and/or groundwater characterization information will be collected in accordance with the M-45-55 Milestone.

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C4.0 CLOSURE ACTIVITIES

The closure action for WMA C involves conducting closure activities on individual components of the WMA. The WMA C is comprised of four primary types of components: 1) SSTs (including 100 and 200 series), 2) ancillary equipment (piping, diversion boxes, pump pits), 3) soil, and 4) groundwater. Component closure activity plans, or alternate decision documentation such as corrective measures studies or CERCLA RODs upon approval through incorporation into the Site-Wide Permit, will be developed to describe how the components or groups of components will be characterized, disconnected, dismantled, decontaminated, removed, and/or stabilized.

This section describes these component closure activities and presents a relative timeline for the completion of the WMA C closure action, including contingent closure actions for closure as a landfill pursuant to WAC 173-303-640(8)(c). Additionally, the section lists the component closure activities that will contribute to meeting the closure performance standards of WAC 173-303-610(2), -640(8), and -645(3) and HFFACO Milestone M-45.

C4.1 WMA C COMPONENT CLOSURE ACTIVITY RELATIVE TIMELINE

Figure C4-1 presents a relative timeline for the major closure activities necessary to complete the WMA C closure, contingent landfill closure, and contingent postclosure actions. The timeline depicts the relative sequence of the major component activities and the anticipated duration of these activities. Key closure dates have been developed and are described in HFFACO Milestone M-45. The first three columns (left to right) presented in the timeline represent intervals during which closure activities associated with each tier of the *SST System Closure Plan* strategy occur. The fourth column represents Hanford's long-term stewardship program. A general summary of each of the four columns follows. A more detailed discussion of the closure activities is presented in Section C4.2.

1. Column One: Performance of the major component closure activities is presented in column one. Initiation of these activities is currently underway with the retrieval of tank C-106. The relative starting points for the ancillary equipment, soil, and groundwater component closure activities are staggered to depict the most logical order for conducting these activities. The dotted vertical line on the right side of the column denotes that a final activity (such as implementation of the surface barrier as a contingent final remediation method) may be necessary to complete one or all of the component closure activities. Groundwater component closure activities extend beyond the dotted line because completion of this component activity is largely determined by programs outside the SST RCRA closure program (such as CERCLA Operable Unit corrective actions and the Central Plateau closure strategies) and can likely be implemented without impacting ongoing WMA C-specific closure actions.

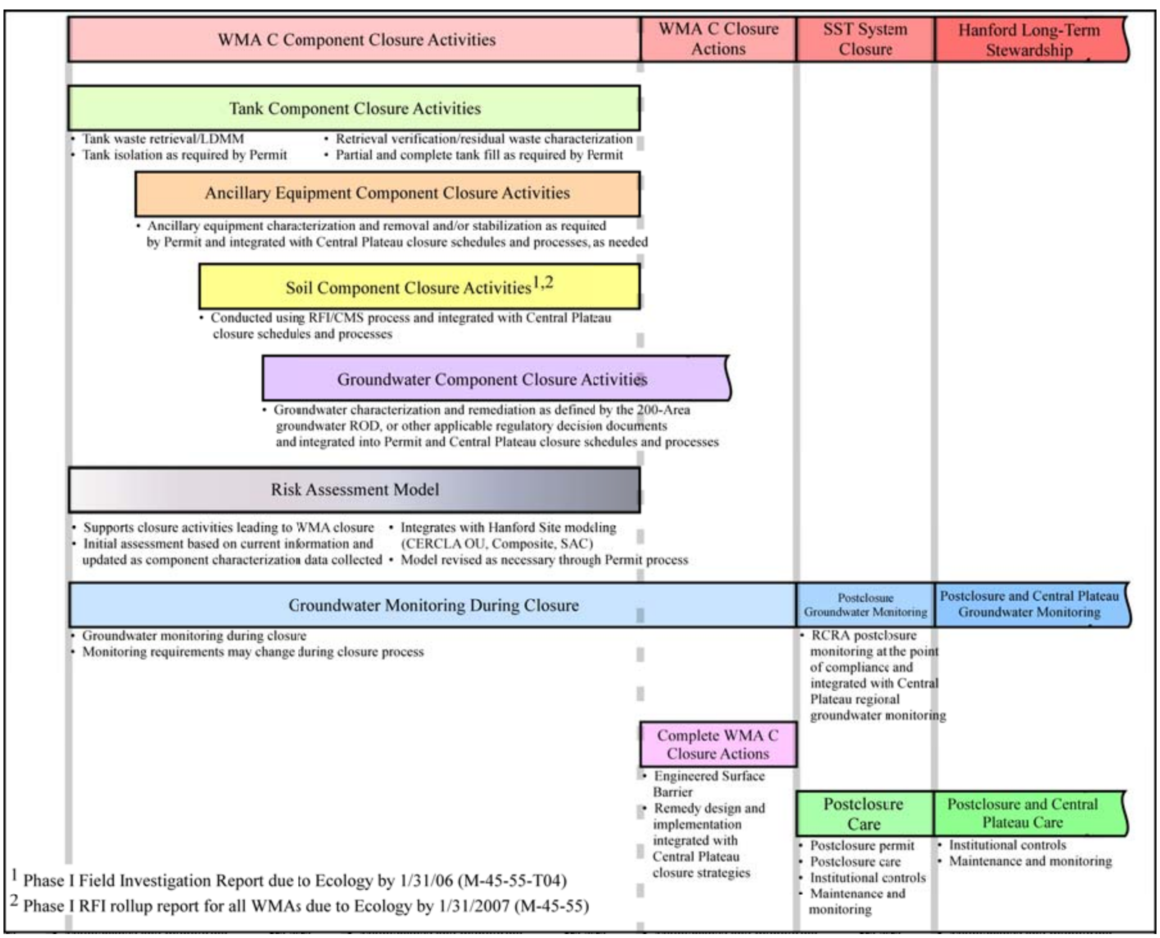
2. Column Two: The second column represents the period during which all WMA C closure activities are completed. This period begins when all of the SSTs within a WMA have

been retrieved, isolated, and filled, and the ancillary equipment and soils have been characterized and appropriately dispositioned. Completion of the WMA closure action occurs when the final remedy (such as the contingent landfill closure engineered surface barrier) for the WMA has been implemented.

3. Column Three: The third column represents the period when the final WMA remedy has been implemented and the contingent WMA postclosure activities, if required, are initiated. A contingent postclosure plan will be developed to define these activities. During this period, other WMA closure actions within the SST system will be ongoing. The period ends when the final WMA closure action is completed.

4. Column Four: The fourth column depicts the integration of any SST postclosure activities with the Hanford long-term stewardship program. Since the SST WMAs are located in the 200 Areas, the postclosure activities will be integrated as specified in the Site-Wide Permit with the Central Plateau closure strategies currently under development by Ecology, EPA, and DOE.

Figure C4-1. Relative Timeline of Major Activities for Closure of WMA C.



C4.2 COMPONENT CLOSURE ACTIVITY DESCRIPTIONS

The following section describes the component closure activities associated with the WMA C closure and postclosure actions. Future characterization activities within WMA C will produce new information. Information pertinent to making closure decisions will be provided as necessary in accordance with the WAC 173-303-830 permit modification process.

C4.2.1 Tank Component Closure Activities

The tank components consist of twelve 100-series SSTs and four 200-series SSTs. Physical tank descriptions and historical process knowledge associated with the WMA C tanks are provided in Section C2.0. Additional detail for individual or groupings of tanks will be provided in the respective component closure activity plans.

Closure of the individual tanks occurs in three major steps: 1) tank waste retrieval, 2) tank stabilization, and 3) physical and administrative isolation of the tank. Each of these steps will be described in the respective component closure activity plans. A general description of these steps follows.

HFFACO Milestone M-45-00 states: "Closure will follow retrieval of as much tank waste as technically possible, with waste residues not to exceed 360 ft^3 in each of the 100-series tanks, 30 ft^3 in each of the 200-series tanks, or the limit of waste retrieval technology capability, whichever is less." DOE will retrieve as much waste as technically possible, with a remaining residual of no more than 360 ft^3 for the 100-series tanks and 30 ft^3 for the 200-servies tanks. Following retrieval activities, DOE will use in-tank survey methods to determine whether retrieval volume criteria have been met. Also as part of this milestone a data report will be submitted to Ecology for approval to demonstrate completion of retrieval in accordance with M-45-00. For tanks that are not subject to milestones, an Ecology-approved data report will also be required to demonstrate completion of retrieval. In addition, the residual will be characterized to support risk assessments. DOE will follow a DQO process for conducting the tank waste characterization activities. As part of the DQO process, characterization requirements will be documented in tank-specific Component Closure Action Data Quality Objectives. DOE will request approval of the DQO by Ecology. The DQO will be attached to or referenced by the respective component closure activity plan.

If the residual waste in individual tanks meets the retrieval criteria and the risk metrics related to the residual waste are accepted, DOE will modify the closure activity plan and the Site-Wide Permit, if necessary, and then proceed with implementing the approved component closure activity plan. If residual waste exceeds the retrieval criteria, DOE will either attempt additional retrieval or request an exception to the retrieval criteria. This request will be prepared pursuant to the procedure in HFFACO, Appendix H, Attachment 2.

Tanks C-104 and C-106 have HFFACO milestones for retrieval and closure. The retrieval sequence for the remaining WMA C tanks is updated annually in accordance with HFFACO Milestone M-45-02. Section C6.0 lists the HFFACO Milestone M-45 series associated with

retrieval and closure operations for these tanks. In addition, tanks C-201, C-202, C-203, and C-204, which are outside of HFFACO milestone commitments, are being retrieved in FY 2004 as defined in the *Specification for the 241-C-200 Series Waste Retrieval System* (RPP-14075). Revisions to the WMA Closure Action Plan and addition of closure activity plans for these tanks as attachments to this plan will be forthcoming in this time frame.

Process Control Plan for Tank 241-C-106 Closure (RPP-13707) and *Process Control Plan for 241-C-106 Acid Dissolution* (RPP-16462) describe the technical operating controls for the waste retrieval and transfer of liquid wastes to the DST system. RPP-13707 includes a description of tank conditions, waste conditions, major equipment, overall process operating strategy, responses to off-normal conditions, and leak detection monitoring and mitigation. A 'Retrieval Functions and Requirements' document will be developed for each tank or group of tanks before commencement of retrieval operations within the WMA C. Additional detail on waste retrieval for individual tanks or groups of tanks will be documented in the respective component closure activity plans.

Once the waste retrieval criteria are met and risks associated with remaining contaminants are determined to be acceptable by Ecology, each tank will be stabilized. Generally, tank stabilization consists of adding grout* in layers in the retrieved tanks. For example, the stabilization approach proposed for C-106 is the addition of three grout* layers as follows:

- Phase I layer will be composed of a free-flowing cementitious grout*.
- Phase II layer will provide structural stability and fill the majority of the tank volume.
- Phase III fill will be a high-compressive-strength grout* designed to deter inadvertent intrusion of the tank from future drilling or excavation activities.

Stabilization activities may differ from tank to tank depending primarily on the volume and characteristics of the residual waste remaining after retrieval and the integrity of the tank. Additionally, information obtained from the field deployment and grout placement* demonstration at C-106 may alter emplacement methodology and grout recipes for future tank stabilization efforts in WMA C. Planned stabilization activities will be documented in the respective tank component closure activity plans.

Physical and administrative isolation of the tanks will occur before and after the tank retrieval and tank stabilization activities. Physical isolation refers to filling (such as by grouting*) and/or capping of pipelines, drains, ducting or other openings into the tank structure to prevent inadvertent liquid introduction. Physical isolation will occur progressively as individual tanks near final stabilization. Administrative isolation, such as lock and tag, controls tank access through procedural actions. Both physical and administrative isolation measures are intended to prevent inadvertent filling of adjacent tanks, lines, and equipment. Additional detail on

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* See Preface in *SST System Closure Plan* (RPP-13774).

implementation of tank isolation will be documented in the respective tank component closure activity plan.

C4.2.2 Ancillary Equipment Closure Activities

Ancillary equipment refers to steel, concrete, electrical, and other equipment both internal and external to the tank including pipelines, conduit, pits, diversion boxes, ventilation systems, electrical/service connections, tank risers, pumps, measuring equipment (such as liquid level detection systems, and thermocouples), shield plugs, and dip legs. A listing of ancillary equipment associated with WMA C is included in Table C2-2.

There are uncertainties associated with the level of contamination contained in ancillary equipment and with potential difficulties in accessing buried equipment. Disposition of in-tank ancillary equipment (such as in-tank measuring equipment and tank risers) will be described in the respective tank component closure activity plans. In-tank equipment will be dispositioned as in-tank debris during the tank closure activity. Disposition of ex-tank ancillary equipment (such as pipelines, diversion boxes, and cascade lines) will be described in either an ancillary equipment component closure activity plan, tank component closure activity plan, or other alternate decision documentation such as a corrective measures study or ROD upon approval through incorporation into the SST system chapter of the Site-Wide Permit. Integration activities for remediating ex-tank ancillary equipment are expected to be developed through the *SST System Implementation Plan* pursuant to HFFACO Milestone M-45-06-T20.

Ancillary equipment closure activities will be integrated as appropriate with soil and groundwater component closure activities and with the Ecology, EPA, and DOE Central Plateau regional closure strategies currently under development. Coordination of these integration actions is expected to occur through modification of the *SST System Implementation Plan*.

C4.2.3 Soils Component Closure Activities

The two primary steps in the WMA C soil component closure activities are 1) characterizing the nature, extent, and mobility of the contamination in the soil column, and 2) performing necessary cleanup in accordance with WAC 173-303-610 and –645. Characterization of soils will involve an assessment of known and suspected contamination. DQOs will be developed to ensure appropriate characterization data are collected to support the soil component closure activities. Characterization information will be used to assess the relative risk associated with the soil component. A corrective measures analysis based on the risk assessment will be conducted to define the appropriate remediation methodologies. Finally, the corrective measures alternative(s) will be implemented.

Soil characterization and corrective measures activities will be integrated as appropriate with ancillary equipment and groundwater component closure activities and with the Ecology, EPA, and DOE Central Plateau regional closure strategies currently under development. Coordination of these integration actions is expected to occur through the *SST System Implementation Plan*

pursuant to HFFACO Milestone M-45-06-T20. After regional closure strategies are finalized, the WMA C closure plan will be modified in accordance with WAC 173-303-830.

C4.2.4 Groundwater Component Closure Activities

The two primary steps in groundwater component closure activities are 1) characterizing the nature and extent of contamination, and 2) performing necessary corrective measures. Characterization of groundwater will involve an assessment of groundwater conditions based on existing groundwater monitoring data and supplemental groundwater data obtained throughout the course of field investigations. DQOs will be developed to ensure appropriate characterization data are collected to support subsequent groundwater component closure activities. Groundwater characterization will be conducted as a groundwater component closure activity under the auspices of WMA C closure actions and may be coordinated with soil component characterization efforts. Characterization information will be used to assess the relative risk associated with the groundwater component. A corrective measures alternatives analysis based on the risk assessment will be conducted to define the appropriate corrective measures.

In the event that it is determined that groundwater corrective measures are necessary, groundwater remediation may be performed pursuant to a RCRA corrective action or CERCLA ROD developed for the 200-PO-1 groundwater operable unit upon approval through incorporation into the Site-Wide Permit. Groundwater monitoring and response actions are integrated within the context of HFFACO Milestones M-24 and M-45 and, as feasible, will be integrated with the Central Plateau regional closure strategy. After groundwater regional strategies are finalized, the WMA C closure plan will be modified in accordance with WAC 173-303-830 to incorporate and/or change the WMA C groundwater monitoring network and/or program description.

C4.2.5 Risk Assessment Model

As described in Section C5.0 and depicted in the relative timeline (Figure C4-1), the risk assessment model developed for the WMA C will be used to support the decision-making processes during the various component closure activities described above. The purpose of the risk assessment is to demonstrate that the planned closure conditions meet the performance objectives. The risk assessment strategy will be implemented at the WMA level in a manner that will allow evaluation of risk contribution from individual components (such as individual tanks, groups of tanks, soil, ancillary equipment, and groundwater) or the entire WMA. The initial assessment will be performed based on current information, such as the BBI for the tank waste, geophysical vadose zone data, and groundwater monitoring data. The initial assessment will be refined by incorporating the results of new field and engineering data obtained as the WMA closure action matures. An iterative approach will allow the level of uncertainty in risk estimates to be progressively reduced as closure activities move from single component activities to eventual closure of the WMA C. New data generated from the major characterization efforts (such as for ancillary equipment and soil) will be documented in Interim-Closure Data Reports as attachments to the Risk Assessment description in Addendum C1.

The WMA C risk assessment will be integrated with other Hanford Site modeling efforts, such as those supporting nearby CERCLA-related characterization and cleanup, Central Plateau strategy development, and the composite analysis.

The System Assessment Capability (SAC) is a computational tool for use in preparing the Hanford site-wide composite analysis of long-term impacts to groundwater. The WMA C risk assessment will be integrated with the SAC by preparing a constituent breakthrough curve for constituents at the water table underlying the WMA. This data set will be inserted into the SAC computations to represent the WMA as a point source in the composite analysis, as available. This will allow the localized fate and transport analysis performed at the WMA level to be directly integrated into the large-scale analysis performed by the SAC. However, output from the SAC will not make any of the cleanup levels for WMA C any less stringent than the regulatory requirements.

C4.2.6 Groundwater Monitoring

During the time that WMA C component closure activities are underway and until WMA closure is achieved, groundwater monitoring will be conducted according to the current groundwater monitoring plan (PNNL-13024, PNNL-13024-ICN-1) or future modifications to that plan as implemented. WMA C specific groundwater monitoring will occur at the WMA C point of compliance. It is recognized that groundwater monitoring at WMA C may support numerous environmental and regulatory data needs, including evaluating the sources of groundwater and vadose contamination, the fate and transport of existing and potential future releases, and long-term risk assessment for purposes of developing component closure performance standards and postclosure care requirements. Groundwater monitoring will be coordinated with these activities, CERCLA remediation, and other site-wide activities as feasible. In addition, those monitoring wells deemed no longer useful (for regulatory purposes or due to a declining water table) will be decommissioned as necessary.

Prior to closure of WMA C, a postclosure groundwater-monitoring plan will be developed as part of the future modifications to the postclosure care plan (WAC 173-303-665(6)(b)(iv)). Postclosure groundwater monitoring will be integrated with the groundwater monitoring approach currently being developed by DOE, EPA, and Ecology as part of the Hanford groundwater strategy.

C4.2.7 Complete WMA Closure Actions

After completion of the tank, ancillary equipment, and soil component closure activities, any remaining closure activities for WMA C will be implemented. During this period, planning and implementation of the final remedy for the WMA C closure action will be conducted. Several factors will be considered for planning the completion of the WMA C closure action:

- Actions necessary to comply with the general performance standards and extent of removal or decontamination of dangerous wastes, waste residues, equipment, and soils

and groundwater containing or contaminated with dangerous waste or waste residue, as discussed in Section C4.3

- Groundwater monitoring at the WMA C point of compliance as necessary to comply with groundwater protection standards
- A risk assessment using site-specific characterization data obtained during the various component closure activities
- Characterization and/or remedial design information from contiguous waste sites
- The 200 Area CERCLA RODs, if available
- Central Plateau closure strategies, if available.

Should removal or decontamination of dangerous waste constituents not be achievable at WMA C, the proposed contingent final remedy for WMA C is closure in accordance with WAC 173-303-665 with the installation of an engineered surface barrier.

Engineered surface barriers are constructed to cover contaminated waste sites to minimize infiltration of precipitation and inhibit contact of moisture with contaminated media, and thus reduce or eliminate potential leaching of contamination to groundwater. In addition to their hydrological performance, barriers function to prevent intrusion by human and ecological receptors, limit wind and water erosion, and attenuate radiation from covered contaminants. The performance standards for barriers under the requirements of WAC 173-303-665 are discussed in Section C4.3. Surface barrier designs developed for application to waste sites located within the Hanford Site 200 Areas will meet or exceed RCRA design criteria, as well as incorporate established long-term performance and maintenance objectives and specified design criteria. A site-specific evaluation will be done to ensure that a surface barrier design candidate is appropriate for specific WMA C characteristics and will be ultimately incorporated into the Site-Wide Permit.

Applicable or relevant and appropriate requirements (ARARs) and technical guidance pertaining to surface barrier design for various RCRA TSD scenarios at the Hanford Site are currently defined in *Focused Feasibility Study of Engineered Barriers for Waste Management Units in 200 Areas* (DOE/RL-93-33). Based on current knowledge of waste sources associated with WMA C, it is anticipated that the minimum design criteria required for the waste site would be the modified RCRA Subtitle C Barrier, as defined in this report. However, any final barrier design will be incorporated into this permit prior to installation. Additional factors that may be considered in barrier design are aspects of risk and performance assessment modeling.

Contingent actions for barrier design and installation of the surface barrier over WMA C would be integrated with Central Plateau regional closure strategies. Additionally, barrier design criteria may need to be modified if the barrier cover encompasses multiple contiguous waste sites.

When the construction of the WMA C engineered surface barrier is complete, the barrier and surrounding disturbed area would be revegetated to further enhance evapotranspiration, limit erosion, and blend the site area into the surrounding landscape of the Central Plateau. Performance monitoring will be implemented to ensure the surface barrier is performing as designed. Monitoring the continued integrity of the surface barrier would be accomplished through visual inspection and will be supplemented with groundwater sampling. The long-term effectiveness of the surface barriers in the Central Plateau depends on maintaining each barrier throughout the natural attenuation of contaminants under its cover to prevent exposure to potential receptors. Maintenance activities would include erosion repairs and possible vegetation maintenance. Subsidence is not considered a major factor in maintenance activities for Central Plateau waste site barriers.

C4.2.8 Postclosure Care

Postclosure care activities would commence at completion of the installation of the final remedial action (such as the engineered surface barrier) if necessary, and would be defined in a postclosure permit. These activities would also satisfy groundwater protection standards. These activities would be integrated with the Hanford Site long-term stewardship program and the Central Plateau closure strategies. A discussion of future postclosure activities is found in Section C8.0.

C4.3 DETERMINATION OF COMPLIANCE WITH CLOSURE PERFORMANCE STANDARDS

The component closure activities and WMA closure actions are intended to satisfy general closure performance standard (WAC 173-303-610(2)), the tank closure standards (WAC 173-303-640(8)) and, should removal or decontamination of dangerous waste constituents not comply with those specified in WAC 173-303-610(2)(b), the landfill closure standards (WAC 173-303-665(6)). The key regulatory language is set forth below in quotations. The corresponding actions that DOE will undertake to meet the standards are shown in italics preceded by checkmarks.

"-610 (2) Closure performance standard. The owner or operator must close a facility in a manner that:

(a)(i) Minimizes the need for further maintenance;"

- ✓ *Retrieval of waste from WMA tanks*
- ✓ *Stabilization and isolation of WMA tanks*
- ✓ *Ancillary equipment removal, isolation, and/or stabilization, as required*
- ✓ *Contaminated soil remediation, as required*
- ✓ *Surface barrier placement, if required*

(ii) "Controls, minimizes or eliminates to the extent necessary to protect human health and the environment, postclosure escape of dangerous waste, dangerous

constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground, surface water, or atmosphere"

- ✓ *Retrieval of waste from WMA tanks*
- ✓ *Stabilization and isolation of WMA tanks*
- ✓ *Ancillary equipment removal, isolation, and/or stabilization, as required*
- ✓ *Contaminated soil remediation , as required*
- ✓ *Surface barrier placement, if required*
- ✓ *Groundwater closure actions (coordinated with CERCLA groundwater operable unit remediation)*

(iii) "Returns the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity."

- ✓ *Actions may include recontouring and revegetation, or placement of manmade surfaces depending on the nature of the land use determined appropriate following closure*
- ✓ *Surface barrier placement, if required*

(b) "Where the closure requirements of this section, or of WAC 173-303-630(10), 173-303-640(8), 173-303-650(6), 173-303-655(6), 173-303-655(8), 173-303-660(9), 173-303-665(6), 173-303-670(8), 173-303-680(2) through (4), or 40 CFR 264.1102 (incorporated by reference at WAC 173-303-695) call for the removal or decontamination of dangerous wastes, waste residues, or equipment, bases, liners, soils or other materials containing or contaminated with dangerous wastes or waste residue, then such removal or decontamination must assure that the levels of dangerous waste or dangerous waste constituents or residues do not exceed:

(i) For soils, ground water, surface water, and air, the numeric cleanup levels calculated using residential exposure assumptions according to the Model Toxics Control Act Regulations, chapter 173-340 WAC as now or hereafter amended. Primarily, these will be numeric cleanup levels calculated according to MTCA Method B, although MTCA Method A may be used as appropriate, see WAC 173-340-700 through 173-340-760, excluding WAC 173-340-745; and"

- ✓ *Contaminated soil remediation , as required*
- ✓ *Groundwater closure actions (coordinated with CERCLA groundwater operable unit remediation)*

(ii) "For all structures, equipment, bases, liners, etc., clean closure standards will be set by the department on a case-by case basis in accordance with the closure performance standards of WAC 173-303-610 (2)(a)(ii) and in a manner that minimizes or eliminates postclosure escape of dangerous waste constituents."

- ✓ *Retrieval of waste from WMA tanks*
- ✓ *Ancillary equipment removal, isolation, and/or stabilization, as required*

The closure requirements for tank systems, WAC 173-303-640(8), read as follows:

(a) "At closure of a tank system, the owner or operator must remove or decontaminate all waste residue, contaminated containment system components (liners, etc.),

contaminated soils, and structures and equipment contaminated with waste and manage them as dangerous waste, unless WAC 173-303-070(2)(a) applies. The closure plan, closure activities, cost estimates for closure, and financial responsibility for tank systems must meet all of the requirements specified in WAC 173-303-610 and 173-303-620."

- ✓ *Retrieval of waste from WMA tanks*
- ✓ *Ancillary equipment removal, isolation, and/or stabilization, as required*
- ✓ *Contaminated soil remediation, as required*
- ✓ *Groundwater closure actions (coordinated with CERCLA groundwater operable unit remediation)*
- ✓ *Waste managed as dangerous waste and sent for storage and ultimate treatment at a permitted treatment facility.*

(b) "If the owner or operator demonstrates that not all contaminated soils can be practicably removed or decontaminated as required in (a) of this subsection, then the owner or operator must close the tank system and perform postclosure care in accordance with the closure and postclosure care requirements that apply to landfills (see WAC 173-303-665(6)). In addition, for the purposes of closure, postclosure, and financial responsibility, such a tank system is then considered to be a landfill, and the owner or operator must meet all of the requirements for landfills specified in WAC 173-303-610 and 173-303-620."

- ✓ *Surface barrier design and placement*
- ✓ *Submittal and approval of Postclosure Permit Application through modification of the Site-Wide Permit*
- ✓ *Postclosure maintenance and monitoring*
- ✓ *Institutional controls*

(c) "If an owner or operator has a tank system that does not have secondary containment that meets the requirements of subsection 4(b) through (f) of this section and is not exempt from the secondary containment requirements in accordance with subsection 4(g) of this section, then:

(i) The closure plan for the tank system must include both a plan for complying with (a) of the subsection and a contingent plan for complying with (b) of this subsection."

- ✓ *Approval of SST System Closure Plan and modification of the Site-Wide Permit*
- ✓ *Further modification of the Site-Wide Permit to include future component closure activities, soil corrective measures, and groundwater remedial actions*

(ii) "A contingent postclosure plan for complying with (b) of this subsection must be prepared and submitted as part of the permit application."

- ✓ *Submittal and approval of Postclosure Permit Application through modification of the Site-Wide Permit*

(iii) "The cost estimates calculated for closure and postclosure care must reflect the costs of complying with the contingent closure plan and the contingent

postclosure plan, if those costs are greater than the costs of complying with the closure plan prepared for the expected closure under (a) of this subsection (not applicable)."

(iv) "Financial assurance must be based on the cost estimates in (c)(iii) of this subsection (not applicable)."

(v) "For the purposes of the contingent closure and postclosure plans, such a tank system is considered to be a landfill, and the contingent plans must meet all of the closure, postclosure, and financial responsibility requirements for landfills under this chapter (WAC 173-303-610 and 173-303-620)."

- ✓ *Surface barrier design and placement*
- ✓ *Submittal and approval of Postclosure Permit Application through modification of the Site-Wide Permit*
- ✓ *Postclosure maintenance and monitoring*
- ✓ *Institutional controls*

The closure requirements for landfills, WAC 173-303-665(6), read as follows:

(a) "At final closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill or cell with a final cover designed and constructed to:

(i) Provide long-term minimization of migration of liquids through the closed landfill."

- ✓ *Surface barrier design and placement*

(ii) "Function with minimum maintenance."

- ✓ *Surface barrier design and placement*

(iii) "Promote drainage and minimize erosion or abrasion of the cover."

- ✓ *Surface barrier design and placement*

(iv) "Accommodate settling and subsidence so that the cover's integrity is maintained."

- ✓ *Surface barrier design and placement*

(v) "Have a permeability less that or equal to the permeability of any bottom liner system or natural subsoils present."

- ✓ *Surface barrier design and placement*

(b) "After final closure, the owner or operator must comply with all postclosure requirements contained in WAC 173-303-610(7), (8), (9), and (10), including maintenance and monitoring throughout the postclosure care period. The owner or operator must:

(i) Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events."

- ✓ *Postclosure maintenance and monitoring*

(ii) "Maintain and monitor the leak detection system in accordance with subsections (2)(h) and (4)(c) of this section, where such a system is present between double liner systems. (not applicable)

(iii) Continue to operate the leachate collection and removal system until leachate is no longer detected. (not applicable)

(iv) Maintain and monitor the groundwater monitoring system and comply with all other applicable requirements of WAC 173-303-645."

- ✓ *Postclosure groundwater monitoring system*

(v) "Prevent run-on and run-off from eroding or otherwise damaging the final cover."

- ✓ *Postclosure maintenance and monitoring*

(vi) "Protect and maintain surveyed benchmarks used in complying with subsection (5) of this section."

- ✓ *Postclosure maintenance and monitoring*

The postclosure care requirements for dangerous waste facilities are specified in WAC 173-303-610(7):

(a) "Postclosure care for each dangerous waste management unit subject to postclosure requirements must begin after completion of closure of the unit and continue for thirty years after that date and must consist of at least the following:

(i) Groundwater monitoring and reporting as required by WAC 173-303-645, 173-303-650, 173-303-655, 173-303-660, 173-303-665, 173-303-680, and"

- ✓ *Postclosure groundwater monitoring system*

(ii) "Maintenance and monitoring of waste containment systems as applicable."

- ✓ *Postclosure maintenance and monitoring*

(d) "Postclosure use of property on or in which dangerous wastes remain after partial or final closure must never be allowed to disturb the integrity of the final cover, liner(s) or any other components of any containment systems,. . . :"

- ✓ *Postclosure maintenance and monitoring*
- ✓ *Institutional controls*
- ✓ *Deed restrictions*

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C5.0 WMA RISK EVALUATION

Under the HFFACO, the Hanford Site SSTs are RCRA hazardous waste management units that will be eventually closed under Washington State "Dangerous Waste Regulations" (WAC 173-303). The risk assessment described in this closure action plan is intended to meet the requirements for closure risk assessment.

This section presents a summary of the initial estimates of the long-term human health associated with the closure of WMA C, an initial assessment of the impacts to workers, and an evaluation of risks posed by potential accident scenarios. The risk assessment assumes wastes or waste constituents are left within the WMA and that a surface barrier and postclosure care are required. Both radiological as well as dangerous waste constituents are included in the risk assessment consistent with HFFACO Action Plan, Section 6.3.2.

Only a summary of the results are provided in this Section C5.0; Addendum C-1 provides the complete risk assessment. Section 3.0 of the Addendum provides the methodology, assumptions, and conceptual model; Section 4.0 provides the numerical results and sensitivity analysis; Section 5.0 lists exposure scenarios; Section 6.0 gives the limitations and uncertainty; Section 7.0 provides the long-term risks related to groundwater; and Sections 8 and 9 provide short-term risk assessment related to closure activities.

The selection of times and points of assessment comply with past agreements (*Contents of Risk Assessments to Support the Retrieval and Closure of Tanks for the Washington State Department of Ecology* [RPP-14284]) and attempts to maximize information provided to decision makers. This assessment represents the first in a series of iterative risk assessments for WMA C. Additional risk assessments will be conducted as wastes are removed from the individual tanks within WMA C, as characterization activities continue, and as other important information is collected.

The simulated peak values for each of the source terms in the groundwater pathway evaluated are given in Table C5-1 for a number of different metrics (additional metrics can be found in Addendums C1 and C2). The risk assessment concludes that that all source terms are below the MCL Derived Constituent Concentration of technetium-99 (900 pCi/L) (note only the chemicals that provide the majority of the risk are presented here (see Addendum C1 Table 28). All source terms are below the incremental lifetime cancer risk (ILCR) of 1.0E-05 for the *Hanford Site Risk Assessment Methodology* (HSRAM, DOE/RL-91-45) industrial use scenario, but only residuals left in pipelines are below the performance objective for the HSRAM residential-user scenario. All source terms are below the radiological dose performance objective of 25 mrem in a year for the HSRAM All-Pathways Farmer.

As one moves downgradient from the WMA C fenceline to the 200 Area Core Zone Boundary (2,900 m [9,500 ft] from the WMA C fenceline) and the Columbia River (14,300 m [47,000 ft] from the WMA C fenceline), the simulated peaks (concentration, radiological dose, ILCR, and HI) drop by a factor of approximately 6 (Core Zone Boundary) and 18 (Columbia River) for non-sorbed mobile contaminants.

Table C5-1. Simulated Peak Values for Simulated Source Terms for Selected Metrics.[1]

Simulated Source Term	Concentration (pCi/L)		ILCR		Radiological Dose (mrem/yr)[3]
	Tc-99	I-129	Industrial	Residential	All-Pathways Farmer
Tank Residual	66	0.14	1.0E-6	2.3E-05	0.19
Hypothetical Retrieval Leaks	416	0.82	6.5E-6	1.4E-4	1.2
Pipeline Residuals	7.4	0.015	1.1E-7	2.6E-6	0.022
Past Unplanned Releases	497	0.96	8.1E-6	1.8E-4	1.7

[1] Additional Metrics can be found sections 4.3, 7.3-7.7 of Addendum C1, and Addendum C2
[2] Only technetium-99 and iodine-129 are presented, because these contaminants are the primary risk drivers (Table 28 of Addendum C1)
[3] effective dose equivalent (EDE)

This risk assessment was developed to show our present understanding of the risks associated with closure of WMA C as a landfill. However, significant limitations and uncertainties exist in this preliminary risk assessment of WMA C. Figure 4-2 of the *Framework Plan for Single Shell System Closure Plan* – Tier 1 (RPP-13774) conceptually shows how this uncertainty is addressed through a series of circles that represent uncertainty with the circles becoming smaller as more data is collected and the uncertainty about a parameter is reduced. Since this is a preliminary risk assessment, an understanding of this uncertainty is necessary before evaluating the summary of the results presented in the following sections. To deal with the uncertainty in this first iteration of the risk assessment, the parameters used to calculate the risk have been biased to yield higher risk numbers, for the most part. It is expected that as retrieval progresses, new information will become available that may potentially lower the risk. Table 27 in *Addendum C1: Risk Assessment for WMA C Closure Plan* - Tier 2 (RPP-13774) lists these uncertainties and the expected impact on the results. Where possible, the impact was estimated quantitatively by running additional sensitivity runs combined with additional field/laboratory work on a model parameter (i.e., hydraulic conductivity, release rate models), and qualitatively through an examination of past modeling results (i.e., recharge). There are cases where the uncertainty remains unknown, but there are programs in place to collect the additional data (i.e., post-retrieval inventory information). The identification of these gaps is integral to the iterative nature of the process agreed on by DOE and Ecology, and the risk assessment will be updated as additional information becomes available.

A short description of the key results from the risk assessment is provided in this section (and a detailed description of the results is provided in Addendum C1: *Risk Assessment for WMA C Closure Plan* - Tier 2 [RPP-13774]). Section C5.1 provides the results from the long-term fate and transport model in which simulated peak concentrations and arrival times are discussed. Section C5.2 provides the results from the exposure scenarios for ILCR and radiological dose. Section C5.3 contains the results for the worker and accident scenario assessment.

The results of an initial risk assessment were developed in accordance with the following documents:

- *Performance Objectives for Tank Farm Closure Risk Assessments* (RPP-14283)
- *Modeling Data Package for an Initial Assessment of Closure for C Tank Farm* (RPP-13310)
- *241-C Waste Management Area Vadose Zone Inventory Data Package* (RPP-15317)
- *Exposure Scenarios and Unit Dose Factors for Hanford Tank Waste Performance Assessments* (HNF-SD-WM-TI-707).

The information contained in those documents was developed during several workshops held for DOE and Ecology personnel.

C5.1 LONG-TERM FATE AND TRANSPORT MODELING RESULTS

The model used in this analysis considered four risk-contributing elements:

- Past leaks from tanks and operations that are currently known to exist in the vadose zone
- Hypothetical leaks that may occur during waste retrieval (such as sluicing)
- Releases from tank ancillary equipment residuals (transfer lines, CR-vaults, and C-301 catch tank) assumed to remain in place after closure
- Releases from residual waste assumed to remain in the tanks after retrieval.

The period of simulation for the risk assessment is 10,000 years. This period was selected because of the long-lived and mobile nature of certain risk-causing contaminants, the expected long residence time for major contaminants within the vadose zone, and regulatory considerations. It is also the period of time recommended by the EPA for long-term risk assessments involving nuclear waste (40 CFR 144 "Environmental Radiation Protection Standards"). The points of calculation for which the risk metrics (dose, ILCR, and hazard index) were evaluated are located at (1) the WMA C fenceline, (2) the edge of the 200 Area Core Boundary, and (3) the Columbia River. For the purpose of this risk assessment, only those selected contaminants assumed to be important (because of inventory, mobility, and/or toxicity/risk) to the estimation of the particular risk metric are featured. These are technetium-99, iodine-129, chromium, nitrate, nitrite, and uranium. Complete discussion of these contaminants is given in Addendum C1 Section 3.5, with summary discussions of technetium-99, iodine-129, chromium provided in this appendix. These contaminants provide the greatest risk (see Table 28 of Addendum C1, Section 7.1). In addition to these contaminants, a total for either radiological dose or ILCR, or HI is computed. The total includes all contaminants given in the best basis inventory (47 radionuclides and 24 non-radionuclides) that apply to either radiological dose, or ILCR, or HI. Futhermore, additional contaminants will be addressed when quantitative analysis results for the contaminants identified in *Tank 241-C-106 Component Closure Action Data Quality Objectives* (RPP-13889) are available from waste sampling efforts following retrieval.

The fate and transport modeling presented was developed in a manner generally consistent with past and current ongoing modeling work in DOE and the SAC (PNNL-11800). The simulated vadose zone travel and contaminant breakthrough times in the initial assessment are in general agreement with results in field investigation reports (RPP-7884, RPP-10098) for various WMAs. As laboratory and field data are developed, their impacts on predictions will be evaluated, updated, and computed as necessary.

The impacts of two tank waste release mechanisms are evaluated in this preliminary assessment: (1) a diffusion-dominated release, and (2) an advection-dominated release. The diffusion and advection mechanisms most closely correspond, respectively, to a stabilized waste form isolated from the environment with grout* and/or reinforced concrete (tank bottom), and an unstabilized waste form assumed to be in full contact with the vadose zone materials.

C5.1.1 Base Case for WMA C

Figure C5-1 shows the individual sources considered in this risk assessment. A complete description of the sources and associated inventories is given in Addendum C1. To begin the estimation of impacts, a base case must be defined for WMA C. For the base case, source terms are applied to the WMA to estimate the cumulative inventory impacts. The base case defines the assumed post-retrieval conditions based on current retrieval plans, except for C-106. After this analysis was completed, the retrieval technology for C-106 was changed from modified sluicing to acid wash[1]. Table C5-2 provides a listing of the selected conditions, constituents, and source terms for the base case. When a cumulative total is given for the WMA, the base-case condition is used.

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* See Preface in *SST System Closure Plan* (RPP-13774).

[1] Oxalic acid will be neutralized by the carbonate minerals naturally present in the soil and, given the amount and concentration of acid in an 8,000 gallon leak of 1M oxalic acid and the present level of carbonate minerals in the soil, it is likely that the soil will neutralize the acid a short vertical distance (tens of feet or less) below the leak. The neutralized pH will likely be in the range of 7 to 8. Oxalic acid is fully deprotonated at a pH of about 4; therefore, above this pH all of the oxalate will be present in solution as the oxalate anion (C204-2). This anion will complex with uranium (uranium oxalate stability constant → log K = +6.36 [*NIST Critically Selected Stability Constnats of Metal Complexes Database* (Smith and Martell 2003)]), although nowhere near as strongly as with other organic complexes such as EDTA (uranium EDTA stability constant → Log K = 9.28 [Smith and Martell 2003]). PNNL found that the formation of the uranium oxalate complex did not reduce the adsorption of uranium onto Hanford soils compared to an oxalate-free solution AUTHOR NEEDS TO CITE THE REFERENCE HERE TO PNNL!!. However, PNNL was not using 1M oxalate solutions so the results are not directly comparable; however, it is possible that the presence of oxalate will not significantly increase the mobility of uranium through the vadose zone.

Figure C5-1. Modeled Sources within WMA C and Surrounding Facilities.

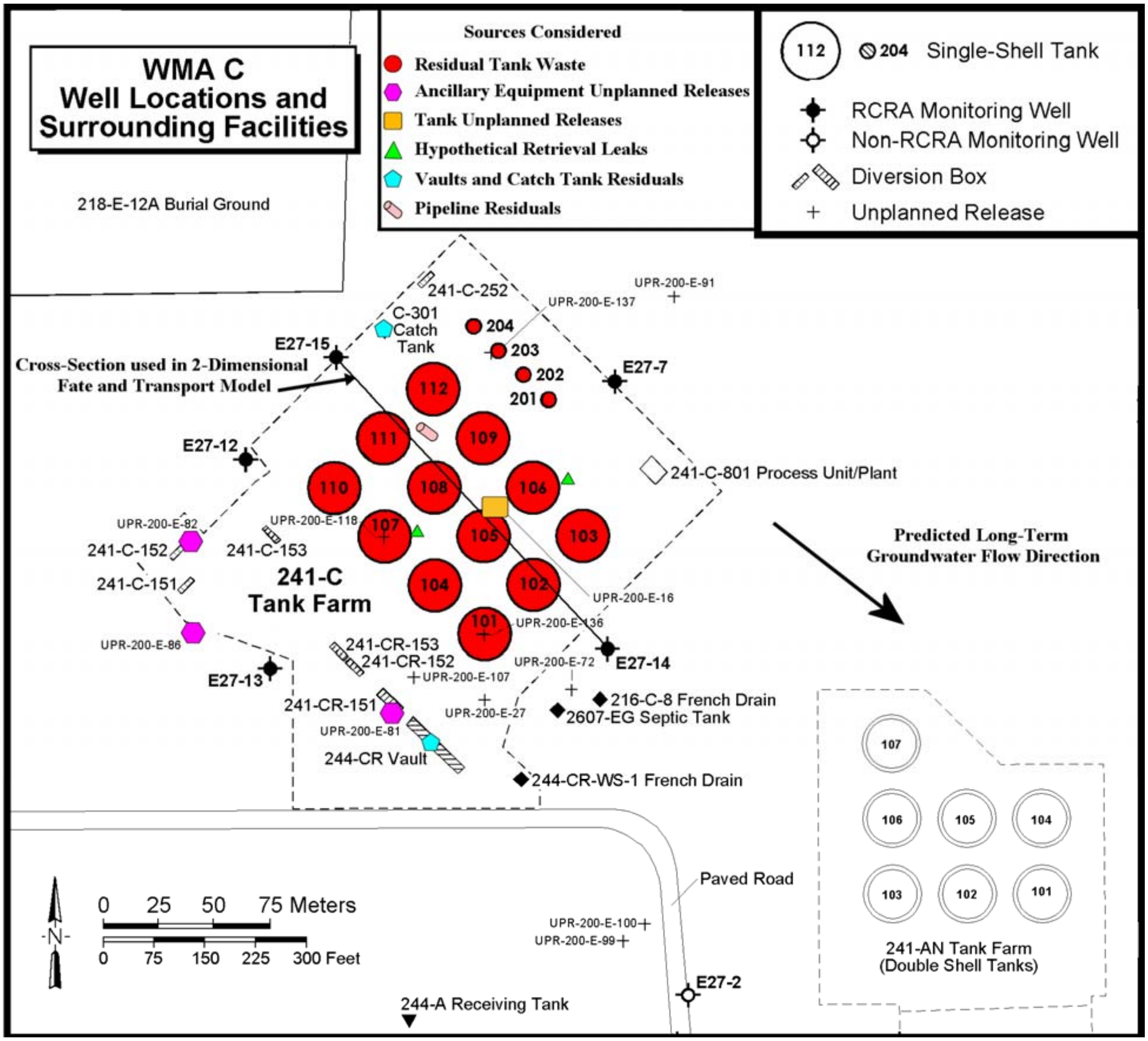

Table C5-2. Features of WMA C Base Case. (2 Pages)

Hydraulic Conductivity of Unconfined Aquifer	50 m/d
Release Model for Residual Waste	Diffusion (coefficient 6E-7 cm^2/s)
Contaminants of Concern (COCs) and Distribution Coefficients	Technetium-99, Iodine-129, Chromium, Nitrate, Nitrate, and Uranium Uranium = 0.6 mL/g All other COCs = 0.0 mL/g

Inventory and Source Terms

Tank Sources		**Retrieval Method**[a]	**Residual Volume/ Inventory Used**	**Vadose Zone Contamination Associated with Past Tank Leak**[b]	**Hypothetical Retrieval Leak**	**Inventory**[c]		
						Residual	**Past Tank Leak**	**Retrieval Leak**
Tanks	C-101	Crawler	360 ft^3/SPR[d]	No	Yes	Table 5-8b		Tables 5-10 and 5-11
	C-102	Crawler	360 ft^3/SPR	No	Yes	Table 5-8b		Tables 5-10 and 5-11
	C-103	Crawler	360 ft^3/SPR	No	Yes	Table 5-8b		Tables 5-10 and 5-11
	C-104	Crawler	360 ft^3/SPR	No	Yes	Table 5-8b		Tables 5-10 and 5-11
	C-105	Crawler	360 ft^3/SPR	Yes	Yes	Table 5-8b	Table 5-6	Tables 5-10 and 5-11
	C-106	Modified Sluicing	360 ft^3/SPR	No	Yes	Table 5-8c		Tables 5-10 and 5-11
	C-107	Past Practice Sluicing	360 ft^3/SPR	No	Yes	Table 5-8c		Tables 5-10 and 5-11
	C-108	Crawler	360 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11
	C-109	Crawler	360 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11
	C-110	Crawler	360 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11
	C-111	Crawler	360 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11
	C-112	Crawler	360 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11
	C-201	Vacuum	30 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11
	C-202	Vacuum	30 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11
	C-203	Vacuum	30 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11
	C-204	Vacuum	30 ft^3/SPR	No		Table 5-8b		Tables 5-10 and 5-11

Table C5-2. Features of WMA C Base Case. (2 Pages)

Past UPR Sources[f]	Inventory[c]	
UPR-200-E-81	Table 5-6	
UPR-200-E-82	Table 5-6	
UPR-200-E-86	Table 5-6	
Ancillary Equipment Sources	**Residual Vol/Type**	**Inventory[c]**
244-CR TK-CR-001	27 ft^3/SPR	Table 5-12
244-CR TK-CR-002	8 ft^3/SPR	Table 5-12
Ancillary Equipment Sources	**Residual Vol/Type**	**Inventory[c]**
244-CR TK-CR-003	8 ft^3/SPR	Table 5-12
244-CR TK-CR-011	27 ft^3/SPR	Table 5-12
241-C-301	19 ft^3/SPR	Table 5-12
Piping	250 ft^3/SPR	Table 5-12

[a] Present plans call for sluicing in all C-100 Tanks with the exception of C-106, which is undergoing an acid wash. A vacuum method is used in all C-200 Series tanks. Minimal water will be used with vacuum technology as opposed to sluicing, which uses large volumes of water to retrieve. Therefore, retrieval leaks will not be considered for the C-200 Series tanks.

[b] Past Tank Leaks - only tanks with verified vadose zone contamination were included in the model. Vadose contamination was verified by either borehole sampling or geophysical logs.

[c] Inventory tables are from Addendum C1, Section 3.6.

[d] SPR = Selected Phase Removal inventory after the retrieval of tank wastes, as reported in *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA: Inventory and Source Term Data Package* (DOE/ORP-2003-02)

[e] HTWOS = Hanford Tank Waste Operation Simulator model output. *Single-Shell Tank Retrieval Sequence and Double-Shell Tank Space Evaluation* (RPP-8554) modeled inventory after retrieval, simulating differential dissolution of waste constituents in high volume retrieval. (Please note that after this risk analysis was completed, the retrieval technology selected for C-106 was changed from modified sluicing to acid dissolution. An inventory analysis has not been completed for tank residuals using acid dissolution. Subsequent risk assessments will address acid-dissolution for this tank.)

[f] Past leaks and hypothetical retrieval leaks are simulated using advective transport through the vadose zone.

C5.1.2 Contaminant of Concern Modeling Results

The modeling results for technetium-99 are discussed in detail while the results for iodine-129, and chromium are briefly summarized. Complete discussions for all contaminants in this risk assessment are given in Addendum C1. Technetium-99, iodine-129, and chromium were chosen for this discussion because technetium-99 and iodine-129 account for 95 % of the total dose and incremental lifetime cancer risk, while chromium is the primary hazard index driver (see Addendum C1, Table 28).

Technetium-99

Table C5-3 provides the technetium-99 results for all sources in the WMA C under the base-case conditions. For comparison, the results for the advection-dominated residual tank waste release model are also included.

Table C5-3. Simulated Peak Concentrations [a] and Arrival Times for Technetium-99 at Various Boundaries. (2 Pages)

Simulation	WMA C Fenceline Boundary		Proposed Core Zone Boundary		Columbia River	
	Time (years)	Conc. (pCi/L)	Time (years)	Conc. (pCi/L)	Time (years)	Conc. (pCi/L)
No-Action (i.e., no retrieval) Tank Residuals						
Unretrieved tank waste advection-dominated release [b]	4,653	9,639	4,676	1,520	4,883	560
Unretrieved tank waste diffusion-dominated release	5,614	3,030	5,637	474	5,839	178
Base Case Post-Retrieval [b]						
Retrieved tank residuals advection-dominated release [b]	4,653	208	4,676	33	4,883	12
Retrieval leak (8,000 gal)	2,082	420	2,107	66	2,324	22
Past tank leaks	2,092	156	2,117	25	2,333	9
Past ancillary equipment leaks (UPR)	2,117	353	2,141	56	2,355	20
Retrieved tank residuals diffusion-dominated release	5,610	66	5,637	10	5,839	4
Residuals in 244-CR vault and catch-tank release limited to diffusion	5,614	1	5,637	0.2	5,839	0.08
Residuals in ancillary pipeline release limited to diffusion (scaled)	4,891	7.4	4,925	1.1	5,130	0.4

[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.

[b] Not part of the base case; only added for comparison purposes between release models.

UPR = unplanned release

The base-case composite analysis, which provides the sum for all sources, is given in Figure C5-2. In this figure, the following six breakthrough curves are shown:

- **Source: Hypothetical Retrieval Leaks** (Figure C5-2 line with hollow square symbols): Hypothetical retrieval leaks were modeled for all C-100 Series tanks, since the expected retrieval methodology is thought to be sluicing. The retrieval methodology for the C-200 series tanks is a dry vacuum. A retrieval leak was not applied to the C-200 Series tanks. The total estimated inventory for retrieval leaks is 5.0 Ci. The inventory from waste retrieval leaks was applied to simulation Case 1 (Table C5-4) with the higher hydraulic conductivity for the unconfined aquifer and then summed to estimate impacts of waste retrieval leaks from all C-100 series tanks. Although retrieval leaks are included in the cumulative curve, it is unrealistic to assume all tanks will leak 8,000 gal. The waste retrieval leaks peak breakthrough occurs approximately 80 years after retrieval with a peak concentration of 420 pCi/L, which is below the MCL derived constituent concentration of 900 pCi/L. The Hanford Advisory Board (HAB) consensus advice #132 states the core zone will have an industrial scenario for 150 years after site closure. At that time the concentration will have dropped to ~175 pCi/L. Following the emplacement of a barrier, contaminant levels would drop until the barrier degrades. After the barrier degrades, a second peak arrives approximately 1,135 years after the first peak with a peak value of 88 pCi/L.

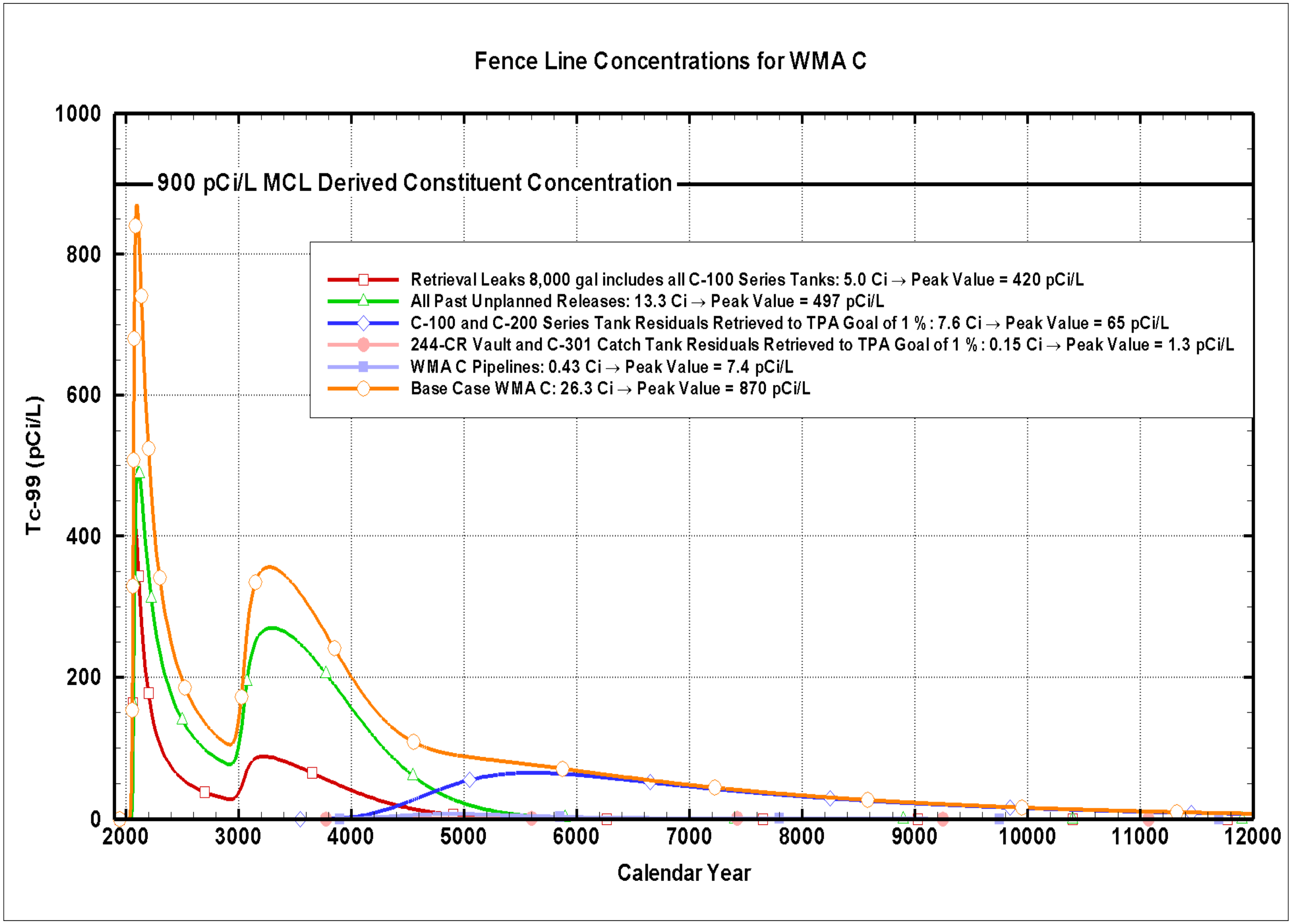

Figure C5-2. Technetium-99 Results for Hypothetical Retrieval Leaks, Past Unplanned Releases, and Tank and Ancillary Equipment Residuals (Diffusion-Dominated Release).

- **Source: Unplanned Releases** (Figure C5-2, line with triangle symbols): Past leaks from C-105 and ancillary equipment have released an estimated 13 Ci of technetium-99. The inventory from these sources was applied to the simulations identified as past tank leaks and past ancillary equipment leaks in Table C5-3. The simulations were then summed to estimate the concentrations for both tank and ancillary equipment leaks. The simulated peak concentration from these sources is 497 pCi/L (Figure C5-2) occurring approximately 110 years after leaking. This is below the MCL Derived Constituent Concentration of 900 pCi/L. Like the retrieval leaks, concentrations decrease following the emplacement of a surface barrier. After the barrier degrades, concentrations rise, reaching a peak approximately 1,180 years after the first peak, with a peak value of 270.6 pCi/L (Figure C5-2).

- **Source: Residual C-100 and C-200 Series Tank Waste Releases** (Figure C5-2, line with diamond symbols): Total technetium-99 inventory left in the residual waste within the tanks is 7.6 Ci using selected phase removal for all tanks and using the selected phase removal method for calculating residual inventory (see Addendum C1, Section 3.6.1 for description of methodology). The diffusion-dominated release model results for residuals are presented. Such a release model represents release from a stabilized waste form isolated from the environment with grout* and/or reinforced concrete. Using the diffusion-dominated release model, the simulated peak technetium-99 concentration for residual waste in all tanks is 66 pCi/L (Table C5-3 and Figure C5-2) occurring approximately 3,500 years after closure. In addition to the diffusion-dominated release, an advection model was run to evaluate the impact of an unstabilized waste form covered with backfill sand and gravel or a failed grout (i.e., the grout has cracked). The impact of having an unstabilized waste form or a failed grout would be to increase the concentration by approximately a factor of 3.

- **Source: Ancillary Equipment—CR-Vaults and C-301 Catch Tank Residual Releases** (Figure C5-2, line with filled circle symbols): This assumes that the waste in CR-vault and C-301 catch tanks will undergo waste retrieval. Assumed inventory for technetium-99 for this ancillary equipment is 0.15 Ci. (See Addendum C1, Section 3.6.1 for how inventory assumption was made.) The inventory from these sources was applied to the simulation identified as residual 244-CR vault and catch-tank release limited to diffusion in Table C5-3. These tanks were modeled in the same manner as the 100- and 200-series tanks. The simulated peak for residual waste in these tanks is 1.3 pCi/L (Table C5-3 and Figure C5-2) occurring 3,500 years after closure.

- **Source: Ancillary Equipment—Pipeline Residual Release** (Figure C5-2, line with filled square symbols): This assumes a total technetium-99 inventory for the transfer piping system of 0.43 Ci (see Addendum C1, Section 3.6.1 for how inventory assumption was made). The inventory from this source was applied to residual ancillary pipeline release limited to diffusion (scaled) (Table C5-3), since this was not simulated with the

* See Preface in *SST System Closure Plan* (RPP-13774).

hydraulic conductivity of the other cases. The scaling factor was determined by comparing the difference between diffusion-dominated tank residual release with the low hydraulic conductivity (4.8 m/d) for the unconfined aquifer against the same case with a high hydraulic conductivity (50 m/d) for the unconfined aquifer. This source was modeled the same as the 100- and 200-series tanks, with a diffusion-dominated release model assuming a waste form in which the pipelines are filled with grout*. With the assumed inventory for residual in the pipelines, the simulated peak technetium-99 concentration is 7.4 pCi/L (Table C5-3 and Figure C5-2). The arrival time for the peak occurs approximately 2,850 years after closure. The residual in the pipeline represents approximately 12% of cumulative impacts at the peak arrival time for release from the pipeline, which occurs 700 years before the impacts from tank residual waste.

- **Source: Cumulative Impacts from All Sources Within WMA C** (Figure C5-2, line with open circle symbols): For this curve, the breakthrough curves for the five sources listed above were summed to calculate a total technetium-99 concentration at the fenceline. The total technetium-99 inventory for the release to the surrounding environment would be 26.3 Ci. The simulated peak technetium-99 concentration for the composite WMA C is 870 pCi/L (Figure C5-2) occurring approximately 100 years into the future. This peak is slightly under the MCL Derived Constituent Concentration of 900 pCi/L. The principal source driver for the peak concentration is from the past leaks. Once the surface barrier is emplaced, the concentrations drop to 105 pCi/L (Figure C5-2). Once the barrier loses its effectiveness, concentrations rise to a second peak value of 356 pCi/L (Figure C5-2) approximately 1,180 years after the first peak. The past UPRs and hypothetical retrieval leaks are the primary source drivers for technetium-99, with the UPRs (tank and ancillary equipment) contributing slightly more than the hypothetical retrieval leak (Figure C5-2).

Iodine-129

Results for iodine-129 are given in Table C5-4 and Figure C5-3. For a retrieval leaks of 8,000 gal for all C-100 Series tanks, previous tank leaks, and previous UPRs, the simulated peak concentration is 0.82, 0.30, and 0.68 piCi/L, respectively, which are under the MCL Derived Constituent Concentration of 1 pCi/L. For no-action residuals, both the advection- and diffusion-dominated release models have peak concentrations well over the MCL Derived Constituent Concentration. For retrieved to HFFACO goals, the peak concentration for the advection-dominated release is 0.43 pCi/L. However, if the release mechanism is diffusion-dominated, the peak concentration decreases to 0.14 pCi/L. For the base-case composite analysis of WMA C, the peak concentration is 1.7 pCi/L (Figure C5-3), which is slightly higher than the MCL Derived Constituent Concentration of 1 pCi/L. The composite peak concentration occurs approximately 100 years from now, with the composite peak decreasing to below the MCL Derived Constituent Concentration approximately 100 years after the peak arrives. It is the impact of hypothetical retrieval leaks that drives the concentration over the MCL Derived Constituent Concentration. If retrieval leaks are mitigated, the peak concentration (0.96 pCi/L,

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* See Preface in *SST System Closure Plan* (RPP-13774).

Figure C5-3) will be primarily due to past UPRs, which is slightly under the MCL Derived Constituent Concentration. Peaks resulting from residuals in tanks and pipelines are observed 3,500 and 2,900 years past closure, respectively, and are approximately one (0.14 pCi/L for tank residuals) and two orders (0.015 pCi/L for pipeline residuals) of magnitude lower than concentration peaks attributed to past leaks.

Table C5-4. Simulated Peak Concentrations[a] and Arrival Times for Iodine-129 at Various Boundaries.

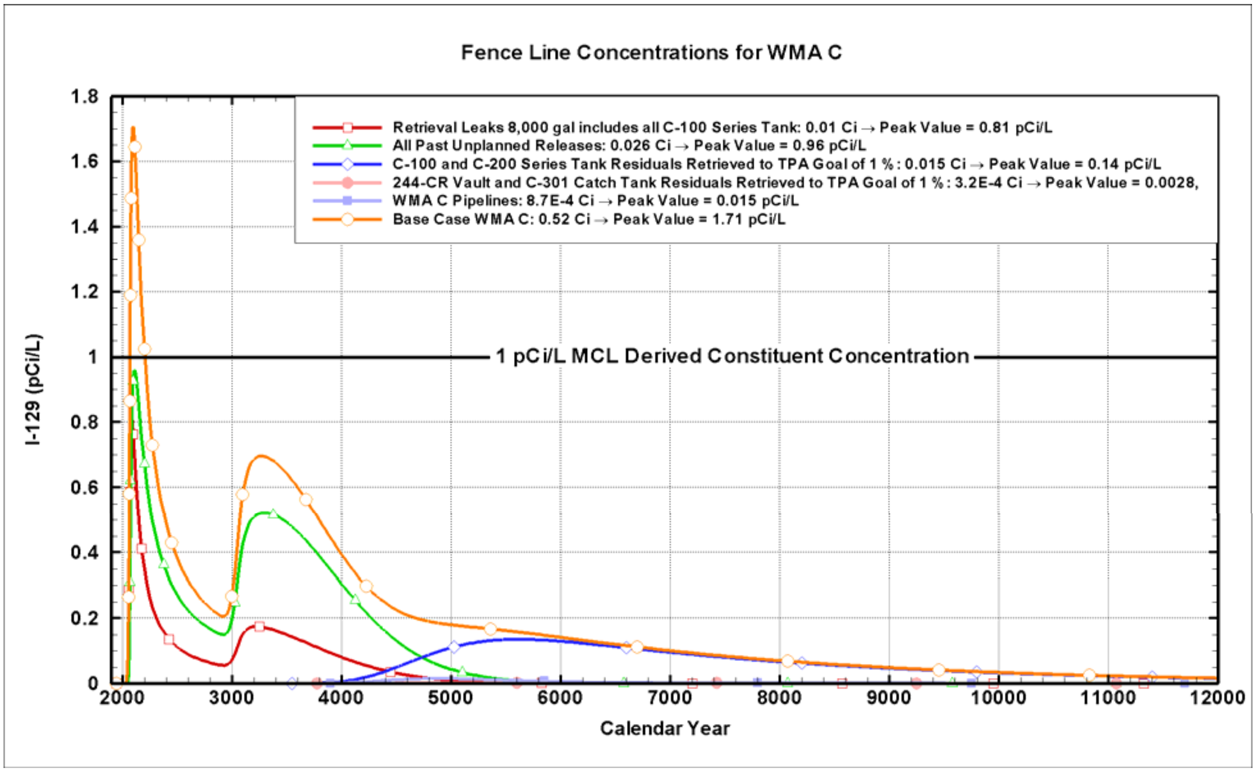
Simulation	WMA C Fenceline Boundary		Proposed Core Zone Boundary		Columbia River	
	Time (years)	Conc. (pCi/L)	Time (years)	Conc. (pCi/L)	Time (years)	Conc. (pCi/L)
No-Action (i.e., no retrieval) Tank Residuals						
Unretrieved tank waste advection-dominated release[b]	4,653	27.4	4,676	4.3	4,883	1.6
Unretrieved tank waste diffusion-dominated release	5,614	8.7	5,637	1.4	5,839	0.50
Base Case Post-Retrieval[b]						
Retrieved tank residuals advection-dominated release[b]	4,653	0.43	4,676	0.05	4,883	0.02
Retrieval leak (8,000 gal.)	2,082	0.82	2,107	0.11	2,324	0.055
Past tank leaks	2,092	0.30	2,117	0.05	2,333	0.02
Past ancillary equipment leaks (UPR)	2,117	0.68	2,141	0.11	2,355	0.04
Retrieved tank residuals diffusion-dominated release	5,614	0.14	5,637	0.025	5,839	0.012
Residuals in 244-CR vault and catch-tank release limited to diffusion	5,614	0.003	5,637	4.4 E-04	5,839	1.6 E-04
Residuals in ancillary pipeline release limited to diffusion (Scaled)	4,891	0.015	4,925	2.5 E-03	5,130	9.1 E-04

[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.

[b] Not part of the base case; only added for comparison purposes between release models.

UPR = unplanned release.

Figure C5-3. Iodine-129 Composite WMA C Fenceline Results for Past Unplanned Releases, Tank Residuals (Diffusion-Dominated Release Model) and Retrieval Leaks.



Chromium

Results for chromium are given in Table C5-5 and Figure C5-4. To be conservative, all chromium was assumed to be chromium(IV) rather than chromium(III). Other than no-action residuals, all sources and release models, the simulated peak concentration is below the MCL (0.1 mg/L) for total chromium. Chromium(IV) is mobile compared to chromium(III). For the base case WMA composite analysis, the peak (0.006 mg/L) is a factor of approximately 15 less than the MCL.

Table C5-5. Simulated Peak Concentrations [a] and Arrival Times for Chromium$^{+6(b)}$ at Various Boundaries. (2 Pages)

Simulation	WMA C Fenceline Boundary		Proposed Core Zone Boundary		Columbia River	
	Time (years)	Conc. (mg/L)	Time (years)	Conc. (mg/L)	Time (years)	Conc. (mg/L)
No-Action (i.e., no retrieval) Tank Residuals						
Unretrieved tank waste advection-dominated release[c]	4,653	0.16	4,676	0.02	4,883	0.009
Unretrieved tank waste diffusion-dominated	5,614	0.05	5,637	0.0077	5,839	0.0028

Table C5-5. Simulated Peak Concentrations [a] and Arrival Times for Chromium^{+6}[(b)] at Various Boundaries. (2 Pages)

release						
Base Case Post-Retrieval (see footnote for advection dominated release)						
Retrieved tank residuals advection-dominated release[c]	4,653	0.003	4,676	4.0 E-04	4,883	1.0 E-04
Retrieval leak (8,000 gal.)]	2,082	0.0064	2,107	1.0 E-03	2,324	3.0 E-04
Past tank leaks	2,092	7.9 E-04	2,117	1.2 E-04	2,333	4.3 E-05
Past ancillary equipment leaks (UPR)	2,117	0.003	2,141	5.2 E-04	2,355	1.9 E-04
Retrieved tank residuals diffusion-dominated release	5,614	7.9 E-04	5,637	1.23 E-04	5,839	4.55 E-05
Residuals in 244-CR vault and catch-tank release limited to diffusion	5,614	2.1 E-05	5,637	3.2 E-06	5,839	1.1 E-06
Residuals in ancillary pipeline release limited to diffusion	4,891	1.0 E-04	4,925	1.8E-05	5,130	6.8 E-06

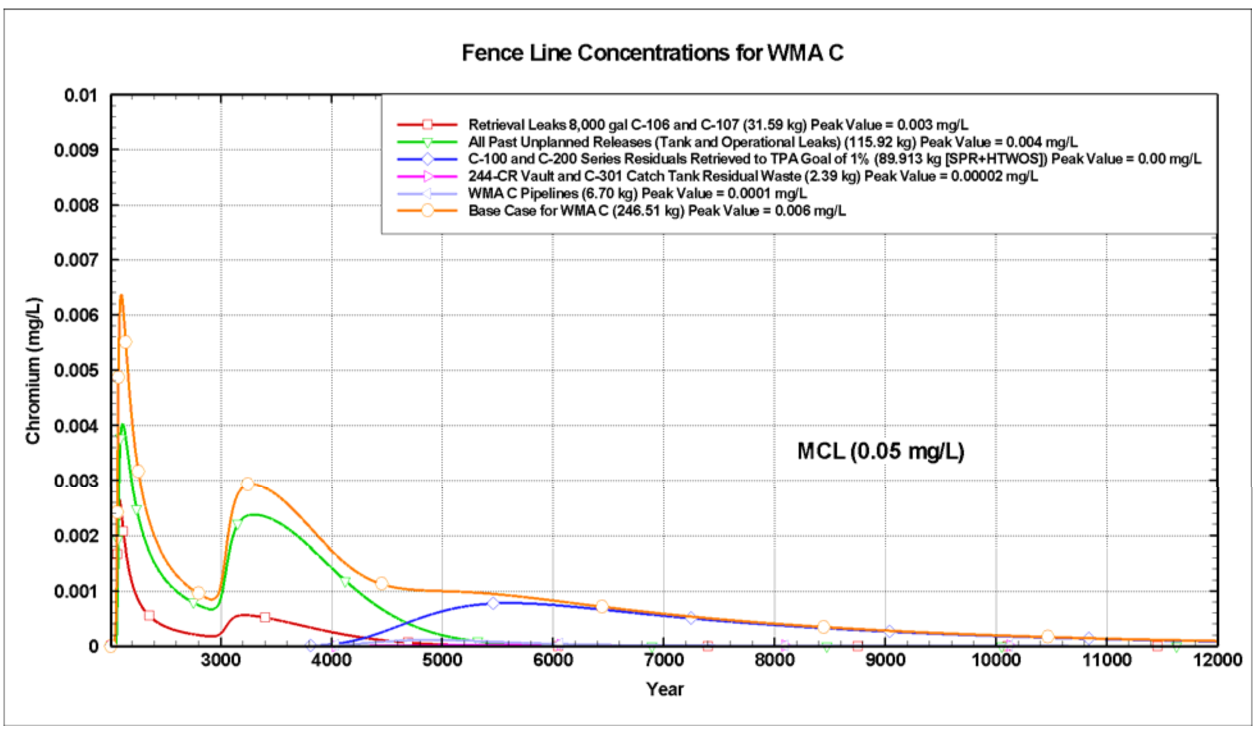
[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.

[b] For conservative purposes all chromium was assumed to be chromium^{+6}.

[c] Not part of the base case; only added for comparison purposes between release models.

UPR = unplanned release.

Figure C5-4. Chromium Composite WMA C Fenceline Results for Past Unplanned Releases, Tank Residuals (Diffusion-Dominated Release Model) and Retrieval Leaks.



Dual Peak Trends

A dual peak trend is shown on all of the previously referenced figures. This results from the leak occurring before the emplacement of a surface barrier and some, but not all, of the contaminant traveling through the vadose zone before the barrier becomes effective. Once the surface barrier becomes effective, the contaminant movement slows until the barrier degrades (in 500 years) and the recharge changes from 0.5 to 3.5 mm/yr, causing a rise in groundwater contamination. The contaminant continues to travel through the vadose zone until all of the mass from the initial leak is released (in 6,500 years).

Downgradient Concentrations

In addition to the breakthrough curves presented in the previous sections, an analytical stream tube model solution from Domenico and Schwartz (*Physical and Chemical Hydrogeology* [Domenico and Schwartz 1990]) was used to model groundwater flow and transport to various points of calculation downgradient from the WMA. The results from the stream tube model are summarized in Tables C5-3 through C5-5. The concentrations in groundwater are expected to attenuate as the contaminants move from the tank farm fenceline. For the base-case model, results indicated that none of the selected COCs are expected to be found at concentrations exceeding their respective MCL at the proposed core boundary (2,900 m [9,500 ft] from the WMA C fenceline) or at the Columbia River (14,300 m [47,000 ft] from the WMA C fenceline).

At the currently proposed core boundary for the 200 Areas, the only contaminants that exceed their respective MCL Derived Constituent Concentration are iodine-129, resulting from the advection- and diffusion-dominated releases without tank waste retrieval (4.3 pCi/L and 1.4 pCi/L, respectively), and technetium-99, resulting from the advection-dominated release case without tank waste retrieval (1,520 pCi/L). The inclusion of the effects of inventory reduction associated with retrieval to HFFACO limits for the advection- and diffusion- dominated releases at the Core Zone Boundary has the effect of reducing the predicted iodine-129 concentrations to 0.05 pCi/L and 0.025 pCi/L, respectively, and the technetium-99 concentration to 32 pCi/L and 10 pCi/L, respectively. When calculations are extended to the river, the calculated concentrations of all of the contaminants for all of the release and inventory cases decrease to levels below the MCL Derived Constituent Concentration (1 pCi/L), except for the iodine-129 concentration (1.6 pCi/L), resulting from the no-action inventory with advection-dominated release.

C5.1.3 No-Action and Post- Retrieval Residual Results for Different Tank Residual Release Models

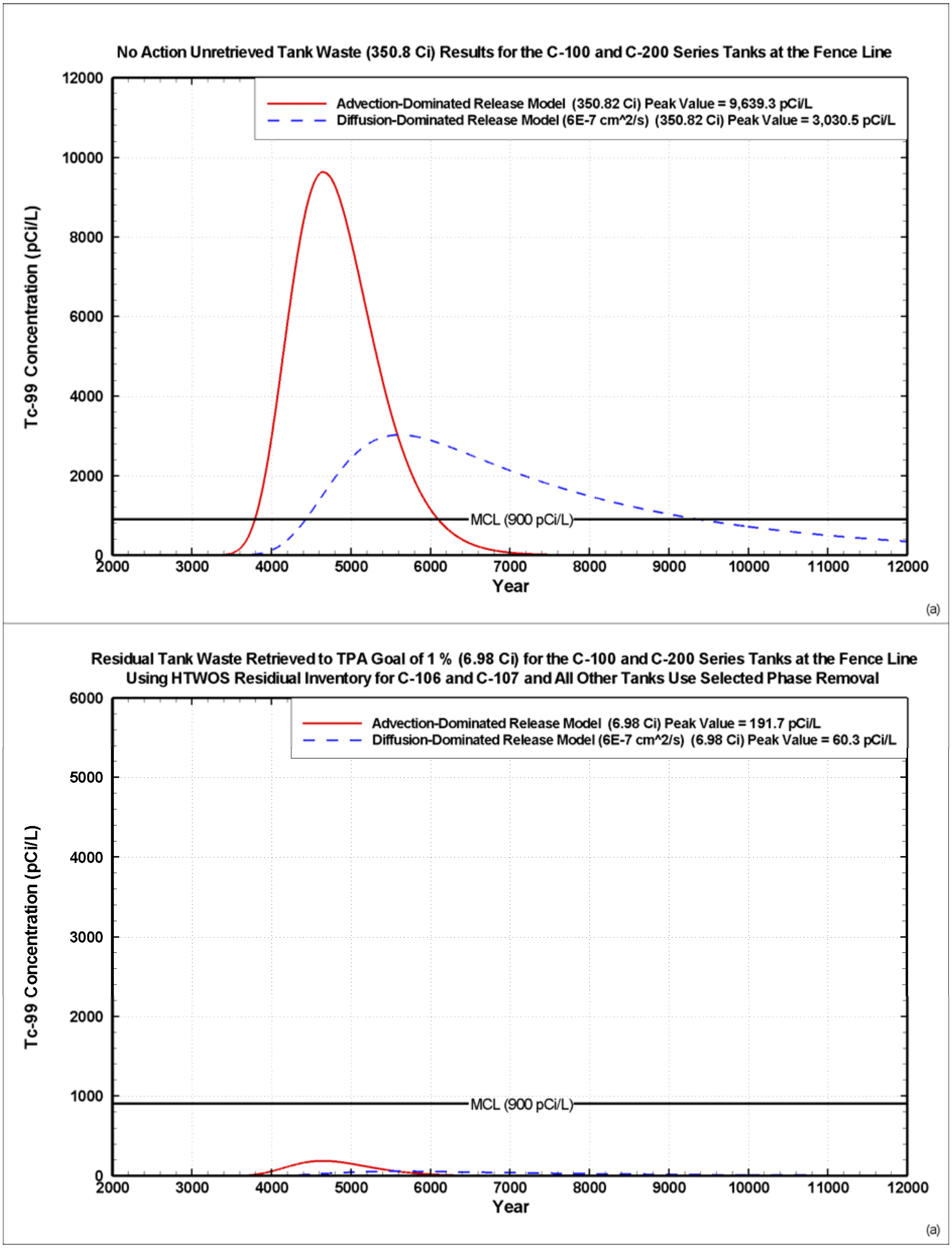
Figure C5-5 shows the simulated fenceline concentrations for technetium-99 for both no-action inventory and post-retrieval inventory. Figure C5-5(a) presents the no-action technetium-99 results for the C farm 100- and 200-series tanks. The total technetium-99 inventory for these tanks before retrieval is 350.8 Ci. Figure C5-5(b) shows simulated post-retrieval technetium-99 results. The total technetium-99 inventory for these tanks after retrieval is 6.98 Ci. (Note: the vertical scale has been increased by a factor of two over the upper figure.) Included in each of the figures is a comparison between the advection- and diffusion-dominated release mechanisms.

- If the release is advection-dominated (that is from a sand or gravel fill material for the tank), the peak concentration at the fenceline is 9,639 pCi/L for the present-day BBI. However, if the tank is filled with a stabilizing agent (such as grout* or concrete) and the release is diffusion-dominated, the resulting concentration drops by approximately 70% to 3,030 pCi/L.

- Retrieving to HFFACO goals reduces the technetium-99 concentration from 9,639 to 208 pCi/L for the advection-dominated release model. However, if the release is diffusion-dominated, the concentration at the fenceline is reduced from 3,030 to 66 pCi/L, which is well below the MCL Derived Constituent Concentration.

* See Preface in *SST System Closure Plan* (RPP-13774).

Figure C5-5. Advection- and Diffusion-Dominated Technetium-99 Release Model Results for All WMA C 100- and 200-Series Tanks Using Both No-Action and Post-Retrieval Inventories.



C5.1.4 Conclusions from Fate and Transport Modeling Results

- The primary contributors to groundwater contamination are contaminants contained in past leaks from tanks and ancillary equipment, with a distribution coefficient of 0.0 mL/g and relatively long half-lives.

- The placement of the surface barrier greatly reduces recharge through vadose contamination, which results in a decrease in the predicted groundwater concentration until the barrier degrades.

- Key parameters affecting the predicted groundwater contaminant concentrations resulting from tank residual waste releases are inventory, groundwater flow rate under the WMA, recharge, release rate, and contaminant mobility (that is, the distribution coefficient).

- Past leaks potentially have the largest impact (depending on inventory).

- Retrieval of tank residuals to the HFFACO goal of 360 ft^3(100-series tanks) and 30 ft^3 (200-series tanks) can reduce fenceline concentrations to below the MCL or MCL Derived Constituent Concentration.

- The foundation for the risk assessment calculations presented in this document is the inventory established by the BBI, which is based on both process knowledge and sampling data. As more knowledge about a tank becomes available, the inventory estimates for a tank are updated. In some cases, this has led to significant changes in inventory values. Post-retrieval sampling and analysis of residuals must be made to further assess the risk associated with the residuals. The risk assessment presented here could easily over/under estimate the risk without this information.

- Work to establish the type of release from a tank waste residual is important in direct proportion to the amount of waste that remains in the tank after retrieval. The more waste left behind, the more important the release model becomes.

C5.2 QUANTITATIVE DOSE AND RISK ESTIMATES FOR WMA C CLOSURE SCENARIO

A summary of the dose and risk estimates is provided in this section for selected exposure scenarios (see Addendums C1 and C2 for additional exposure scenarios). In these scenarios, a human receptor is exposed when that receptor uses groundwater contaminated by release of contaminates from the various sources within WMA C. Intruder scenarios were not considered in this document. However, in the future, DOE O 435.1-based intruder calculations will be provided to Ecology as part of a performance assessment. Based on preliminary discussions on implementing the recently proposed TPA Closure Process, performance assessments will replace risk assessments. The performance assessments will be designed to meet DOE, Ecology, and EPA's needs in this area. The performance assessment will become a central document in the

effective integration of each agencies regulations and guidelines. The performance assessment document's contents will generally follow the DOE O 435.1 but with modifications based on local discussions among Ecology, EPA, and DOE.

The long-term fate and transport modeling provided a series of quantitative estimates for contaminant groundwater concentrations over time assuming different waste sources and their associated release and migration characteristics. To calculate dose and risk values for a given waste source and exposure scenario, the peak groundwater contaminant concentrations from the corresponding waste source analysis are multiplied by the appropriate dose and/or risk conversion factor derived for that exposure scenario. The appropriate dose and/or risk conversion factor is provided in *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment* (HNF-SD-WM-TI-707, Rev. 3). Use of the groundwater included a number of exposure pathways (direct exposure, ingestion, inhalation, and food chain). Please see Addendum C1, Section 7.1, Tables 25 and 26 for exposure pathways related to groundwater.

The following source terms were evaluated to describe the relative impacts to groundwater:

- Residual tank waste following retrieval to a maximum of 360 ft^3 in each 100-series tank (30 ft^3 in each 200-series tank) and residual waste in ancillary equipment (pipes, vaults, and catch tanks)
- Estimated inventory of past leaks from tanks and ancillary equipment
- Hypothetical retrieval leaks resulting in the release of liquid waste during sluicing-type retrieval operations.

Resultant groundwater effects of these source terms are evaluated at the following locations:

- The downgradient WMA C fenceline
- A proposed nearest boundary of the 200 Area Core Zone Boundary (2,900 m (9,500 ft) from the WMA C fence line)
- The extent of groundwater immediately before discharge of the aquifer into the Columbia River (14,300 m (47,000 ft) east of the WMA C fenceline).

Radiological dose from groundwater contaminants is presented in terms of EDE for defined receptors along with estimated ILCR, and non-carcinogenic hazard index. The results presented here cover radiological dose and ILCR. For non-carcinogenic hazard risk, please see Addendum C1.

C5.2.1 Radiological Dose

An analysis of the radiological dose for the All-Pathways Farmer and Residential Drinking Water (2 L/day) scenarios are presented in Table C5-6. These are DOE exposure scenarios for radiological dose required by DOE O 435.1. Other exposure scenarios for radiological dose are

presented in Addendum C1, Section 7.0. Table C5-6 has been divided into three sections to show the relative contribution from each source term (residual tank waste [diffusion-dominated release], all past UPRs [tank leaks and ancillary equipment], and hypothetical retrieval leaks). The results for radiological dose are briefly summarized. Only major sources are discussed; see Addendum C1 for discussion of minor sources (i.e. ancillary equipment). Highlights from Table C5-6 are as follows:

- **Residual Tank Waste:** Cumulative groundwater dose at the WMA C fenceline from all radionuclides is 0.194 mrem/yr with technetium-99 and iodine-129 accounting for 96% of the dose (Addendum C1, Table 28). The cumulative dose from tank residuals is well below the target maximum value of 25 mrem/yr performance objective for the All Pathways Farmer scenario at all locations evaluated. The Residential Drinking Water scenario is based on a daily ingestion rate of 2 L/day, and the dose is calculated for each radionuclide based on a conversion factor utilizing a derived concentration for each constituent, resulting in an annual dose of 4 mrem/yr EDE. The Industrial Drinking Water scenario assumes a 1 L/day ingestion rate and only 250 days on site rather than 365 days on site; thus, the dose for each constituent is reduced by 66% as compared to the residential scenario. Calculated doses for Residential Drinking Water scenarios and Industrial Drinking Water scenarios are 0.097 mrem/yr and 0.033 mrem/yr, respectively, and are below the target maximum value of 4 mrem/yr. Dose contributions from technetium-99 and iodine-129 make up approximately 71% and 27%, respectively, of the total dose.

- **All Past Leaks:** Cumulative groundwater dose from all radionuclides originating from post-retrieval residual tank waste is 1.7 mrem/yr, which is well below the target maximum value of 25 mrem/yr performance objective for the All Pathways Farmer scenario. Calculated doses for Residential and Industrial Drinking Water scenarios are 0.8 and 0.27 mrem in a year, respectively. Dose contributions from technetium-99 and iodine-129 account for 88% of the drinking water dose.

- **Hypothetical Retrieval Leaks:** In this analysis all C-100 series tanks leak 1,000 gallons. The cumulative groundwater dose from all radionuclides originating from hypothetical retrieval leaks is 1.2 mrem/yr, which is well below the target maximum value of 25 mrem/yr performance objective for the All Pathways Farmer scenario. Calculated doses for Industrial and Residential Drinking Water scenarios are 0.62 and 0.21 mrem/yr, respectively. Dose contributions from technetium-99 and iodine-129 accounts for 97% of the total drinking water dose.

- **Cumulative Effects for All Source Terms:** The summary results for the All-Pathways Farmer scenario are presented in Figure C5-6, including individual contribution curves for the individual source terms and the cumulative curve representing the additive effects of the source terms. All of the results of this analysis are based on groundwater concentrations at the WMA C fenceline. The maximum dose for the WMA C is 2.8 mrem/yr, occurring approximately 100 years into the future. This dose is related to past leaks. Peak impacts from residual waste are not observed until 3,500 years after closure.

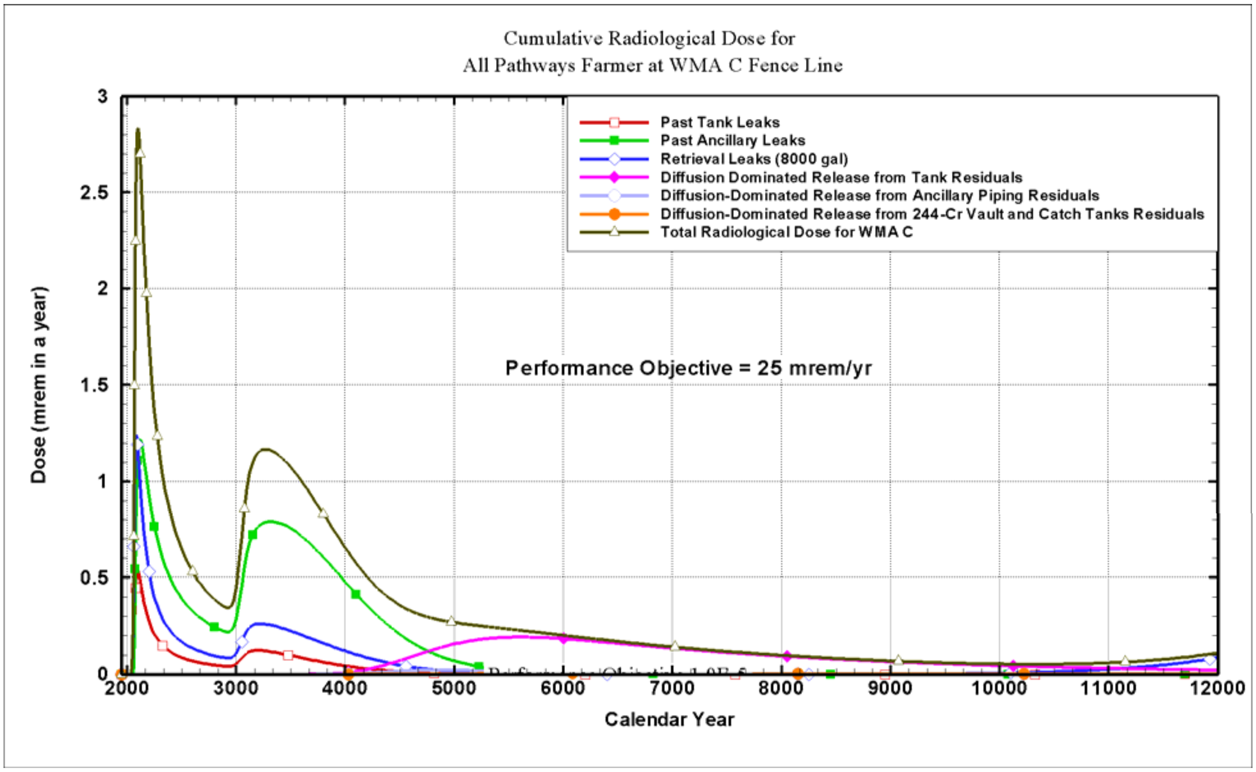
Table C5-6. Radiological Dose from Exposure to Groundwater and Drinking Water for Technetium-99 and Iodine-129 along with the Cumulative for All Radionucldes.

Constituent	WMA C Fenceline		Core Zone Boundary		Columbia River (Groundwater)	
	Time (CY)	**Dose (mrem/yr)**	**Time (CY)**	**Dose (mrem/yr)**	**Time (CY)**	**Dose (mrem/yr)**
Contribution from Tank Residuals						
All Pathways Farmer (compare to 25 mrem/yr target)						
Technetium-99	5,610	1.2 E-01	5,637	1.8 E-02	5,839	6.8 E-03
Iodine-129	5,614	7.1 E-02	5,637	1.1 E-02	5,839	4.2 E-03
Cumulative		1.9 E-01		3.0 E-02		1.1 E-03
Residential Drinking Water Dose (compare to 4 mrem/yr EDE target)[a]						
Technetium-99	5,610	6.9 E-02	5,637	1.1 E-02	5,839	3.8 E-03
Iodine-129	5,614	2.6 E-02	5,637	4.0 E-03	5,839	1.5 E-03
Cumulative		9.7 E-02		1.5 E-02		5.3 E-03
Contribution from Past Tank Leaks and Unplanned Releases						
All Pathways Farmer (compare to 25 mrem/yr target)						
Technetium-99	2,117	8.7 E-01	2,141	1.4 E-01	2,355	5.1 E-02
Iodine-129	2,117	5.1 E-01	2,141	7.8 E-02	2,355	3.0 E-02
Cumulative		1.7 E+00		2.7 E-01		1.0 E-02
Residential Drinking Water Dose (compare to 4 mrem/yr EDE target)[a]						
Technetium-99	2,117	5.2 E-01	2,141	8.2 E-02	2,355	2.9 E-02
Iodine-129	2,117	1.8 E-01	2,141	2.8 E-02	2,355	1.0 E-02
Cumulative		8.0 E-01		1.3 E-01		4.4 E-02
Contribution from Hypothetical Retrieval Leaks						
All Pathways Farmer (compare to 25 mrem/yr target)						
Technetium-99	2,082	7.3 E-01	2,107	1.2 E-01	2,324	3.9 E-02
Iodine-129	2,082	4.3 E-01	2,107	6.9 E-01	2,324	2.3 E-02
Cumulative		1.2 E-00		2.0 E-01		6.6 E-02
Residential Drinking Water Dose (compare to 4 mrem/yr EDE target)[a]						
Technetium-99	2,082	4.4 E-01	2,107	7.0 E-02	2,324	2.3 E-02
Iodine-129	2,082	1.6 E-02	2,107	2.6 E-03	2,324	8.5 E-03
Cumulative		6.2 E-01		9.9 E-02		3.3 E-02

[a] Based on 2 L/day ingestion.

CY = calendar year

Figure C5-6. Impacts of Base-Case Multiple Source Terms on Groundwater Dose—Tank Residuals after Retrieval, Past Leaks, and Hypothetical Retrieval Leaks from Selected Tanks in WMA C for the All-Pathways Farmer Receptor at Downgradient Fenceline.



C5.2.2 Drinking Water Dose Calculation Methods

The radiological dose resulting from the presence of radionuclides in drinking water may be calculated by either of the following two methods:

- Target Organ
- Effective Dose Equivalent.

The derivation and application of these two methods are described in the following subsections.

C5.2.2.1 Target Organ Method. The Target Organ method, as presented in this discussion, is the method prescribed by EPA for determination of compliance of drinking water supply systems with the MCL requirements of the "National Primary Drinking Water Regulations" (40 CFR 141.66, Final Rule 7, December 2000). The MCL for beta/photon emitters in drinking water is 4 mrem/yr. This method is derived from dose calculations described in *National Bureau of Standards Handbook 69* (NBS 1963, *Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure*).

The Radionuclide Rule is implemented according to procedures described by EPA in the *Implementation Guidance for Radionuclides* (EPA 2002. *Implementation Guidance for Radionuclides*) utilizing a sum-of-fractions calculation based on observed radionuclide concentrations in water and predetermined derived concentrations for each radionuclide that would result in a 4 mrem/yr dose if the nuclide was the only nuclide present. The 4 mrem/yr MCL, based on the target organ calculation, has been in place as the drinking water standard since 1976. The derived concentrations for selected radionuclides of interest to tank closure are shown in Table C5-7.

Table C5-7. Comparison of Derived Concentrations for Selected Beta and Photon Emitting Radionuclides.

Nuclide	Concentration resulting in 4 mrem/yr MCL to critical organs (pCi/L)	Risk at MCL	1991 proposed concentration resulting in 4 mrem/yr EDE (pCi/L)	Risk at EDE
Tritium	20,000	3.57 E-05	60,900	1.09 E-04
Carbon-14	2,000	1.09 E-04	3,200	1.75 E-04
Technetium-99	900	7.28 E-05	3,790	3.07 E-04
Antimony-125	300	4.12 E-05	1940	2.67 E-04
Iodine-129	1	4.22 E-06	21	8.87 E-05

Source: EPA 2000, *Radionuclides Notice of Data Availability Technical Support Document,* Table III-3.

C5.2.2.2 Effective Dose Equivalent Method. The EDE method of calculating radiological dose from drinking water was proposed for use in determining compliance with the radionuclide MCL in 1991. This method was proposed because it would result in a more consistent risk level within EPA's target risk range, and would be more consistent with similar dose calculations used by other agencies (such as DOE). In codifying the final rule in December 2000, however, EPA decided to retain the existing Target Organ calculation method on the basis that it is protective of public health. The EDE dose calculation method is prescribed by DOE in DOE Order 5400.5 (DOE 1990, *Radiation Protection of the Public and the Environment*). The EDE dose is implemented in the same manner as the Target Organ dose method utilizing a sum-of-fractions calculation. The derived concentrations for individual nuclides that result in 4 mrem/year EDE drinking water dose are different from those established for the Target Organ method. The EDE derived concentrations for selected radionuclides are shown in Table C5-7.

C5.2.2.3 Comparison of Dose Calculation Methods. The EDE calculation method was selected for use in the WMA C closure risk evaluation because of the apparent direct applicability of DOE Order 5400.5 to the Hanford site. For the selected nuclides shown in Table C5-7, the difference between derived concentrations for EDE and Target Organ methods ranges from a low of about 1.5 times higher for the EDE method for carbon-14 to as much as 21 times higher for the EDE method for iodine-129. This difference means that for a specific concentration of a particular nuclide present in drinking water, the dose resulting from that nuclide will be lower using the EDE calculation method than for the Target Organ method. For drinking water containing a mixture of nuclides, the difference between the two methods is

greater when nuclides such as iodine-129 or antimony-125 are present because of the greater difference in the derived concentration for these nuclides between the two methods. Because iodine-129 and technetium-99 account for the majority of calculated dose in the preliminary WMA C dose estimates, there is a substantial difference between the two methods. There remains substantial uncertainty in the actual iodine-129 and technetium-99 content of the wastes contained in WMA C tanks. The iodine-129 concentration may actually be substantially lower that current estimates. Sampling and analysis of residual waste is planned and should result in reduced uncertainty and more accurate dose estimates.

C5.2.3 Incremental Lifetime Cancer Risk (ILCR)

The ILCR analysis is presented in this section. Results for the cumulative impacts for tank residuals (diffusion-dominated release), past leaks (tank leaks and ancillary equipment), and hypothetical retrieval leaks are discussed first, followed by cumulative releases for all sources. Two of the HSRAM Exposure Scenarios are discussed. These are the Industrial and Residential scenarios for ILCR which are described in HNF-SD-WM-TI-707. Additional exposure scenarios are given in Section 7 of the Addendum C-1 and in Addendum C-2.

The HSRAM Industrial is presented because the Hanford Advisory Board Advice recommends the industrial scenario for the 200 Core Zone Boundary for the next 150 years. The results of the risk assessment show that highest risks are due to past leaks and hypothetical retrieval leaks. The highest predicted release from WMA C occurs within the next 150 years due to past leaks and hypothetical retrieval leaks. Therefore, the industrial scenario is presented. The HSRAM residential scenario is presented because it is unrealistic to assume that an industrial scenario is appropriate once the existing groundwater plumes have been remediated or have naturally attenuated. It is expected that the existing groundwater plumes will have been either remediated or naturally attenuated by the time contamination due to residual tank waste arrives at the water table. Both of the HSRAM scenarios account for multiple exposure pathways (food chain, ingestion, inhalation, etc. See Table 26 of Addendum C1 for a complete listing of exposure pathways).

The ILCR results are presented in Table C5-8. The table has been divided into three sections to show the relative contribution from each of the major source terms (residual tank wastes [diffusion-dominated release], all past UPRs [tank leaks and ancillary equipment], and hypothetical retrieval leaks). Only these major sources are discussed; see Addendum C1 for discussion of minor sources (i.e., ancillary equipment). Highlights of this table include the following:

- **Residual Tank Waste:** Cumulative ILCR risk is 1.0 E-06 from all radioactive chemicals (inventory from RPP-15317), of which technetium-99 and iodine-129 contribute 99% of the total risk (see Addendum C1, Table 28). The cumulative ILCR is below the performance objective value of 1.0 E-05 at all evaluation points for the HSRAM Industrial exposure scenario. However, for the HSRAM Residential scenario, at the WMA fenceline, cumulative ILCR is approximately twice (2.3 E-05) the performance objective, but below the performance objective at calculation points located

downgradient from the fenceline. Risk from technetium-99 and iodine-129 account for more than 98% of the total risk (see Addendum C1, Table 28).

- **Past Leaks:** For the HSRAM Industrial exposure scenario, cumulative total ILCR from all radioactive chemicals at the WMA C fenceline is 8.1 E-06, which is below the performance objective value. Technetium-99 and iodine-129 are responsible for 94% of the total risk (see Addendum C1, Table 28). For the HSRAM Residential scenario at the WMA fenceline and 200 Area Core Zone Boundary, cumulative ILCR is 1.8 E-04 and 2.7 E-05, respectively, which are both above the performance objective. At the Columbia River calculation point, the risk drops to 1.9 E-05, which is right at the performance metric. Risk from technetium-99 and iodine-129 accounts for greater than 98% of the total risk.

- **Hypothetical Retrieval Leaks:** For the HSRAM Industrial exposure scenario, cumulative total ILCR from all radioactive chemicals at the WMA C fenceline is 6.5 E-06, which is below the performance objective value. For the HSRAM Residential scenario at the WMA fenceline and 200 Area Core Zone Boundary, cumulative ILCR is 1.4 E-4 and 2.2 E-05, respectively, which are both above the performance objective. At the Columbia River calculation point, the risk drops to 7.4 E-06.

- **Incremental Lifetime Cancer Risk Cumulative Impacts from All Sources:** An analysis of cumulative effects of all source terms (radioactive chemicals), including the minor source terms, for the HSRAM Industrial ILCR is presented Figure C5-7. Note that the highest peak ILCR (1.4 E-05) occurs early in the postclosure period. Existing past leaks and hypothetical retrieval leaks contribute almost the entire peak value. Without the hypothetical retrieval leaks, the peak value would be below the target performance objective of 1.0 E-05. After approximately calendar year (CY) 4,800, the residual waste contribution becomes the primary contributor to risk. For the HSRAM Residential Scenario, the values shown on this curve can be scaled by a factor of approximately 22 and the peak value 3.0 E-04 ILCR.

Table C5-8. Incremental Lifetime Cancer Risk from Exposure to Groundwater for Selected Constituents. (3 Pages)

Constituent	**WMA C Fenceline**		**Core Zone Boundary**		**Columbia River (Groundwater)**	
	Time (CY)	**Risk**	**Time (CY)**	**Risk**	**Time (CY)**	**Risk**
Contribution from Tank Residuals						
HSRAM Industrial Scenario – RISK (compare to 1.0 E-05 Target)						
Technetium-99	5610	9.0 E-07	5637	1.4 E-07	5839	5.2 E-08
Iodine-129	5614	1.0 E-07	5637	1.6 E-08	5839	5.8 E-09
RAD TOTAL[a]		1.0 E-06		1.6 E-07		6.0 E-08
Chromium[+6b]	5614	2.8 E-08	5637	4.4 E-09	5839	1.6 E-09
Non-RAD Total		2.8 E-08		4.4 E-09		1.6 E-09

Table C5-8. Incremental Lifetime Cancer Risk from Exposure to Groundwater for Selected Constituents. (3 Pages)

Constituent	WMA C Fenceline		Core Zone Boundary		Columbia River (Groundwater)	
	Time (CY)	Risk	Time (CY)	Risk	Time (CY)	Risk
HSRAM Residential Scenario – RISK (compare to 1.0 E-05 Target)						
Technetium-99	5610	2.2 E-05	5637	3.4 E-06	5839	1.3 E-06
Iodine-129	5614	5.2 E-07	5637	8.2 E-08	5839	3.0 E-08
RAD TOTAL[a]		2.3 E-05		3.5 E-06		1.3 E-06
Chromium^{+6} [b]	5614	6.3 E-08	5637	9.8 E-09	5839	3.6 E-09
Non-RAD Total		6.3 E-08		9.8 E-09		3.6 E-09
Contribution from Past Tank Leaks and Unplanned Releases						
HSRAM Industrial Scenario – RISK (compare to 1.0E-5 Target)						
Technetium-99	2117	6.9 E-06	2141	1.1 E-06	2355	3.8 E-07
Iodine-129	2117	7.1 E-07	2141	1.1 E-07	2355	4.0 E-08
RAD TOTAL[a]		8.1 E-06		1.3 E-06		4.5 E-07
Chromium^{+6} [b]	2117	1.1 E-07	2141	1.7 E-08	2355	6.1 E-09
Non-RAD Total		1.1 E-07		1.7 E-08		6.1 E-09
HSRAM Residential Scenario – RISK (compare to 1.0E-5 Target)						
Technetium-99	2117	1.7 E-04	2141	2.6 E-05	2355	1.0 E-06
Iodine-129	2117	3.7 E-06	2141	5.7 E-07	2355	2.1 E-07
RAD TOTAL[a]		1.8 E-04		2.8 E-05		1.0 E-05
Chromium^{+6} [b]	2117	2.4 E-07	2141	3.8 E-08	2355	1.5 E-8
Non-RAD Total		2.4 E-07		3.8 E-08		1.5 E-8
Contribution from Hypothetical Retrieval Leaks						
HSRAM Industrial Scenario – RISK (compare to 1.0 E-05 Target)						
Technetium-99	2082	5.7 E-06	2107	9.1 E-07	2324	3.0 E-07
Iodine-129	2082	6.1 E-07	2107	9.7 E-08	2324	3.2 E-08
RAD TOTAL[a]		6.5 E-06		1.0 E-06		3.4 E-07
Chromium^{+6} [b]	2082	1.7 E-07	2107	2.8 E-08	2324	9.2 E-09
Non-RAD Total		1.7 E-07		2.8 E-08		9.2 E-09
HSRAM Residential Scenario – RISK (compare to 1.0 E-05 Target)						
Technetium-99	2082	1.4 E-04	2107	2.2 E-05	2324	7.4 E-06
Iodine-129	2082	3.2 E-06	2107	5.0 E-07	2324	1.7 E-08
RAD TOTAL[a]		1.4 E-04		2.3 E-05		7.6 E-06
Chromium^{+6} [b]	2082	3.8 E-07	2107	6.1 E-08	2324	2.0 E-08
Non-RAD Total		3.8 E-07		6.1 E-08		2.0 E-08

Table C5-8. Incremental Lifetime Cancer Risk from Exposure to Groundwater for Selected Constituents. (3 Pages)

Constituent	**WMA C Fenceline**		**Core Zone Boundary**		**Columbia River (Groundwater)**	
	Time (CY)	**Risk**	**Time (CY)**	**Risk**	**Time (CY)**	**Risk**

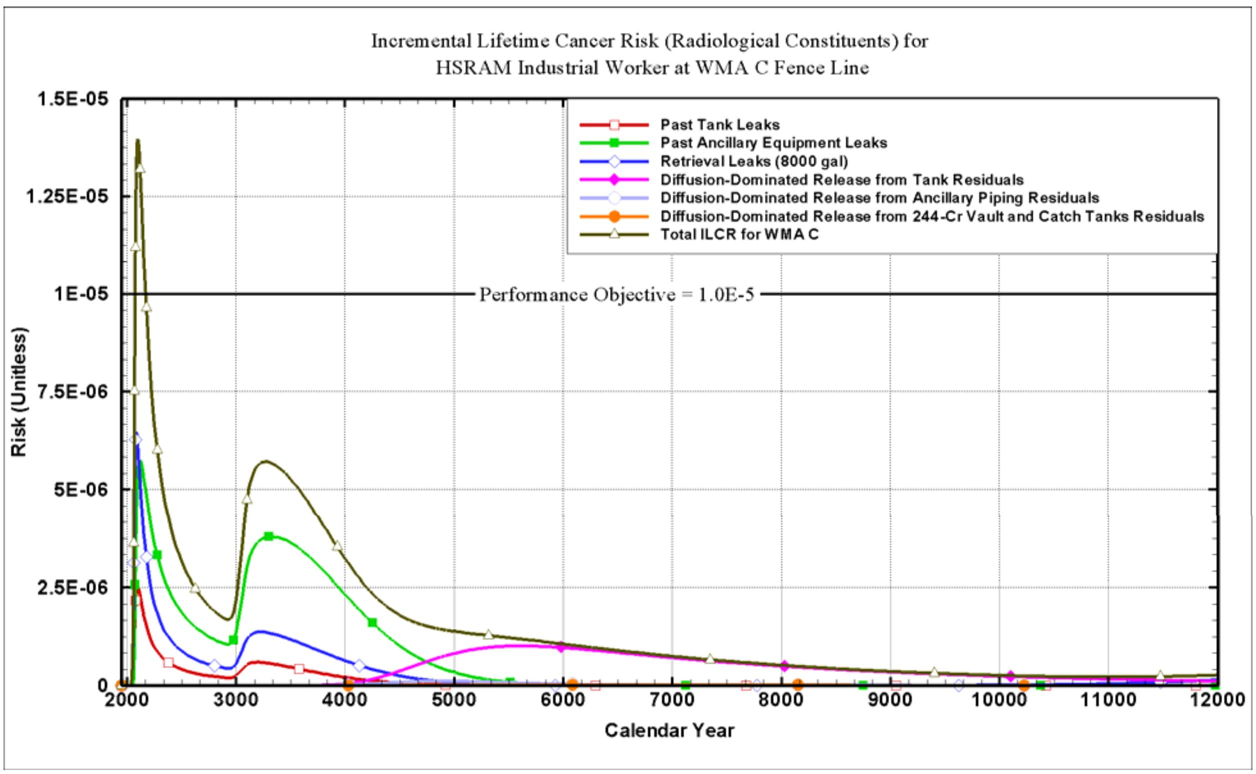
CY = calendar year.

RAD = radiological component of ILCR

[a] Cumulative includes all COPCs listed in *Inventory and Source Term Data Package* (DOE/ORP-2003-02) and *241-C Waste Management Inventory Data Package* (RPP-15317) that contribute to this risk metric

[b] For conservative purposes, all chromium is assumed to be in the +6 valence state additionally, when calculating ILCR, only the slope factors for inhalation are available, chromium is assumed to be inhaled through shower, sprinklers, and/or dust contaminated with it

Figure C5-7. Impacts of All Source Terms – Tank Residuals after Retrieval, Past Leaks, and Hypothetical Retrieval Leaks for the WMA C HSRAM Industrial Receptor at Downgradient Fence Line.



C5.2.4 Conclusions from Exposure Scenarios

The following conclusions can be drawn from the exposure scenarios:

- Following retrieval of tank waste to meet the maximum residual specified in the HFFACO, known past leaks and hypothetical retrieval leaks are responsible for the largest peak values for dose and cancer risk.
- Radiological dose resulting from the contribution of the various source terms (tank residuals, past UPRs, and hypothetical retrieval leaks) do not exceed target values at any of the points of computation.
- Cumulative ILCR exceeded the target value of 1.0E-05 at the WMA C fenceline for both the HSRAM Industrial and Residential receptor with technetium-99 responsible for the majority of the estimated risk.
- Cumulative ILCR exceeded the targe value of 1.0 E-05 for the HSRAM residential scenario at core zone boundary and was at the target value at the Columbia River. This is primarily due to past UPRs and hypothetical retrieval leaks.

C5.3 WORKER AND PUBLIC EXPOSURE RISK ASSESMENT

The worker and public exposure human health risk analysis estimated the potential health impacts from both accident and normal (non-accident) conditions resulting from various scenarios for C-106 and the C farm during closure activities. However, a safety analysis that identifies accident scenarios for closure activities is currently being developed under the document safety analysis effort and will be considered in the future evaluation of short-term risk. The analysis provided below shows the methodology and calculations used in a worker and public exposure risk assessment. It uses the safety analysis completed for retrieval of wastes from tanks for its accident scenarios. Thus, these are expected to provide conservatively high risk estimates because much of the waste has been removed and less contact between waste and workers is expected during closure.

C5.3.1 Assumptions

Occupational injuries, illnesses, and fatalities resulting from potential accidents are calculated based on the following assumptions:

- C-106 labor requirements for Phase I grouting* of the tank
  - Phase I grouting of tank = 3,800 hours
  - Phase I grouting of all C farm tanks = 60,800 hours.
- Hanford-specific incidence rates for occupational accidents

* See Preface in *SST System Closure Plan* (RPP-13774).

- Total recordable cases = 1.93×10^{-5} total recordable cases/hour
- Lost workday cases = 8.04×10^{-6} lost workday cases/hour
- Fatalities = 1.35×10^{-8} fatalities/hour.

In calculating the radiological latent cancer fatality (LCF) risk from routine exposure approach, the following assumptions were made:

- Volume of respirable waste released in the accident is as calculated in *Potential Accidents with Radiological and Toxicological Source Terms for Hanford Tank Waste Remediation System Environmental Impact Statement* (WHC-SD-WM-ANAL-041).
- Concentration of radionuclides is calculated from the inventory presented in *Inventory and Source Term Data Package* (DOE/ORP-2003-02) and provided in Addendum C1, Table 8(b).
- For the noninvolved workers and general public exposure scenarios, the atmospheric dispersion coefficients were calculated using the GXQ computer code (WHC-SD-GN-SWD-30002).
- For the involved workers it was assumed the respirable waste released in the accident would be released as a "puff" and spread instantaneously and uniformly around the exhaust port over a hemisphere 10 m (33 ft) in radius (WHC-SD-WM-ANAL-041).
- Breathing rates for the various receptors are provided in HNF-SD-WM-TI-707.
- Inhalation dose conversion factors for a 50-year dose commitment for each radionuclide are taken from HNF-SD-WM-TI-707.
- Dose-to-risk conversion factors for converting receptor doses to LCFs are referenced in "Preamble to Standard for Protection Against Radiation" (56 FR 23363) and *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991) and apply as follows:
  - Involved worker and noninvolved worker = 4.0×10^{-4} LCF/rem for low doses under 20 rem, 8.0×10^{-4} LCF/rem for high doses over 20 rem
  - General public = 5.0×10^{-4} LCF/rem for low doses under 20 rem, 1.0×10^{-3} LCF/rem for doses equal to or over 20 rem.

The number of accidents is calculated by multiplying the annual frequency of the accident by the time required to perform the activity. The annual frequency of a ventilation failure accident is referenced in WHC-SD-WM-ANAL-041. The time required to close the tanks is based on *Engineering Report for Interim Closure for Tank 241-C-106 and the 241-C Farm 200-Series Tanks* (RPP-14590).

In calculating the chemical hazard index from accident and routine exposure approach, the following assumptions were made:

- The chemical inventory used for these assessments were made up of two components, the organic chemicals and the inorganic chemicals. The emission rates for organic chemicals are taken from *Organic Vapor Source Term for Tanks 241-C-201, 241-C-202, 241-C-203, and 241-C-204 During Waste Retrieval Operations* (RPP-14841).

- Organic pollutant release concentrations and ammonia release concentrations were calculated assuming that 900 m^3/hr of air containing the pollutant concentrations observed in C-204 are exhausted year around.

- The mean concentrations of the organic pollutant and ammonia release were increased by two times the standard deviation to reflect statistical variability in the results. Two times the standard deviation represents a 95% confidence that the actual concentration is bounded.

- Only 33% of total chromium was assumed to be chromium(VI).

C5.3.2 Worker and General Public Exposure Risk Assessment Conclusions

Based on the worker and general public exposure human health risk analysis, the estimated potential health impacts from both accident and normal (non-accident) conditions resulting from WMA C tank closure activities are as follows:

- For the scenarios analyzed, the administrative control level of 0.5 rem/yr for a worker and the standard for routine exposure to the public of 0.1 rem/yr are not exceeded.

- In all cases, the acute exposure limit of 5.0 rem to an involved worker (located at 10 m [33 ft] from the point of release) from a radiological accident with an extremely unlikely probability of occurrence ($>10^{-6}$ to $\leq 10^{-4}$) would be exceeded. Mitigative measures are currently in place to prevent this type of accident from occurring through administrative procedures, worker training, and other types of preventive measures. As indicated, this accident is extremely unlikely. However, the assumptions used in calculating this probability are extremely conservative.

- For the scenarios analyzed, in no case would there be a fatality from occupational accidents nor would there be at least one lost workday case.

- Short-term radiation risk to the public for closure activities, expressed as LCFs, is very small, and of the order of 1.0 E-07 LCF.

- Conservative chemical accident impacts do not exceed the TEEL/ERPG-3 threshold for the involved worker, however small refinements to the methodology may allow the impacts to meet the TEEL/ERPG-2 threshold as the current estimate exceeds the

threshold values by only 2 percent. The impacts to the non-involved worker and the general public would not exceed the TEEL-0 threshold, of no impact.

- Routine chemical exposures would exceed the regulatory limit of 1.0 for noncarcinogenic chemicals.

Because the safety analysis of tank closure activities is not yet available, analogous safety data from other tank-related activities (retrieval) were used for the worker and public exposure risk assessment.

It is assumed that the accident scenarios developed for retrieval activities would be considered a bounding case for closure activities, since closure does not involve removing waste from tanks.

C6.0 CLOSURE SCHEDULE FOR WMA C

The timeline presented in Section C4.0 (Figure C4.1) depicts the relative sequence of closure activities associated with the WMA closure and postclosure actions.

The HFFACO Milestone M-45 series (revised per change number M-45-02-03) defines major, interim, and target milestones for the SST system closure. Specific milestones related to WMA C component closure activities or the WMA C closure action are listed below:

- M-45-05I-T01 – Conduct C-106 waste retrieval and closure demonstration project 30% design consultation. Milestone date 1/31/2003 (completed).
- M-45-05J-T01 – Complete C-106 waste retrieval and closure demonstration project design. Milestone date 4/30/2003 (completed).
- M-45-05K-T01 – Complete C-106 waste retrieval and closure demonstration project construction. Milestone date 9/30/2003.
- M-45-05L-T01 – Complete full-scale C-106 waste retrieval. Milestone date 11/1/2003.
- M-45-05M-T01 – Submit C-106 waste retrieval results, analysis of residual waste(s), and (if appropriate) request for exception to the criteria pursuant to HFFACO Appendix H. Milestone date 2/27/2004.
- M-45-05H – Interim completion of C-106 waste retrieval and closure demonstration project. Milestone date 4/30/2004.
- M-45-05N-T01 – Final completion of C-106 retrieval and closure demonstration project. Milestone date 12/31/2004.
- M-45-03-T04 – Submit C-104 sludge/hard heel, confined sluicing and robotic technologies, waste retrieval functions and requirements document. Milestone date 12/31/2001 (completed).
- M-45-03G – Complete C-104 sludge/hard heel, confined sluicing and robotic technologies, waste retrieval cold demonstration. Milestone date 6/30/2004.
- M-45-03H – Complete C-104 sludge/hard heel, confined sluicing and robotic technologies, waste retrieval demonstration design. Milestone date 9/30/2004.
- M-45-03I – Complete C-104 sludge/hard heel, confined sluicing and robotic technologies, waste retrieval demonstration construction. Milestone date 9/30/2006.
- M-45-03F – Complete full-scale sludge/hard heel, confined sluicing and robotic technologies, waste retrieval demonstration at tank C-104. Milestone date 12/31/2007.

- M-45-06A – Submit a certified (framework) SST system closure plan modification and C-106 waste retrieval and closure demonstration plan to Ecology. Milestone date 12/19/2002 (completed).
- M-45-06D – Submit a certified (framework) SST system closure plan modification and C-104 waste retrieval and closure demonstration plan to Ecology. Milestone date 6/30/2007.
- M-45-14 – Interim completion of tank C-104 SST waste retrieval and closure demonstration project. Milestone date 6/30/2008.
- M-45-14-T01 – Final completion of tank C-104 SST waste retrieval and closure demonstration project. Milestone date 6/3/2009.
- M-45-06 – Complete closure of all SST farms in accordance with approved closure/postclosure plan(s). Milestone date 9/30/2024.

DOE will work closely with the regulators to develop the schedule for the WMA C closure action as component closure activities progress and as specific scheduling information becomes available.

C7.0 CLOSURE CERTIFICATION, NOTICE IN DEED, AND SURVEY PLAT

In accordance with WAC 173-303-610(6), "Certification of Closure," within 60 days of completing the final closure of WMA C, DOE will submit to Ecology by registered mail, a certification that WMA C has been closed according to the specifications in this closure action plan. The certification will be signed by DOE and an independent registered professional engineer.

In accordance with WAC 173-303-610(9) and (10), "Notice to local land authority," and "Notice in deed to property," no later than the date of submission of the certification of closure of WMA C, DOE will provide a survey plat to Benton County indicating the location and dimensions of the closed dangerous waste units with respect to permanently surveyed benchmarks. The survey plat will be prepared and certified by a professional land surveyor. After the final closure, the survey plat of the WMA will be submitted to Benton County and Ecology. In addition, any restrictive covenants on the use of the land also will be submitted to Benton County for attachment to the property deed, as necessary.

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C8.0 POSTCLOSURE CARE

In accordance with WAC 173-303-640(8)(c)(ii), a contingent postclosure plan is required to be included in a closure plan for a tank system that does not comply with secondary containment, such as the SST system. This postclosure plan must provide for contingent postclosure care in accordance with the requirements for landfills contained in WAC 173-303-665(6). Further details regarding postclosure care will be developed on completion of a WMA C surface barrier design. This information will be submitted in modifications to the WMA C Closure Action Plan prior to final closure as described in the relative timeline (Figure C4-1) and, if required, should removal or decontamination actions leave dangerous waste constituents in place above clean closure standards.

The DOE will provide to Ecology an amended WMA C Closure Action Plan if it determines that WMA C must be closed as a landfill. Should this determination be made, the contingent postclosure plan provided in this section would be amended and would become the WMA C Postclosure Plan.

C8.1 CONTINGENT POSTCLOSURE PLAN

After completing final closure activities and if closed with waste in place, WMA C would enter a postclosure care period. When this occurs, the postclosure requirements for WMA C will be incorporated into Part VI, “Unit-Specific Conditions for Units in Postclosure,” of the Site-Wide Permit.

C8.1.1 Groundwater Monitoring

Prior to closure of WMA C, a RCRA-compliant postclosure groundwater monitoring plan will be developed as identified in Figure C4-1. Postclosure groundwater monitoring will be integrated with the Central Plateau regional groundwater monitoring system. At that time, a description of the planned groundwater monitoring activities, frequencies at which they will be performed, and reporting requirements as required by WAC 173-303-645 and -665 will be included.

C8.1.2 Maintenance Activities

Barrier performance monitoring and maintenance activities, including inspections, will be performed as part of postclosure care of dangerous waste units (WAC 173-303-610(7)) and of tanks closed as landfills (WAC 173-303-665(6)). WMA inspection activities will be developed to include inspecting the institutional controls, the surface barrier (after final closure action), security elements, benchmarks, subsurface monitoring systems, groundwater monitoring wells, and other equipment that may be installed as part of postclosure monitoring. Surface barrier inspections will monitor such things as the condition of the vegetation, signs of intrusion, and run-on/run-off control. Maintenance will be scheduled when a problem is discovered during the

inspections. Maintenance activities would include repairs to the surface barrier as necessary to correct the effects of settling, subsidence, erosion, or other effects.

C8.1.3 Institutional Controls

Institutional controls generally include non-engineered restrictions on activities and access restrictions to land, groundwater, surface water, waste sites, waste disposal areas, and other areas or media that contain hazardous substances. The institutional controls are grouped into five main types of controls in the *Sitewide Institutional Control Plan for Hanford CERCLA Response Actions* (DOE/RL-2001-41). These five types of controls are warning notices or signs, entry restrictions, land-use management, groundwater-use management, and waste site information management. Entry restrictions include fencing and procedural requirements for access, and land-use management includes land-use and real property controls, and excavation permits.

Institutional controls will be implemented following WMA remedial measures if the endstate of the selected remedy cannot support unrestricted human use and unlimited human exposure (DOE/RL-2001-41). The institutional controls required will be specified in the postclosure permit for WMA C. The scope and duration of institutional controls will be based on an evaluation of residual contamination, the location of that material, reasonably anticipated future human land uses and environmental impacts.

C8.1.4 Postclosure Contact

DOE will be the official contact for WMA C during the postclosure activities at the following address:

U.S. Department of Energy
P.O. Box 450 (H6-60)
Richland, Washington 99352

C8.2 CERTIFICATION OF COMPLETION OF POSTCLOSURE CARE

No later than 60 days after completion of the established postclosure care period for WMA C, DOE will submit to Ecology, by registered mail, a certification that the postclosure care period for WMA C was performed in accordance with the specifications in the approved postclosure plan. The certification will be signed by DOE and an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification will be furnished to Ecology upon request.

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ADDENDUM C1

RISK ASSESSMENT FOR WMA C CLOSURE PLAN

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CONTENTS

FIGURES

TABLES

LIST OF TERMS

BBI	best-basis inventory
BTC	breakthrough curve shows peak concentration and arrival time at a specified location
COC	contaminant of concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
EDE	effective dose equivalent
ERPG	emergency response planning guideline
HAB	Hanford Advisory Board
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HTWOS	Hanford Tank Waste Operations Simulator
ILCR	incremental lifetime cancer risk
K_d	distribution coefficient
LCF	latent cancer fatality
MCL	maximum concentration limit
MEI	maximally exposed individual
MTG	minimum technology guidance
RCRA	*Resource Conservation and Recovery Act of 1976*
SPR	selected phase removal
SST	single-shell tank
TEDE	Total Effective Dose Equivalent
TEEL	threshold emergency exposure limit
TWINS	Tank Waste Information System database
UPR	unplanned release
WMA	waste management area
WTP	waste treatment plant
χ/Q	atmospheric dispersion coefficient

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1.0 INTRODUCTION

Under the *Hanford Federal Facility Agreement and Consent Order* (HFFACO; Ecology et al. 1989) the Hanford Site single-shell tanks (SST) and double-shell tanks (DST) are *Resource Conservation and Recovery Act of 1976* (RCRA) hazardous waste management units that will be eventually closed under Washington State "Dangerous Waste Regulations" (WAC 173-303). A closure plan for the tanks must be submitted to and approved by the Washington State Department of Ecology (Ecology).

Appendix C to the *Single-Shell Tank System Closure Plan* (RPP-13774) for the Hanford Site 200 Area contains the Waste Management Area C (WMA C) Closure Action Plan. Tank 241-C-106 (hereinafter referred to as C-106) is scheduled to have almost all of the remaining waste it contains removed and to undergo interim closure. To determine that the necessary amount of waste is removed for the interim closure of this tank, a risk assessment is required that determines the long-term human health and environmental impacts caused by the waste that cannot be removed from all of the tanks in the WMA C, including C-106.

This addendum to the WMA C Closure Action Plan presents a preliminary risk assessment (summarized in Section 5 of the plan), and was written before retrieval of C-106 waste to the HFFACO goal of 360 ft^3 to demonstrate the methods, data, and related analyses that will be used in the post-retrieval performance assessment. Consequently, this preliminary risk assessment highlights analyses and findings when data is sufficient, and identifies gaps in existing data. Assumptions have been made when data is insufficient or absent to enable impacts to be estimated and tentative findings to be made. Where data is insufficient, areas requiring additional data collection are identified.

1.1 BACKGROUND

The basis for the contents of this initial risk assessment is the result of a workshop on "Tank Closure Risk Assessments" that was held on December 13, 2002 in Ecology offices. In this workshop, the following categories of risk assessment were identified:

- Field investigation reports
- Pre-retrieval functions and requirements
- Post-retrieval tank risk assessment
- Pre-closure tank risk assessment
- Tank farm feasibility study
- Tank farm closure risk assessment.

These six categories represent the iterative nature of risk assessments, with each iteration providing greater detail and understanding of how the overall system behaves. The first category covers reports that are part of the RCRA Corrective Action Program and deals with past leaks. The next three categories deal with decisions on SSTs, but the information is presented in the context of WMA C. The risk assessment categories for tank farm feasibility study and tank farm closure risk assessment deal with decisions on a WMA basis. Unlike the first category, the remaining categories will include past leaks as well as hypothetical retrieval leaks and residual

waste (in tanks and tank ancillary equipment) as sources of contamination. An overview of these categories is given in Table 1.

Table 1. Important Features of Risk Assessment.

Category	Purpose	Significant Feature
Field investigation reports	Determine additional corrective actions needed to address past leaks	Gather field/laboratory data to fill in data gaps. Perform numeric calculations to understand transport conceptual model. Recommend additional corrective actions, if any.
Pre-retrieval functions and requirements	Provide environmental information for the design of retrieval systems	Use existing data to estimate risk (based on technetium-99) of no action, residual waste, and potential future leaks.
Post-retrieval tank risk assessment	Determine whether additional retrieval of waste is necessary	Determine inventory of key contaminants in residual waste in tank and in any retrieval leaks. Perform numeric calculations of impacts of waste remaining (including impacts from other tanks and equipment in WMA) assuming no impacts from tank fill.
Pre-closure tank risk assessment	Determine whether closure of tank can proceed using the methods proposed	Determine impacts from various options to close a tank (including fill and barriers). Impacts will include impacts from other tanks and equipment in WMA. Provide worker risk information for proposed closure options.
Tank farm feasibility study	Determine actions that are needed to close a WMA	Determine impacts from various options to close tank farm or WMA. Provide worker risk information for proposed closure options. Also includes ecological risk.
Tank farm closure risk assessment	Determine whether or not closure actions as implemented have been successful	Determine impacts from closed WMA, once all closure activities (except possibly final surface barrier) are completed. Also includes ecological risk.

WMA = waste management area

The categories of risk assessments, the scope, and decisions supported are provided in *Contents of Risk Assessments To Support the Retrieval and Closure of Tanks for the Ecology* (RPP-14284), which was written shortly after the workshop. The risk assessment presented in this closure action plan is considered preliminary post-retrieval and includes the risk assessment for C-106 as well as impacts from other tanks, equipment, and past leaks in WMA C. The plan is preliminary because it is being prepared before important information is known (such as post-retrieval residual waste characterization data and the content of the fill material). Also, the plan includes some aspects of the pre-closure tank risk assessment to identify data needs for closure. The final version of the risk assessment is expected in early 2004 as part of the process to verify that sufficient waste has been retrieved from C-106.

1.2 SCOPE AND OBJECTIVES

The overall scope of the closure risk assessment is to provide quantitative estimates of both short- and long-term human health risks related to closure activities and the anticipated final conditions in WMA C. The long-term human health risk estimates are placed in the perspective of potential risk contributions from all sources within WMA C. Specific assumptions (such as inventory in post-retrieval residuals) are made for tanks and other sources within the WMA

for which information is not available. The general objectives of the risk assessment are as follows:

- Provide quantitative estimates of long-term human health risk associated with the activities related to WMA C tank closure and final conditions of the WMA C tank systems.
- Identify short-term human health risks and accident scenarios related to tank closure activities that may produce unacceptable risks to Hanford Site workers or the public. These scenarios will be used to ensure that adequate controls are implemented to mitigate the risks.

The scope of this initial risk assessment includes the following four types of contaminant sources within WMA C:

- Past leaks from tanks
- Past leaks from tank ancillary equipment
- Potential leaks during waste retrieval
- Residual waste in tanks and tank ancillary equipment.

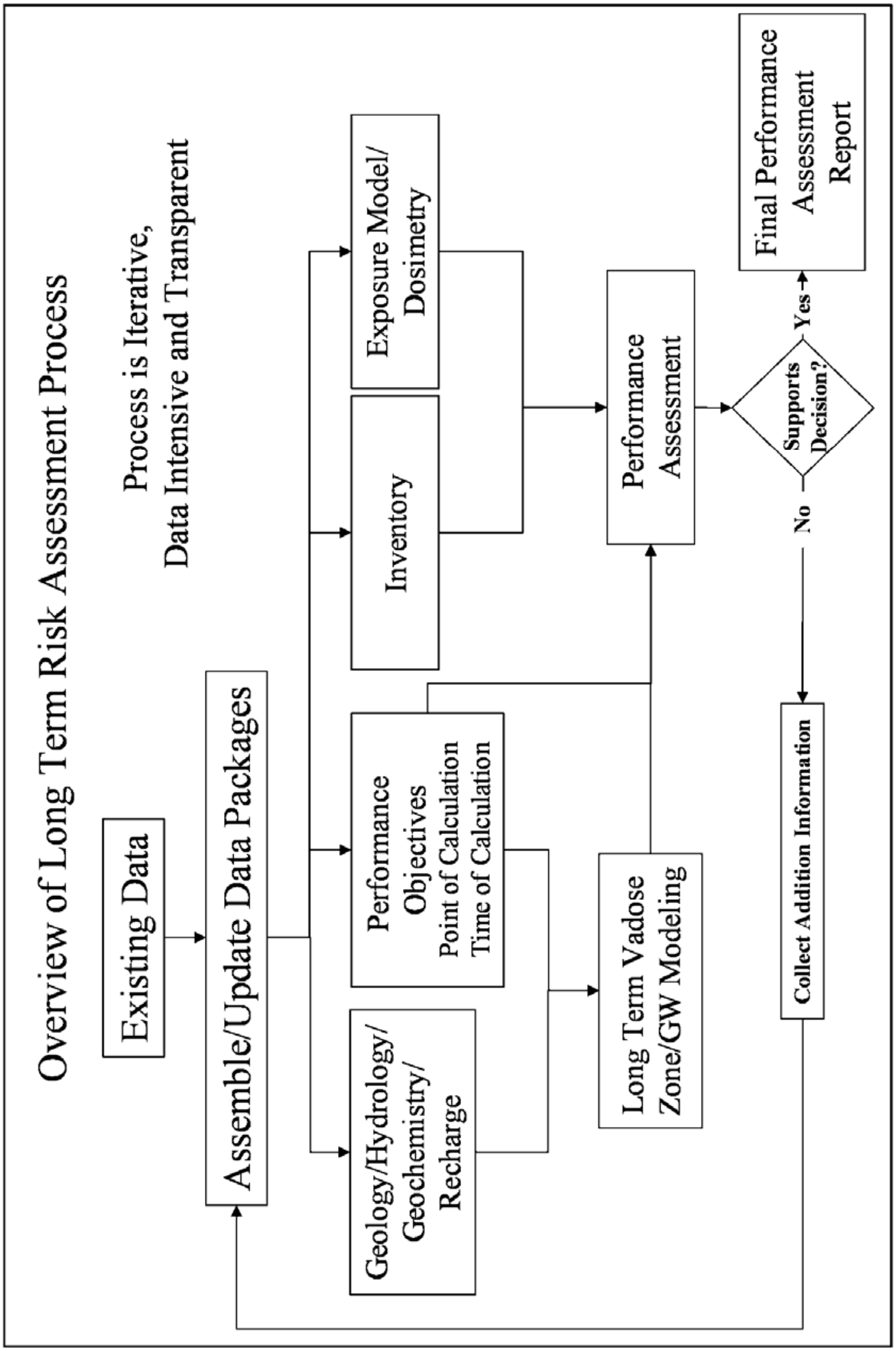
The primary focus of this risk assessment is to evaluate impacts to long-term human health risk for the WMA C over a 10,000-year time period as a result of exposure to a long-lived mobile radionuclide, such as technetium-99. However, to assess impacts from other mobile and relatively immobile contaminants, contaminants are grouped into several categories according to their distribution coefficient (K_d). All impact calculations are performed for unit curie (or unit mass) as a source term for each of the four contaminant sources. The resulting contaminant breakthrough curves (BTC) at the WMA C fenceline are then scaled for the appropriate source term inventory. BTCs show peak concentration and arrival time at a specified location.

1.3 BASIS OF METHODOLOGY AND LONG-TERM HUMAN HEALTH RISK ASSESSMENT DATA PACKAGES

The methodology for conducting long-term human health risk assessments is given in Figure 1. Key to conducting the risk assessments is the development of data packages. The following data packages were developed in support of the long-term human health risk assessment:

- *Performance Objectives for Tank Farm Closure Risk Assessments* (RPP-14283)
- *Modeling Data Package for an Initial Assessment of Closure for C Tank Farm* (RPP-13310)
- *241-C Waste Management Area Vadose Zone Inventory Data Package* (RPP-15317)
- *Exposure Scenarios and Unit Dose Factors for Hanford Tank Waste Performance Assessments* (HNF-SD-WM-TI-707).

Figure 1. Long-Term Human Health Risk Assessment Process for Closure.



These data packages are briefly summarized in the following sections and were used as the basis for this initial long-term human health risk assessment.

The analysis methodology is based on the following documents:

- *Field Investigation Report for Waste Management Area S/SX* (RPP-7884)
- *Field Investigation Report for Waste Management Area B/BX/BY* (RPP-10098)
- *Hanford Immobilized Low-Activity Waste Performance Assessment* (DOE/ORP-2000-24)
- *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds* (WHC-EP-0645)
- *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds* (WHC-EP-0875).

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2.0 PERFORMANCE OBJECTIVES AND METRICS

To be meaningful, results from a numeric risk assessment of the consequences of an action must be compared to the standards for such an action. That is, before one disposes of waste or closes a facility with waste, one must show that the disposal or closure action protects the public health and safety and the environment. These standards are called performance objectives.

Regulations requiring performance assessments usually require that the determination of performance objectives be one of the first steps performed. This is true whether they are federal regulations such as *Radioactive Waste Management* (DOE O 435.1[1]) and its implementing guides or state regulations like the regulations implementing "Model Toxics Control Act – Cleanup" (WAC 173-340). These performance objectives set comparison levels for the numeric results and define the media, pathways, exposure scenarios (receptors), spatial locations, and times that the performance assessment must consider. Thus, a performance objective consists of a metric level, place(s) of assessment, and time(s) of assessment.

Performance objectives are those levels to which the results of the numeric simulation will be compared to judge the success of the proposed cleanup or disposal actions. Additional comparison levels may be requested for information purposes, but are not officially part of the decision on the adequacy of the proposed action. Performance objectives are not the levels that a regulatory agency will enforce in a permit or authorization. Those levels, often called enforcement levels, will be set in the permit or authorization.

The initial step in identifying performance objectives is to note the requirements that could be applied to the proposed action. If that action is the disposal of radioactive mixed waste on the Hanford Site, a variety of requirements should be considered:

- U.S. Department of Energy (DOE) requirements
- U.S. Nuclear Regulatory Commission requirements
- U.S. Environmental Protection Agency (EPA) requirements
- Ecology requirements
- Programmatic requirements
- Public involvement.

An analysis of these requirements shows that the risk assessment must evaluate the following:

- General public
- Workers
- Inadvertent intruders

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[1] *Implementation Guide* for use with DOE M 435.1-1, July 9, 1999, Chapter IV, Section IV.P.(1) through IV.P.(4).

- Groundwater
- Surface water.

In addition, there are restrictions on the waste itself if it is land disposed.

The evaluation for risk assessment is done by defining exposure scenarios. The exposures scenarios describe the affected individuals (industrial worker, resident, recreational user, Native American), the exposure media (water, soil, and air), and the exposure pathway (ingestion, inhalation, and direct [dermal contact] exposure). A complete description of these exposure scenarios is given in Section 5.1 of this Addendum. Ecological risk assessment for native plants and animals will be done at WMA Closure (see Section 4.0 of the *Framework Plan for Single Shell System Closure Plan*, RPP-13774*)*. Once the risk assessment evaluation of the different exposure scenarios is completed, the numbers are then compared against the performance objectives.

This entire process, along with all the regulations and values considered, is documented in RPP-14283. The major performance objectives are summarized in Table 2. These objectives are the same as those of RPP-14283 (please see that document for additional performance objectives), except in this preliminary assessment the air pathway is not calculated.

Table 2. Performance Objectives for Tank Closure [a].

Protection of General Public and Workers [b, c, d]	
All-pathways dose from only this facility	25 mrem in a year [e]
All-pathways dose including other Hanford Site sources	100 mrem in a year [e]
Chemical carcinogens (incremental lifetime cancer risk)	10^{-5} [f]
Non-cancer-causing chemicals (Hazard Index)	1 [f]
Protection of an Inadvertent Intruder [e, g]	
Acute exposure	500 mrem
Continuous exposure	100 mrem in a year
Protection of Groundwater Resources [b, c, d, h, j, n]	
Alpha emitters	
^{226}Ra plus ^{228}Ra	5 pCi/L
All others (excluding uranium)	15 pCi/L
Beta and photon emitters	4 mrem in a year
Technetium-99	900 pCi/L
Iodine-129	1 pCi/L
Protection of Surface Water Resources [b, k]	
Alpha emitters	
^{226}Ra plus ^{228}Ra	0.3 pCi/L [m]
All others (excluding uranium)	15 pCi/L [m]
Beta and photon emitters	4 mrem in a year [m]

[a] All doses are calculated as effective dose equivalent. Values given are in addition to any existing amounts or background. The risk assessment provides calculations of dose based on the results of a review of all pertinent regulations. As noted, regulations vary in how dose is calculated (see Appendix C *WMA C Action Closure Plan*, Chapter 5.2.2 Drinking Water Dose Calculation Methods for a comparison between different methodologies for calculating dose)

[b] Evaluated for 1,000 years, but calculated to the time of peak or 10,000 years, whichever is longer.

[c] Groundwater use starts at the time when groundwater contaminated by Hanford Site operations before the year 2000 is estimated to be potable.

[d] Evaluated at the point of maximal exposure, but no closer than the fenceline of the waste management area in which the tank farm belongs. Also calculated at the edge of the 200 Area Core Zone and just before groundwater enters the Columbia River.

[e] Main driver is DOE O 435.1.[2]

[f] Main driver is WAC 173-340.

[g] Evaluated for 500 years, but calculated from 100 to 1,000 years.

[h] All concentrations are in water taken from a well.

[j] Main driver is DOE Order 5400.5 (II)(d).

[k] Evaluated at well at the edge of the Columbia River. No mixing with the river is assumed.

[m] Main driver is WAC 173-201A-250 (which states that Surface Water can be U.S. EPA Drinking Water Regulations for radionuclides, which is 4 mrem/yr.

[n] MCL Derived Constituent Concentration

[2] *Implementation Guide* for use with DOE M 435.1-1, July 9, 1999, Chapter IV, Section IV.P.(1) through IV.P.(4).

As noted in RPP-14283, a number of options were considered for metric levels, places of assessment, and times of assessment. Based on past experience in performing risk assessments for the Hanford Site (*Hanford Immobilized Low-Activity Tank Waste Performance Assessment* [DOE/ORP-2000-24]), the most important metrics are the following:

- All-pathways exposure (25 mrem in a year as established by DOE O 435.1[3]), Incremental Lifetime Cancer Risk (10^{-5}), and the chemical hazard index (1), the latter two established by WAC 173-340

- Groundwater protection (4 mrem in a year for beta and photon emitters as established in DOE Order 5400.5 (II)(d), "Radiation Protection of the Public and the Environment."

- Groundwater Drinking water standard after the existing plumes have either been remediated or have naturally attenuated.

The selection of times and places of assessment was driven by the desire to provide maximum information to the decision makers. Because of the relatively long travel time in the vadose zone associated with disposal of dry waste forms at the Hanford Site (approximately 3,000 years), calculations for such actions must extend past the 1,000 years often used in risk assessments. Calculations will be carried out for at least 10,000 years to show the peak impact (for events/waste forms having relative short release times compared to vadose zone travel) or the plateauing level (for waste forms having long release times). Various places of assessment will be used (WMA C fenceline, 200 Area Core Zone Boundary, shore of the Columbia River). However, because the WMA C fenceline, being closest, is expected to have the largest impacts, most comparisons will be performed there.

Potential risk provided by assumed final closure conditions is determined by using performance objectives-specific exposure scenarios that yield risk estimates that can be compared to Table 2 metrics. To evaluate the impact of final closure conditions on groundwater and surface water resources, contaminant leaching and migration analyses have been completed to estimate maximum groundwater concentrations from contaminants released from the WMA sources. These calculated contaminant concentrations are then compared directly with the groundwater and surface water concentration performance objectives. The relevant dose performance objectives (4 and 1 mrem/yr from beta and photon emitters for groundwater and surface water resources, respectively) are compared to calculated concentrations by converting concentrations to dose using radionuclide-specific dose conversion factors.

Evaluation of protection to the general public, workers, and inadvertent intruders requires the use of exposure scenarios. For the general public and workers, exposure primarily results from the use of contaminated groundwater. In this analysis, several scenarios and their respective limits are considered, including the following:

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[3] *Implementation Guide* for use with DOE M 435.1-1, July 9, 1999, Chapter IV, Section IV.P.(1) through IV.P.(4).

- All pathways farmer who lives 100 m downgradient of the waste site (25 mrem/yr performance objective)
- Native American who lives near the site (i.e., within the core zone boundary) and at the Columbia River (incremental lifetime cancer risk [ILCR] of 10^{-5} and a Hazard Index of 1)
- Industrial worker who works near the site (ILCR of 10^{-5} and Hazard Index of 1)
- Resident who lives near the site (ILCR of 10^{-5} and Hazard Index of 1)
- Farmer who lives near the site (ILCR of 10^{-5} and Hazard Index of 1)
- Recreational shoreline user who participates in leisure activities at the Columbia River (ILCR of 10^{-5} and Hazard Index of 1).

Evaluation of intruder protection (acute exposure of 500 mrem and chronic exposure of 100 mrem/yr) has been completed using two scenarios, the well driller who exhumes waste and the post-intruder resident who distributes exhumed waste in a garden. The waste contaminants are the primary sources of dose in these scenarios.

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3.0 MODELING APPROACH: EXISTING DATA AND ASSUMPTIONS

As part of the WMA C closure, an assessment is conducted to evaluate impacts on groundwater resources (the concentration of contaminants in groundwater) and long-term human health risk (associated with groundwater use). The evaluations consider the extent of contamination from residual wastes in tanks and tank ancillary equipment; past leaks, spills, and retrieval leaks; contaminant movement through the vadose zone to the saturated zone (groundwater); contaminant movement in the groundwater to various locations in groundwater; and assumed human receptor activities at those locations. A plan view of WMA C and associated sources is shown in Figure 2.

The following information is included in this section:

- Modeling approach
- Recharge (infiltration) data for C farm under current and post-closure conditions
- Source-term release scenarios and numerical cases considered
- Stratigraphic cross-sectional model for the C farm
- Contaminants of concern (COCs)
- Inventory data for various sources.

3.1 OVERVIEW OF LONG-TERM HUMAN HEALTH RISK ASSESSMENT MODELING APPROACH

The overall modeling approach is illustrated in Figure 3. The dominant pathway is through groundwater, as indicated by previous Hanford Site performance assessments and environmental impact statements (DOE/ORP-2000-24). Following closure, it is assumed that infiltration of moisture from precipitation eventually enters the tank facility (Step 1), most water is diverted by the tank structure or the barrier (Step 2), and contaminants are released into the vadose zone from the degraded tank structure (Step 3a-b). The released contaminants then travel through the vadose zone where they meet and mix with already-released contaminants, if any, from past leaks, spills, and leaks during the retrieval process (Step 4). The contaminants travel through the vadose zone until they reach the water table and the unconfined aquifer (Step 5). The contaminant breakthrough curves ([BTC] provide the concentration history through time) from residual wastes, past leaks, and retrieval for all tanks in C farm are combined via a spatial and temporal superposition (Step 6). The combined BTCs are then routed to various locations within the unconfined aquifer and the Columbia River, using an analytical solution (streamtube model) (Step 7). In the final step, the exposure scenarios are applied to determine risk (Step 8).

Figure 2. Waste Management Area C, Sources Considered in the Risk Assessment, and Surrounding Facilities.

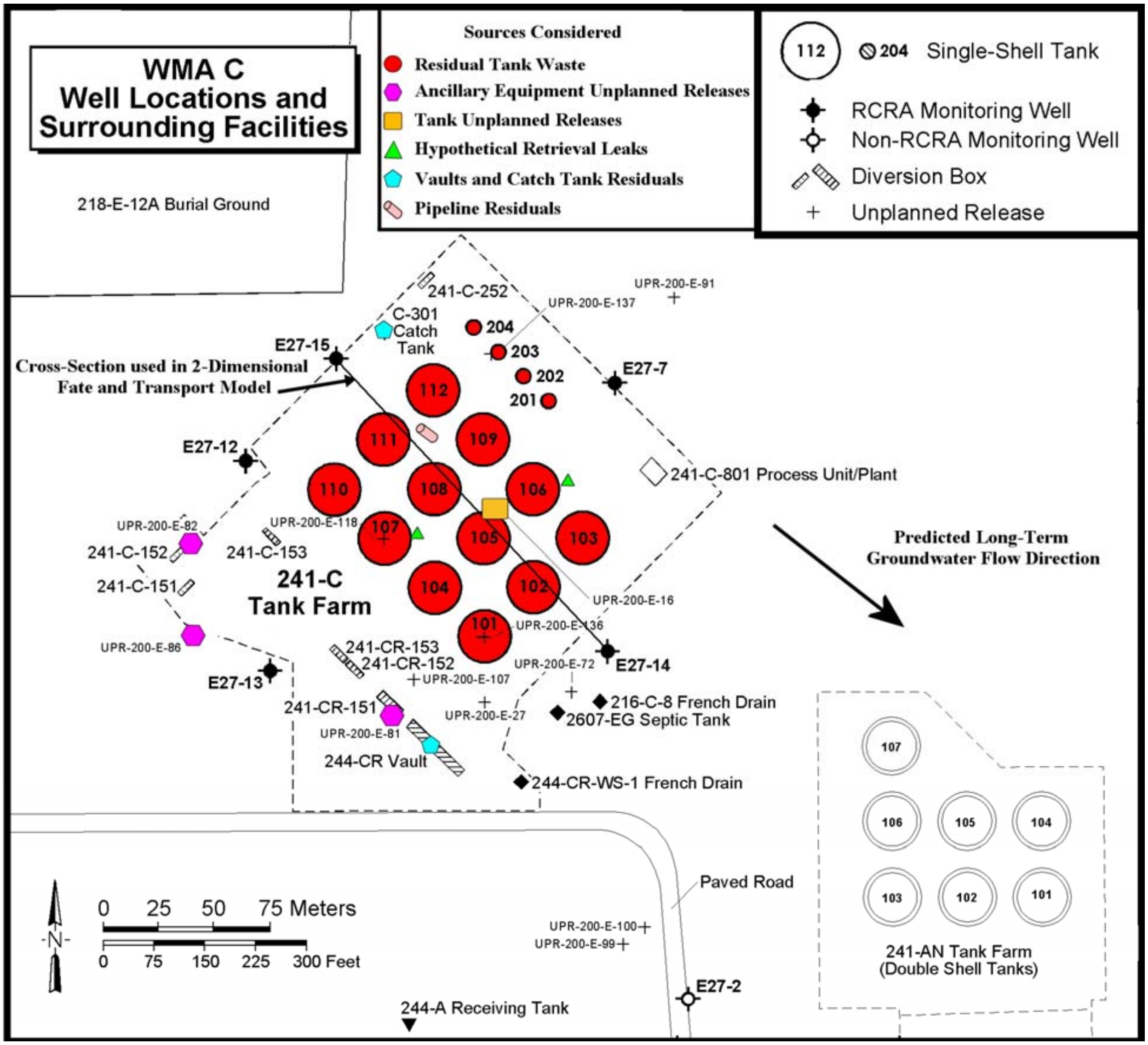
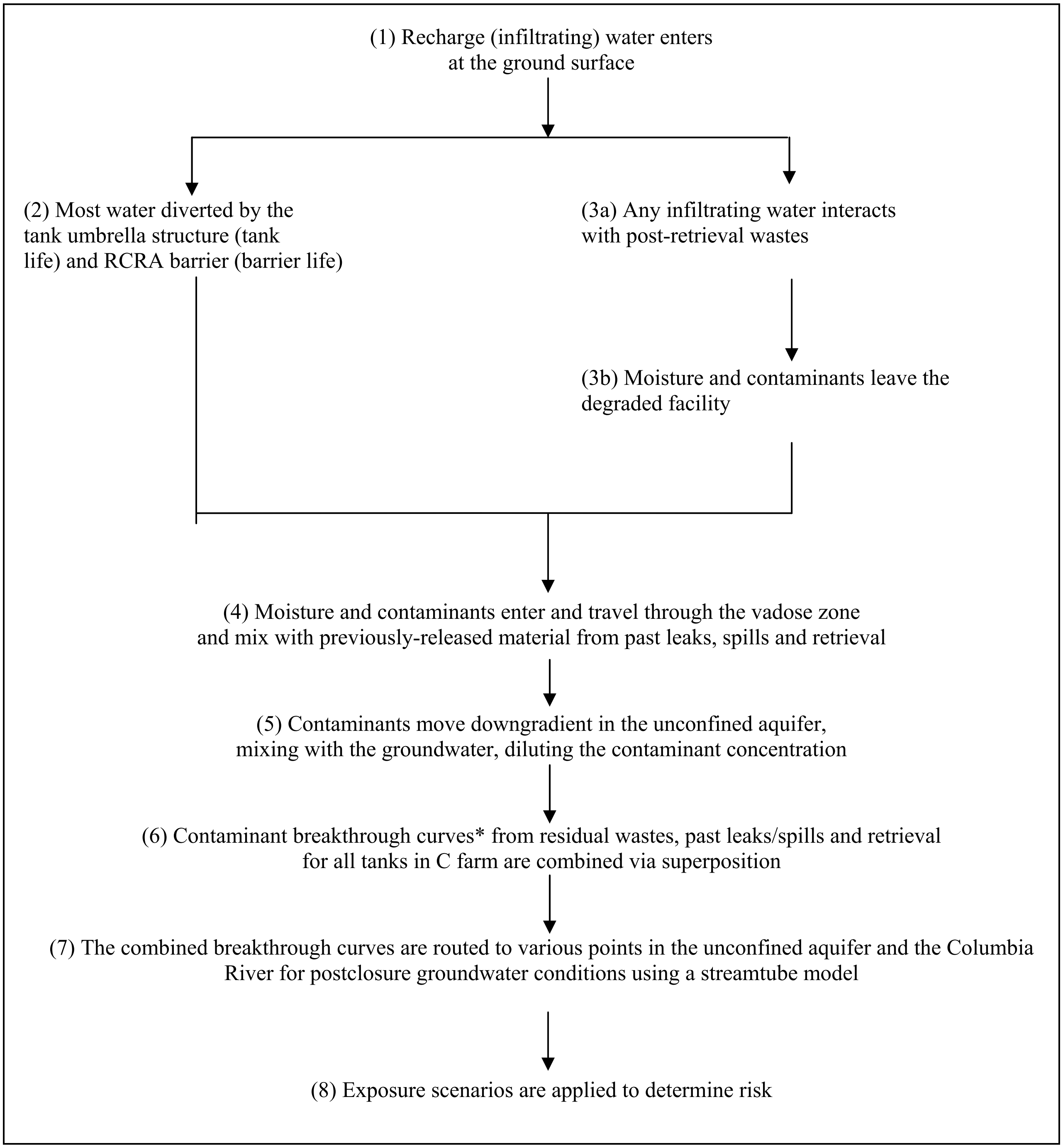


Figure 3. Overall Modeling Approach for Risk Assessment.



*Contaminant Breakthrough Curves are concentration history at a given point

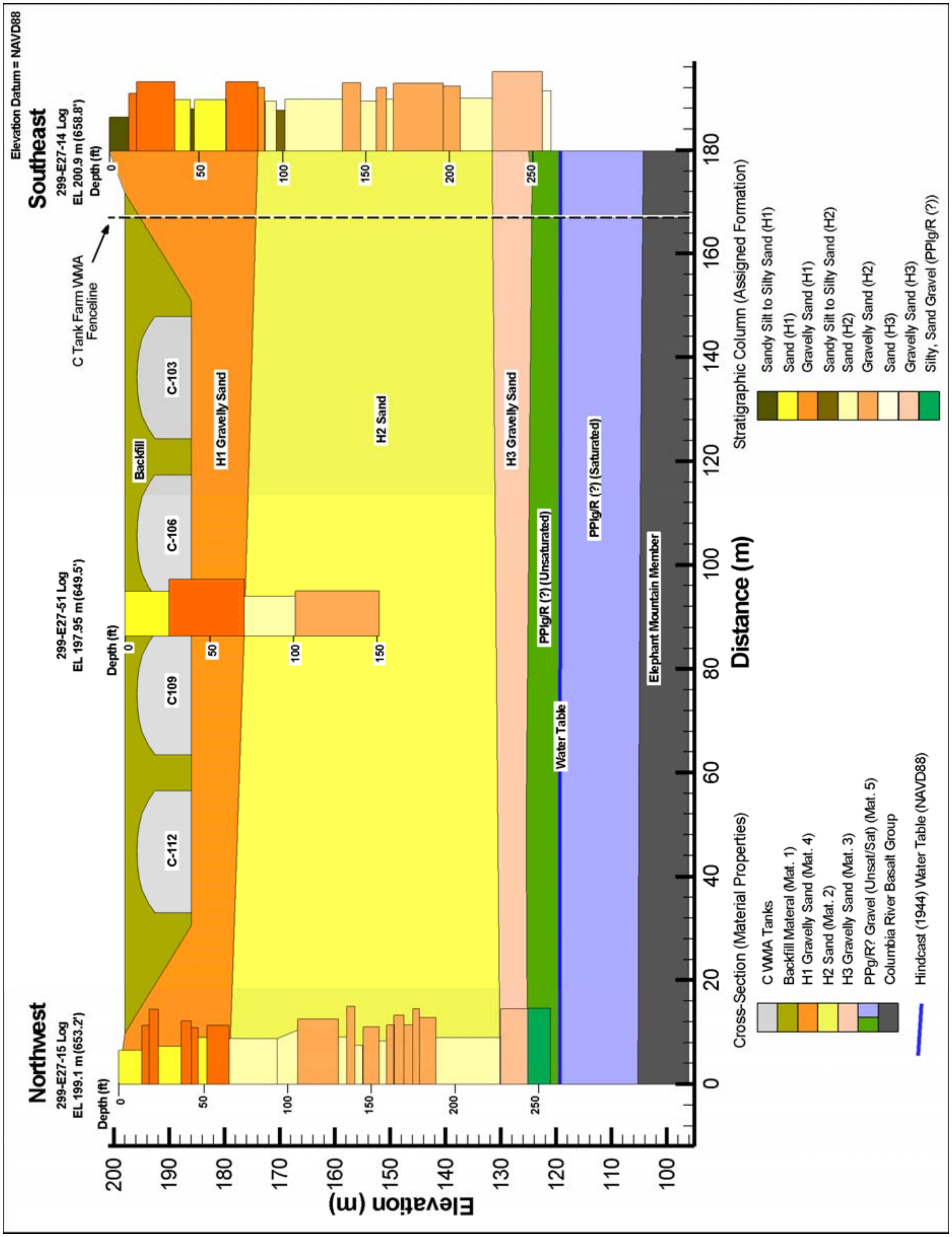
The concentration of the individual contaminants at the points of assessment is calculated by scaling unit inventory results from the various sources, and applying the principle of superposition to sum the concentrations. Each tank may have up to four sources of contamination associated with it: past leaks and spills, retrieval, residual tank wastes, and ancillary equipment. The model calculations are performed using one unit Curie (or one unit mass) as a source term for each of the four possible sources. The concentration of the individual contaminants resulting from the individual sources may then be calculated by scaling the unit source results by the actual contaminant inventory for each of the sources. The results associated with the different sources and different tanks may then be summed, using the principle of superposition, to produce a total fenceline concentration. Any one tank in a row may represent any other tank in the model simply by changing the distance from the tank to the fenceline for the following reasons: 1) the tanks were constructed and placed in a grid-like manner, 2) the geology beneath the tank farm appears to be consistent beneath the tanks, and 3) the rows of tanks are aligned parallel to the generalized future direction of groundwater flow. Thus the model constructed for C-112 (approximately 114 m from the WMA fenceline; see Figure 4) may be applied to C-109, C-106, and C-103 by collecting the model output at locations approximately 83 m, approximately 52 m, and approximately 21 m, respectively, from the tank. Verification tests were performed for all simulation cases (discussed in Section 3.3) in which sources are present at all four tank locations (in the row containing C-112, C-109, C-106, and C-103) and compared against the case with sources for C-112 only. The results of this comparison are given in Section 4.4.

The two-dimensional, cross-sectional simulations yield the contaminant mass flux and BTCs at the WMA C fenceline along the tank centerlines for the selected cross-section. To account for three-dimensional aspects, the tank centerline mass flux and BTCs are transformed to average values across the WMA C fenceline using two translations given in *FY00 Initial Assessment for S-SX Field Investigation Report (FIR): Simulations of Contaminant Migration and Surface Barriers* (PNWD-3111). In the first translation, the centerline quantities are converted to average quantities on the WMA C fenceline as the cross-sectional projections. The length of the cross-sectional projection equals the mean inventory diameter, where the mean inventory diameter is computed for each source inventory. The inventory diameter is not necessarily the tank diameter. In the second translation, the cross-sectional average mass flux or BTCs for various cross-sections are translated to a single average mass flux or BTC across the entire WMA C fenceline length using a length-weighted averaging scheme (PNWD-3111).

3.2 RECHARGE ESTIMATES FOR CURRENT AND POST-CLOSURE CONDITIONS

WMA C ground surfaces are presently covered with gravel to prevent vegetation growth and provide radiation shielding for site workers. Bare gravel surfaces, however, enhance net infiltration of meteoric water, compared to undisturbed naturally vegetated surfaces. Infiltration is further enhanced in tank farms by the effect of percolating water being diverted by an impermeable, sloping surface of the tank domes. This umbrella effect is created by the 23-m-diameter buried tank domes. Water, shed from the tank domes, flows down the tank walls into underlying sediments. Sediments adjacent to the tanks, while remaining unsaturated, can attain elevated moisture contents. Enhanced infiltration from a gravel-covered tank dome can provide potential for faster transport of contaminants to the water table.

Figure 4. Northwest-Southeast Cross-Section through C Farm



Infiltration (recharge) can vary greatly depending on factors such as climate, vegetation, surface condition, and soil texture. For the purpose of this risk assessment, a base case infiltration estimate of 100 mm/yr will be used before closure (Table 3).

Table 3. WMA C Infiltration (Recharge) Estimates for Pre-Construction Period, Current Conditions, and Following Emplacement of Closure Barrier.

Condition Simulated	Recharge Estimate (mm/yr)	Duration	Comment
Before 1943-1944 construction of C farm	3.5*	Until steady state moisture conditions are achieved for the year 1945	Vadose zone flow simulated at the recharge rate of 3.5 mm/yr to develop initial moisture conditions for subsequent simulations.
Current conditions	100	1945 to 2050	Recharge is assumed to increase from the pre-construction period estimate of 3.5 mm/yr to the current value of 100 mm/yr. During this period, the ground cover is gravel with no vegetation. An enhanced RCRA Subtitle C barrier is assumed to be in place by 2050.
Transition to conditions of restricted recharge with enhanced RCRA Subtitle C barrier	0.5	2050 to 2550	Recharge is assumed to decrease from a current estimate of 100 mm/yr to the barrier design value of 0.5 mm/yr. The barrier is assumed to function to its design estimate of 500 years.
Degraded barrier condition	3.5	2550 to 12000	The barrier is degraded and recharge increases from 0.5 mm/yr to 3.5 mm/yr until the end of simulation at 12,000 years.

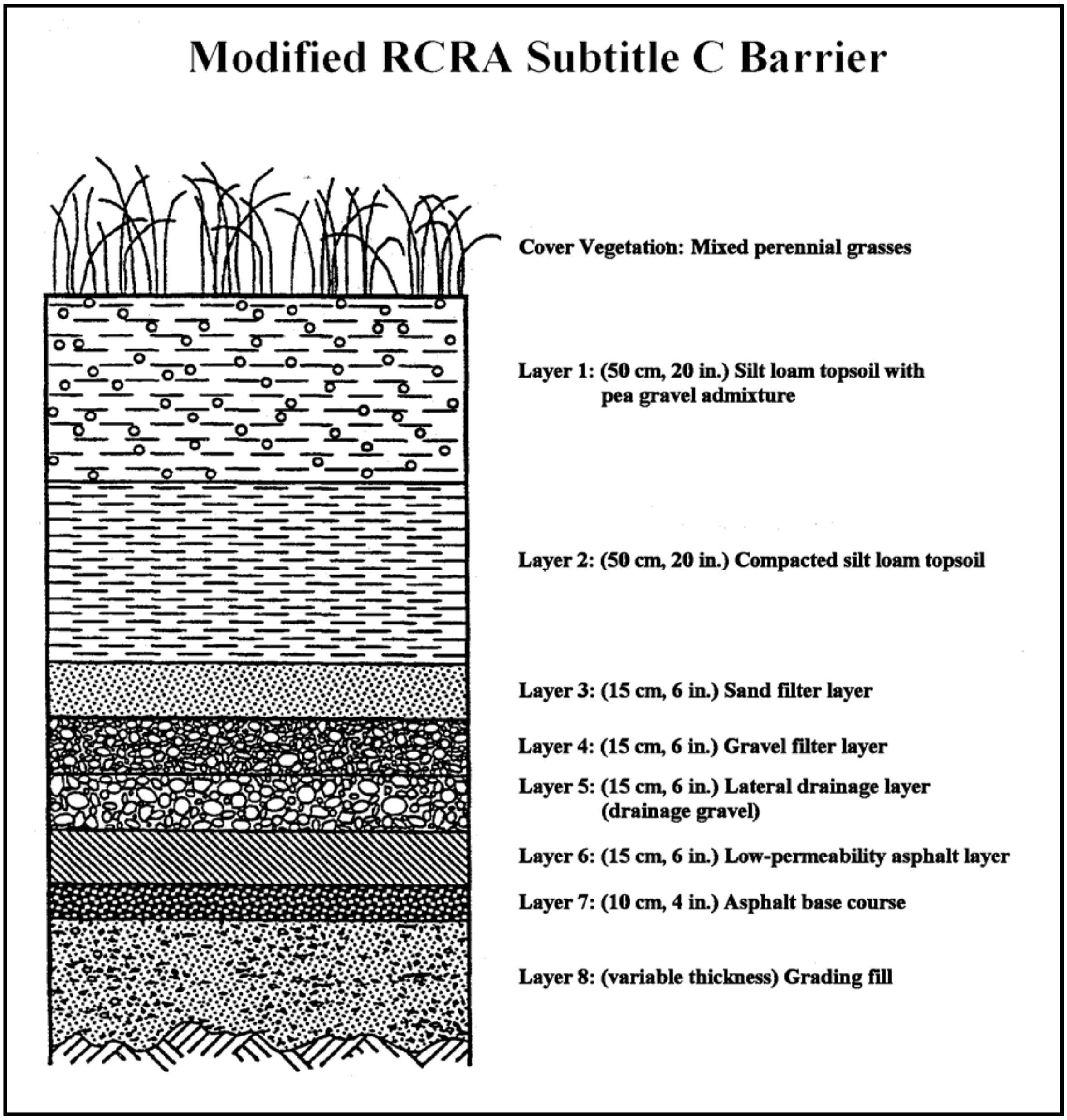
*Based on 8-year lysimeter data for graveled surface (PNNL-13033).

RCRA = *Resource Conservation and Recovery Act of 1976*.

3.2.1 Modified RCRA Subtitle C Barrier

The closure barrier for tank farms is assumed to be a Modified RCRA Subtitle C Barrier. The design of this barrier is given in *Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas* (DOE/RL-93-33 Rev. 1). This barrier is designed to provide long-term containment and hydrologic protection for a period of performance of 500 years. It is composed of eight layers of durable material with a combined minimum thickness of 1.7 m (5.5 ft) (Figure 5). This design incorporates RCRA minimum technology guidance (MTG) with modifications for extended performance. One major change is the elimination of the clay layer, which may desiccate and crack over time in an arid environment. The geomembrane component has also been eliminated because of its uncertain long term durability.

Figure 5. Modified RCRA Subtitle C Barrier Profile from DOE/RL-93-33.



The Modified RCRA Subtitle C Barrier is similar in structure to the Hanford Barrier (DOE/RL-93-33), but layer thicknesses are reduced and there is no fractured basalt. The design incorporates provisions for biointrusion and human intrusion control. The design of this barrier could be enhanced by increasing the thickness of the topsoil layers and by including some type of intrusion layer (similar to the fractured basalt in the fractured basalt layer in the Hanford Barrier) so that it would provide additional protection. It is assumed that the barrier placed over the WMA will be at least 15 ft (4.6 m) thick.

The recharge through such the Modified RCRA Subtitle C Barrier is estimated to be as low as 0.1 mm/yr (*Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance*

Assessment, PNNL-13033). For these simulations, a recharge rate of 0.5 mm/yr will be used. This is based on experimental data from a prototype Hanford barrier that has been designed and built in 200 Area to limit recharge to ≤ 0.5 mm/yr ("Quest for the Perfect Cap," Wing and Gee 1994). This is also supported by the numerical simulation results of *Simulations of Infiltration of Meteoric Water and Contaminant Plume Movement in the Vadose Zone at Single-Shell Tank 241-T-106 at Hanford* (WHC-EP-0332), which shows that with a relatively impermeable barrier over the tank farm, the drainage to a 2-m backfill depth decreased to less than 0.5 mm/yr after 8 years for cases of either a backfill or a clean graveled surface. For a degraded closure barrier, recharge rates are expected to return to predevelopment conditions (i.e., shrub-steppe ground cover), with a recharge estimate of 3.5 mm/yr. Such an estimate is within the range of values reported in *Estimated Recharge Rates at the Hanford Site* (PNL-10285).

Table 3 also summarizes the timeline estimates for barrier emplacement at the C farm and the corresponding recharge estimates.

3.3 SOURCE TERM RELEASE SCENARIOS, TRANSPORT MODELING, AND NUMERICAL CASES

This section provides an overview of the source term release scenarios, transport modeling, and numerical cases used in this risk assessment.

3.3.1 Source Term Release Scenarios

The source terms for the long-term closure assessment consist of four separate sources: past leaks and spills, leakage during retrieval, residual waste leachate from tanks following closure, and residual waste leachate from tank ancillary equipment following closure. The past leaks represent tank waste that has leaked into the vadose zone and has been migrating through the vadose zone for a number of years. Retrieval leakage refers to leakage to the vadose zone that could occur during waste retrieval operations using water-based sluicing. Releases from the residual wastes (both from tank and tank ancillary equipment) would typically occur over an extended period following closure of the tank farm when infiltrating water would enter the tank or tank ancillary equipment, dissolve contaminants, and migrate into the vadose zone and to the groundwater.

As discussed in Section 3.1, for each simulation unit, the curie or mass (unit source) is used as the source-term inventory for each of the four sources. A unit source means that for a particular source (i.e., residuals, past leaks, retrieval leaks), the numerical model simulated the release of one curie (radionuclides) or one kg (non-radionuclides) of contaminant. The results from the numerical model are then multiplied by the appropriate number of curies (radionuclides) or kg (non-radionuclides) for that source term (see Section 4.2 of this addendum for further discussion of unit source inventory). This is a logical approach when dealing with uncertainty and sensitivity of inventory estimates for various sources. As the best-basis inventory (BBI) and vadose zone inventory data are updated and refined, the contaminant breakthrough results, on the basis of unit source inventory, can be easily scaled to account for total inventory.

Past Leaks and Retrieval Losses. The retrieval case simulations assume that leaks occur over a specified area at the base of the tank near the edge, generally considered to be of low structural integrity (*Description of Vadose Zone/Groundwater Flow and Transport Numerical Modeling for S Tank Farm Retrieval Performance Evaluation* [PNWD-31-11]). The simulations for past leaks and spills do not attempt to model a waste release; instead, they model the potential risk posed by the existing vadose zone contamination footprint from past leaks and spills. Information on contamination footprint (inventory diameter with unit source) is based on spectral gamma data for drywells in the vicinity of WMA C.

Residual Waste Release. In contrast to releases from past leaks and retrieval losses, releases from residual waste generally are expected occur over a much longer time period. For residual tank wastes and residual ancillary equipment wastes, actual release mechanisms are unknown at this time. For an accurate determination of the source term, the chemical and physical processes controlling contaminant release from the residual wastes must be explicitly modeled. In the absence of post-retrieval tank waste characterization data and a lack of information of the controlling processes, a series of scenarios are assumed for contaminant release from tank wastes and tank ancillary equipment such that the modeling results include the range of possible outcomes.

One set of release scenarios assumes essentially uniform release rates over specified release periods, with the unit source inventory released over the entire release duration. A similar approach has been used in various versions of the immobilized low-activity tank waste performance assessment (DOE/ORP-2000-24). The other set of release scenarios allows the release duration to vary on the basis of various controlling processes (advection, diffusion, or solubility) that are active during release from residual wastes. In addition to recharge (infiltration) rates, these models consider the mixing (advection and diffusion) processes occurring within the residual wastes. A similar approach has been recommended by the U.S. Nuclear Regulatory Commission for the low-level waste performance assessment (*Background Information for the Development of a Low-Level Waste Performance Assessment Methodology* [NUREG/CR-5453]) and has been used for the 200 East and 200 West Areas solid waste performance assessment analyses at the Hanford Site (WHC-EP-0645; WHC-EP-0875). The advection-dominated release model is used to simulate contaminant release from unstabilized wastes (a waste form covered with backfill sand and gravel or a failed grout). The diffusion-dominated release model is used to simulate contaminant release from stabilized, contained wastes (a waste form covered with grout or cementitious grout). The solubility-dominated release model represents a waste form bound in a material that releases risk-driving contaminants congruently with the dissolution of the material. Details are presented in the modeling data package (*Modeling Data Package For An Initial Assessment of Closure for C Tank Farm* RPP-13310).

For some of the first set of scenarios, because of the assumed slow release of contaminants from the residual wastes, the anticipated BTCs in the groundwater are expected to show a relative broadening of the peak concentration rather than a sharp peak. In any case, the two sets of scenarios for release from residual wastes in tanks and tank ancillary equipment are chosen to produce conservative estimates.

3.3.2 Transport Modeling

Two-dimensional flow and transport models along the row of tanks are used for all vadose zone simulations. Figure 4 shows the NW-SE geologic cross-section through WMA C, and Figure 2 shows the location of the cross-section within WMA C. The simulations are composed of steady-flow and transient components, where flow fields developed from the steady-flow component are used to initialize the transient simulation. Steady-state initial conditions are developed by simulating from a prescribed unit hydraulic gradient condition to a steady-state condition, dictated by the initial meteoric recharge at the surface, water table elevation, water table gradient, no flux vertical boundaries, variation of hydrologic properties, and location of impermeable tanks.

The steady-flow simulation, representing flow conditions for the year 1945 (when WMA C tank farm construction was completed), is used as the initial condition for all subsequent flow and transport simulations. From the starting conditions, transient transport simulations are conducted for a 10,000-year period (i.e., years 2000 to 12000) that involve changes in the flow fields in response to current conditions, placement of closure barrier, and effects of degraded barrier. The infiltration (recharge) estimates for various times are described in Section 3.2. All simulations are run assuming isothermal conditions. The vadose zone is modeled as an aqueous-gas porous media system where transport through the gas phase is neglected.

Fluid flow within the vadose zone is described by Richards' Equation, whereas the contaminant transport is described by the conventional advective-dispersive transport equation with an equilibrium linear distribution coefficient formulation. A series of mobile to moderately retarded contaminant species (K_d = 0, 0.01, 0.03, 0.1, 0.3, 0.6, and 1.0) are considered for each run. The purpose of simulating the system with a suite of distribution coefficients with the unit source allows applying inventories to a wide range of COCs following retrieval.

No site-specific data are available on soil moisture characteristics for the C farm. Data catalogs are, however, available for 200 Area soils. For this work, data on laboratory measurements for moisture retention, particle-size distribution, saturated and unsaturated hydraulic conductivity, and bulk density for individual stratum are based on data for similar soils in 200 East and 200 West Areas. Details on modeling inputs are provided in the modeling data package (RPP-13310).

The computer code STOMP (*STOMP Subsurface Transport Over Multiple Phases, Version 2.0, Theory Guide* [UC-12030]) was chosen to model transport through the vadose zone and groundwater out to the WMA C fenceline. STOMP was chosen because it meets the requirements of *Computer Code Selection Criteria for Flow and Transport Code(s) To Be Used in Vadose Zone Calculations for Environmental Analyses in the Hanford Site's Central Plateau* (HNF-5294) and has been used for a number of risk assessments on the Hanford Site (RPP-7884; RPP-10098).

An analytical/streamtube approach is used to model groundwater flow and transport away from the WMA. The analytical solution in *Physical and Chemical Hydrogeology* (Domenico and Schwartz 1990) is used to model saturated transport.

3.3.3 Numerical Cases

As discussed in Section 3.3.1, the source terms for the risk assessment consist of four separate sources: leakage during retrieval, past leaks and spills, residual waste leakage from the tanks following closure, and residual waste leakage from the tank ancillary equipment following closure. Table 4 lists the release scenarios and numerical cases considered. The following provides a rationale for the selection of individual cases.

Table 4. Release Scenarios and Numerical Cases Considered (2 Pages).

Retrieval Leak

- **Case 1: Retrieval leaks, 8,000 gal.** A retrieval leak of 8,000 gal on the tank corner with start of leakage on January 1, 2000 and continuing for 14 days, with the leak occurring at the bottom east corner of tank C-112.
- **Case 2: Retrieval leaks, 20,000 gal.** A retrieval leak of 20,000 gal on the tank corner with start of leakage on January 1, 2000 and continuing for 14 days, with the leak occurring at the bottom east corner of tank C-112.

Past Leak

- **Case 3: Past leaks**. A past leak with its vadose zone inventory at a depth of 80 ft (based on drywell data) below ground surface (bgs) and an inventory diameter of 25 ft (based on drywell data) as of January 1, 2000, with the inventory distributed between tanks C-112 and C-109.
- **Case 4: Past leaks from ancillary equipment**. A past leak with its vadose zone inventory at a depth of 30 ft bgs (based on drywell data) and an inventory diameter of 25 ft (based on drywell data) as of January 1, 2000, with the inventory distributed between tanks C-112 and C-109.

Residual Waste Leak

- **Case 5: Residual tank waste; release rate R_0**. Residual tank waste source with a release rate R_0 (10^{-3} Ci/yr for 500 yr and 0.1 Ci/yr for 5 yr), a release start date of January 1, 2050 (i.e., date tank integrity is lost) and release over the tank bottom.
- **Case 6: Residual tank waste; release rate R_1**. Residual tank waste source with a release rate R_1 (10^{-4} Ci/yr for 500 yr, 10^{-2} Ci/yr for 95 yr), a release start date of January 1, 2050 (i.e., date tank integrity is lost) and release over the tank bottom.
- **Case 7: Residual tank waste; release rate R_2**. Residual tank waste source with a release rate R_2 (10^{-5} Ci/yr for 500 yr, 10^{-3} Ci/yr for 995 yr), a release start date of January 1, 2050 (i.e., date tank integrity is lost) and release over the tank bottom.
- **Case 8: Residual tank waste; release rate R_3**. Residual tank waste source with a release rate R_3 (10^{-6} Ci/yr for 500 yr, 10^{-4} Ci/yr for 9,995 yr), a release start date of January 1, 2050 (i.e., date tank integrity is lost) and release over the tank bottom.
- **Case 9: Residual tank waste; release rate R_4**. Residual tank waste source with a release rate R_4 (0.1 Ci/yr for 10 yr), a release start date of January 1, 2500 (i.e., date tank integrity is lost) and release over the tank bottom.
- **Case 10: Residual tank waste; advection-dominated release**. Residual tank waste source with advection-dominated release, a release start date of January 1, 2050 (i.e., date tank integrity is lost) and release over the tank bottom.
- **Case 11: Residual tank waste; diffusion-dominated release**. Residual tank waste source with a diffusion-dominated release rate ($K_d = 6 \times 10^{-7}$ cm^2/s; *Performance Assessment of Grouted Double-Shell Tank Waste Disposal at Hanford* [WHC-SD-WM-EE-004]), a release start date of January 1, 2050 and release over the tank bottom.

Table 4. Release Scenarios and Numerical Cases Considered. (2 Pages)

- **Case 12: Residual tank waste; solubility-controlled release**. Residual tank waste source with a solubility-dominated release; a release start date of January 1, 2050 (i.e., date tank integrity is lost) and release over the tank bottom.
- **Case 14: Residual tank waste; diffusion-dominated release**. Residual tank waste source with a diffusion-dominated release rate ($K_d = 5 \times 10^{-8}$ cm^2/s; *Hanford Waste-Form Release and Sediment Interaction A Status Report and Rational and Recommendations for Additional Studies* [PNL-7297]), a release start date of January 1, 2050 and release over the tank bottom.

Ancillary Equipment Waste Leak

- **Case 13: Residual ancillary equipment waste**. Residual tank ancillary equipment waste source with inventory located at a depth of 20 ft bgs, a release start date of January 1, 2050, and a diffusion-dominated release ($K_d = 6 \times 10^{-7}$ cm^2/s;WHC-SD-WM-EE-004) over an inventory diameter of 25 ft for the grouted* residual waste.

- **Retrieval Leak Loss.** There is considerable uncertainty regarding the performance of retrieval technologies and the ability to respond to a retrieval leakage event. This initial assessment used the assumption that hydraulic sluicing will be used to retrieve waste and if a leak were to occur, all tanks would experience an equal leak loss volume of 8,000 gal per tank (Case 1). Such an estimate of 8,000 gal per tank has been used in earlier retrieval performance evaluation analyses (*Retrieval Performance Evaluation Methodology for the AX Tank Farm* [DOE/RL-98-72]). However, a higher leakage loss of 20,000 gal per tank was also used as a sensitivity case (Case 2). These estimated retrieval leaks are higher than the hypothetical retrieval leaks (4,000 gal) reported in *Waste Retrieval and Storage Data Package* (DOE/ORP-2003-06).

- **Past leaks and spills.** As stated in Section 3.3.1, the simulated cases for past leaks (Case 3) and spills (Case 4) do not attempt to model a waste release; instead they model the potential risk posed by their existing vadose zone contamination footprint (RPP-15317). Information on contamination footprint and its location within the vadose zone for Cases 3 and 4 is based on spectral gamma data for drywells in the vicinity of C-106.

- **Residual waste leakage.** Residual waste leakage is considered for both tank (Cases 5 through 12 and Case 14) and tank ancillary equipment (Case 13). As discussed in Section 3.3.1, a series of post-closure scenarios are assumed for contaminant release from tank wastes and tank ancillary equipment such that the modeling results include the range of possible outcomes.

One set of scenarios (Cases 5 through 9) assumes uniform release rates over specified release periods, with the unit source inventory released over the entire release duration. The other set of release scenarios (Cases 10 through 12 and Case 14) allows the release duration to vary on the

* See Preface in *SST System Closure Plan* (RPP-13774).

basis of various controlling processes (advection, diffusion, or solubility) that are active during release. In effect, Cases 5, 6, 7, 8, and 9 arbitrarily release half of the unit inventory in the first 500 years, with the remaining inventory released in 5-, 10-, 100-, 1,000-, and 10,000-year release periods, respectively.

Cases 10, 11, 12, and 14 recognize whether the tank wastes are stabilized or unstabilized. The stabilized tank wastes (Cases 11 and 14) correspond to a waste form covered with grout* or cementitious grout (diffusion-dominated release), whereas the unstabilized wastes (Case 10) refer to a waste form covered with backfill sand and gravel/failed grout (advection-dominated release). Case 12 represents a waste form bound in a material that releases risk-driving contaminants congruently with the dissolution of the material (solubility-dominated release). Although both Cases 11 and 14 use diffusion-dominated release, Case 11 uses a distribution coefficient of 6×10^{-7} cm^2/sec, whereas Case 14 uses almost an order of magnitude lower distribution coefficient of 5×10^{-8} cm^2/sec.

The waste in the tank ancillary equipment, following closure, is assumed to be stabilized (i.e., grouted* waste form). Therefore, Case 13 for residual waste release from ancillary equipment considers only a diffusion-dominated release.

3.4 WASTE MANAGEMENT AREA C GEOLOGY

A detailed discussion of WMA C geology is provided in *Subsurface Conditions Description of the C and A-AX Waste Management Areas* (RPP-14430). A geologic cross-section taken through the middle of WMA C is provided in Figure 4. RPP-14430 identifies the following sedimentary sequences (from top to bottom) overlying the basalt beneath the WMA C:

- Backfill (material type 1, sandy gravel) – backfill materials consist of unstructured, poorly sorted mixtures of gravel, sand, and silt removed during tank excavation, and then later used as fill around the tanks.

- Hanford formation – upper gravelly sequence (H1 unit, material type 4, gravelly sand); Hanford formation H1 unit consists of predominantly loose coarse-grained gravel and sand deposits, with minor beds of sand to silty sand. Coarser beds may contain boulder-sized materials.

- Hanford formation – sand sequence (H2 unit, material type 2, sand); Hanford formation H2 unit consists of predominantly fine- to coarse-grained sand with lenses of silty-sand to slightly gravelly sand. Minor sandy gravel to gravelly sand beds occur sporadically.

- Hanford formation – lower gravelly sequence (H3 unit, material type 3, gravelly sand); Hanford formation H3 unit consists of predominantly gravelly facies of clast-supported, sandy, pebble- to boulder-sized gravel to matrix-supported pebbly sand.

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* See Preface in *SST System Closure Plan* (RPP-13774).

- Undifferentiated Plio-Pleistocene unit gravel (PPlg) and/or Ringold Formation Unit A? (PPlg/R(?) unit, material type 5). The PPLg/R(?) unit consists of predominantly sandy pebble- to cobble-sized gravel with occasional boulders. The unit shares characteristics of both coarse-grained facies of the Ringold Formation and the Plio-Pleistocene unit.

The geologic strata (Figure 4) are assumed to be continuous but not of constant thickness; the model includes the effect of dipping strata. The water table is located about 79.84 m (approximately 262 ft) bgs. The hydraulic and transport properties used for these sedimentary sequences in the flow and transport modeling are given in RPP-13310.

Hydraulic Conductivity of the Unconfined Aquifer: For all cases listed in Section 3.3.3, a hydraulic conductivity value of 4.8 m/day was used for the undifferentiated Plio-Pleistocene/ Ringold gravels. Although this value is consistent with laboratory measured values, it is inconsistent with the large-scale hydraulic conductivities for the unconfined aquifer reported within the 200 East Area, which are typically higher by at least factor of 10. To address the inconsistency in hydraulic conductivity values until additional data is obtained, Cases 1, 3, 4, 10, and 11 were also simulated with a hydraulic conductivity of 50 m/day, which is the lower limit of the hydraulic conductivity reported in Section 4.3. Drilling of RCRA monitoring wells in the vicinity of WMA C is scheduled for the summer of 2003. One well is scheduled to be drilled to the base of the unconfined aquifer. The hydraulic conductivity of the unconfined aquifer will be estimated during the development phase of that well.

3.5 CONTAMINANTS OF POTENTIAL CONCERN FOR CLOSURE

As part of the C-106 closure demonstration project, *Accelerated Tank Closure Demonstration Data Assessment* (RPP-10950) identifies that the primary pathway of concern from a human health risk standpoint is the groundwater pathway. On this basis, the COCs for these tanks are the more mobile long-lived contaminants that could migrate and impact groundwater at concentrations greater than the federal drinking water standards or maximum concentration limit (MCL). For the groundwater pathway, RPP-10950 lists the following contaminants:

- Carbon-14
- Iodine-129
- Technetium-99
- Selenium-79
- Uranium
- Nitrite
- Nitrate
- Cyanide.

The risk-based COCs listed by RPP-10950 are also consistent with past performance assessments (DOE/ORP-2000-24; WHC-EP-0645; WHC-EP-0875), as well as groundwater monitoring of the unconfined aquifer. For the COCs identified by RPP-10950, this risk assessment provides detailed information on the following COCs for the long-term risk assessment:

- Technetium-99
- Iodine-129

- Chromium(IV)
- Nitrate
- Nitrite
- Total uranium (moderately retarded K_d = 0.6 mL/g).

Note that carbon-14, selenium-79, and cyanide have been dropped from the RPP-10950 list, and chromium has been added. The basis for changing the list is that empirical information from the Hanford Site-wide groundwater monitoring indicates that chromium is a COC for groundwater protection, but that carbon-14, selenium-79, and cyanide may not be COCs. Additionally, Section 7.1 provides the relative contribution of these contaminants to the total risk metric (i.e., radiological dose, Incremental Lifetime Cancer Risk, and Hazard Index). The total risk metric provides includes all contaminants that are listed in the inventory estimates given in the *Inventory and Source Term Data Package* (DOE/ORP-2003-02) that contribute to the risk metric.

The post-retrieveal risk assessment will address additional potential COCs identified from the post-retrieval sampling and analysis, as well as the COCs identified in the regulatory category. To facilitate the post-retrieval risk assessment, this analysis used multiple distribution coefficient categories to address, at a later date, a wide range of contaminants.

3.6 INVENTORY

The conceptual model for WMA C has been developed to include multiple source terms, including tanks, ancillary equipment, and past releases. Although detailed, quantitative inventories are not yet available for many of these sources, the risk assessment has identified them for inclusion when characterization is complete before final closure of the WMA. The sources identified in Table 5 have been incorporated into the computational basis for the WMA C risk assessment. These sources include components specifically identified in the RCRA Part A permit application, inactive miscellaneous underground storage tanks, RCRA past-practice sites associated with the WMA, and other components and systems (such as piping systems) that are geographically associated with the WMA (such as Building 801-C). The following discussion presents the current state of understanding of the estimated inventory associated with known source terms in WMA C.

3.6.1 Source Term Inventory

The inventories for the data sources listed in Table 5 are given in Tables 6 through 12. However, only the inventories for the examined COCs for this risk assessment are given in those tables. A complete listing of inventories can be found in *241 Waste Management Area C Inventory Data Package* (RPP-15317). Inventory information compiled in RPP-15317 came from *Subsurface Conditions Description of the C and A-AX Waste Management Areas* (RPP-14430) and *Inventory and Source Term Data Package*, (DOE/ORP-2003-02), which supports preparation of the Closure Environmental Impact Statement. Tank leak and pipe leak inventory estimates shown in Table 6 were developed as part of the WMA C subsurface description report (RPP-14430). The Best Basis Inventory (BBI) estimate for current tank inventory estimates is shown in Table 7, which was taken from DOE/ORP-2003-02. Retrieval leak inventory was estimated from Hanford Tank Waste Operations Simulator runs, while the residual pipeline and ancillary tank

inventories were developed from assumptions on pipe length, and estimated percentage of blockage in pipes and assumed retrieval inventories for catch tanks and CR-Vaults. A completed description of the basis of these assumptions is given below.

Table 5. Sources Included in the WMA C
Risk Assessment Conceptual Model (2 Pages).

Source Type	Individual Sources	Inventory	Included in Risk Assessment
Past leaks from tanks	One confirmed leak near tank C-105	Yes Estimated. See Table 6.	Yes
	UPR-200-E-136	No Reported 24,000-gal leak from C-101[a]	No Please See Footnote[4]
	UPR-200-E-136	No Reported 400-gal leak from C-203.[a]	
Past leaks from tank ancillary equipment	UPR-200-E-81	Yes Estimated. See Table 6	Yes
	UPR-200-E-82	Yes Estimated. See Table 6.	Yes
	UPR-200-E-86	Yes Estimated. See Table 6.	Yes
	UPR-200-E-16	No Small leak (50 gal).[a]	No Size of unplanned release was significantly smaller than unplanned releases E-81, E-82, and E-86.
	UPR-200-E-107	No Small leak (4 gal).[a]	
	UPR-200-E-72	No Solid waste located outside of WMA C.[a]	No Release is nearby, but outside WMA C. It is solid waste consisting of miscellaneous trash and debris.
	UPR-200-E-91	No Contaminated soil remediated.[a]	No Site has been remediated.

[4] Only leaks or discharges that have been verified either through geophysical logging or sampling in the vadose zone and/or groundwater were included in the risk assessment model. HNF-EP-0182 (2002) lists tank C-101 as a "known or suspected leaker" with a leak volume estimate of 20,000 gallons. Decreases in waste levels were documented in the late 1960s, a time when this tank contained aged PUREX high-level supernatant. A 20,000-gallon loss of this waste type would have released approximately 127,000 curies of cesium-137 (BHI-01496), more than all of the cesium-137 projected to have been lost from all of the SX tank farm leaks (RPP-6285). The spectral gamma logging data, reported in *Subsurface Conditions Description of the C and A-AX Waste Management Areas* (RPP-14430), from drywells around tank C-101 show little evidence of any leaks and certainly nothing of that order of magnitude. The lack of high levels of cesium-137 activity in nearby drywells provides strong evidence that the leak information from HNF-EP-0182 (2002) is incorrect. A far more likely scenario is the liquid level drops in the late 1960s were associated with evaporation caused by the continuing high heat load of the aged PUREX high-level waste supernatants. Furthermore, although no leaks have been reported from Tank C-105, there is contamination reported in the vadose zone from routine geophysical monitoring between this tank and C-104, therefore, C-105 was included in this risk assessment. (Please See RPP-15317, RPP-14430, and *Vadose Zone Characterization Project at the Hanford Tank Farms C Tank Farm Report* (DOE-GJO, 1998 & 2000) for additional information on vadose zone contamination)

Table 5. Sources Included in the WMA C
Risk Assessment Conceptual Model (2 Pages).

Source Type	Individual Sources	Inventory	Included in Risk Assessment
Past leaks from tank ancillary equipment (cont'd)	UPR-200-E-27	No Airborne release. [a]	No Airborne releases not considered.
	UPR-200-E-68		
	UPR-200-E-99		
	UPR-200-E-100		
	UPR-200-E-118		
(including intentional discharge sites)	216-C-8 french drain	Yes System Assessment Capability has estimated technetium-99 and iodine-129, but not the inorganics. Estimated volume discharged to French drain is 2,640 gal	No Reported inventories for technetium-99 and iodine-129 are much smaller than unplanned releases E-81, E-82, and E-86.
Residual waste in tanks and ancillary equipment	Twelve 100-series tanks	Yes TWINS BBI. See Tables 8b and 8c.	Yes
	Four 200-series Tanks		
	300-series catch tank	Yes Assumed inventory based on TWINS BBI. See Table 9.	Yes
	Four 244-CR vault tanks		
	Three CR-150 series diversion boxes	No [a]	No Diversion boxes are designed to drain to catch tank. Contamination is mainly surficial. Residual in catch tank is examined.
	Three C-150 series diversion boxes		
	One C-252 diversion box		
	Building 801-C	No [a]	No Building is expected to be decontaminated and decommissioned.
(minor ancillary equipment)	Pipes and valves, associated WMA	Yes Assumed inventory based on TWINS BBI. See Table 9.	Yes
Potential leaks during waste retrieval	Two 100-series tanks (C-106 and C-107) are scheduled for liquid retrieval, all others scheduled for dry retrieval	Yes TWINS BBI. See Table 7.	Yes Calculated inventory based on TWINS BBI.

[a] Waste information data system report, http://ww.bhi-erc.com/eisdata/wids/.
BBI = best-basis inventory.
TWINS = Tank Waste Information System
UPR = unplanned release
WMA = waste management area

Table 6. Vadose Inventory Estimates for C Farm Waste Loss Events.

Tank	**C-105**	**UPR-200-E-81**	**UPR-200-E-82**	**UPR-200-E-86**
Leak volume	1,000 gal	36,000 gal	2,600 gal	17,400 gal
Analyte	**kg**	**kg**	**kg**	**kg**
Chromium	9.82 E+00	2.18 E+01	2.55 E+01	5.88 E+01
Nitrite	3.15 E+02	5.79 E+03	8.18 E+02	1.21 E+03
Nitrate	2.69 E+02	1.82 E+03	6.98 E+02	1.45 E+03
Uranium-total	7.06 E+00	1.30 E+02	1.83 E+01	3.73 E+01
Radionuclides				
Analyte	**Ci**	**Ci**	**Ci**	**Ci**
Technetium-99	1.93 E+00	1.02 E-01	5.01 E+00	6.22 E+00
Iodine-129	3.73 E-03	1.97 E-04	9.69 E-03	1.20 E-02

Table 7. Best-Basis Inventory for
Waste Management Area C.

Tank	**Iodine-129**	**Technetium-99**	**Chromium**	**Nitrite**	**Nitrate**	**Uranium (Total)**
	Ci	**Ci**	**kg**	**kg**	**kg**	**kg**
C-101	1.34 E-03	0.697	299	9,180	61,400	9,610
C-102	2.74 E-03	1.32	735	16,900	73,200	8,150
C-103	0.0662	34.2	690	16,300	1,380	5,960
C-104	0.754	58	1460	36,500	19,600	35,300
C-105	0.093	81.4	413	8,420	8,140	9,840
C-106	0.017	3.14	61.8	1,530	76.9	132
C-107	4.83 E-02	37.9	930	35,300	47,800	9,290
C-108	1.32 E-03	6.19	232	8,740	15,700	153
C-109	2.00 E-03	32.3	118	12,200	18000	4,060
C-110	1.10 E-03	31.8	420	6,530	98000	1,970
C-111	2.01 E-03	2.7	85.2	9,490	17300	4,250
C-112	4.26 E-03	61.1	139	27,800	37200	24,100
C-201	2.74 E-05	0.0141	2.29	41.8	227	1.14
C-202	2.85 E-05	0.0147	2.39	214	639	1.19
C-203	5.46 E-05	0.0282	4.57	245	838	2.26
C-204	3.52 E-05	0.0181	2.95	158	541	1.46
Totals	0.993	350.8221	5,595.2	189,548.8	400,041.9	112,821.05

Table 8a. Summary of Tank Residuals Final Inventory Estimates Based on Simple Volume Ratio Following Waste Retrieval with 360 ft^3 Remaining (30 ft^3 in 200-Series Tanks).

Tank	**Iodine-129**	**Technetium-99**	**Chromium**	**Nitrite**	**Nitrate**	**Uranium (Total)**
	Ci	**Ci**	**kg**	**kg**	**kg**	**kg**
C-101	4.10 E-05	0.0213	9.15	281	1,880	294
C-102	2.34 E-05	0.0113	6.27	144	624	69.5
C-103	8.83 E-04	0.456	9.21	218	18.4	79.5
C-104	7.84 E-03	0.603	15.2	380	204	367
C-105	1.90 E-03	1.66	8.42	172	166	201
C-106	1.26 E-03	0.232	4.57	113	5.68	9.75
C-107	5.24 E-04	0.411	10.1	383	518	101
C-108	5.38 E-05	0.252	9.46	356	640	6.24
C-109	8.50 E-05	1.37	5.01	518	765	172
C-110	1.66 E-05	0.481	6.35	98.8	1,480	29.8
C-111	9.44 E-05	0.127	4	446	813	200
C-112	1.11 E-04	1.59	3.61	721	965	625
C-201	5.82 E-06	0.00299	0.486	8.88	48.2	0.242
C-202	6.05 E-06	0.00312	0.508	45.5	136	0.253
C-203	4.64 E-06	0.0024	0.388	20.8	71.2	0.192
C-204	2.99 E-06	0.00154	0.251	13.4	46	0.124
Totals	0.0128	7.22	93	3,920	8,380	2,160

Table 8b. Summary of Tank Residuals Final Inventory[1] Estimates Based on Selected Phase Removal Following Waste Retrieval with 360 ft^3 Remaining (30 ft^3 in 200-Series Tanks).

Tank	**Iodine-129**	**Technetium-99**	**Chromium**	**Nitrite**	**Nitrate**	**Uranium (Total)**
	Ci	**Ci**	**kg**	**kg**	**kg**	**kg**
C-101	4.09 E-05	0.0213	9.15	281	1,880	294
C-102	2.34 E-05	0.0113	6.26	145	623	69.5
C-103	1.13 E-03	0.583	14.7	244	23.7	100
C-104	7.84 E-03	0.602	15.2	380	204	368
C-105	1.90 E-03	1.66	8.43	172	166	201
C-106	3.67 E-03	0.457	25.3	35.8	5.23	18.2
C-107	5.24 E-04	0.411	10.1	384	518	101
C-108	5.37 E-05	0.252	9.47	356	641	6.22
C-109	8.46 E-05	1.37	5.02	519	765	172
C-110	1.67 E-05	0.484	6.38	99.1	1,490	30
C-111	9.47 E-05	0.127	4	446	811	200
C-112	1.11 E-04	1.59	3.61	720	963	626
C-201	5.82 E-06	2.99 E-03	0.486	8.88	48.2	0.242
C-202	6.05 E-06	3.12 E-03	0.508	45.5	136	0.253
C-203	4.64 E-06	2.40 E-03	0.388	20.8	71.2	0.192
C-204	2.99 E-06	1.54 E-03	0.251	13.4	46	0.124
Totals	0.016	7.57865	119.253	3,870.48	8,390	2,190

[1]See RPP-15317 for complete BBI inventory, which includes the following radionuclides and non-radionuclides:

Radionuclides	Tritum, Carbon-14, Nickel-59, Cobalt-60, Nickel-63, Selenium-79, Strontium-90, Yttrium-90, Niobium-93m, Zirconium-93, Techneitum-99, Ruthenium-106, Cadmium-113m, Antimony-125, Tin-126, Iodine-129, Cesium-134, Barium-137m, Cesium-137, Samarium-151, Europium-152, Europium-154, Europium-155, Radium-226, Actinium-227, Radium-228, Thorium-229, Protactinium-231, Thorium-232, Uranium-232, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Neptunium-237, Plutonium-238, Uranium-238, Plutonium-239, Plutonium-240, Americium-241, Plutonium-241, Curium-242, Plutonium-242, Americium-243, Curium-243, Curium-244
Non-Radionuclides	Aluminum, Bismuth, Calcium, Chlorine, Chromium, Fluorine, Iron, Lanthanum, Lead, Manganese, Mercury, Nickel, Nitrate, Nitrite, Phosphate, Potassium, Silicon, Sodium, Strontium, Sulfate, Total inorganic carbon as carbonate, Total organic carbon, Uranium total, Zirconium

Table 8c. Summary of Tank Residuals Final Inventory Estimates Based on HTWOS Predictions Following Waste Retrieval with 360 ft^3 Remaining (30 ft^3 in 200-Series Tanks).

Tank	Iodine-129	Technetium-99	Chromium	Nitrite	Nitrate	Uranium (Total)[1]
	Ci	Ci	kg	kg	kg	kg
C-101	5.17 E-06	0.0027	1.16	35.5	238	37.2
C-102	6.44 E-06	0.0031	1.72	39.8	171	19.1
C-103	8.29 E-05	0.0428	1.25	20.3	1.98	8.5
C-104	1.03 E-03	0.0791	1.99	49.9	26.7	48.1
C-105	1.43 E-04	0.125	0.633	12.9	12.5	15.1
C-106	1.08 E-03	0.199	3.91	97	4.87	8.4
C-107	7.95 E-05	0.0681	2.15	76.7	116	9.2
C-108	1.34 E-05	0.0628	2.36	88.6	160	1.6
C-109	1.58 E-05	0.256	0.937	96.8	143	32.2
C-110	8.43 E-06	0.243	3.2	49.8	747	15.1
C-111	1.47 E-05	0.0197	0.622	69.3	126	31.1
C-112	2.85 E-05	0.408	0.929	186	248	161.4
C-201	6.15 E-07	3.17 E-04	0.0514	0.938	5.1	0.026
C-202	6.33 E-07	3.27 E-04	0.0531	4.75	14.2	0.026
C-203	6.31 E-07	3.26 E-04	0.0528	2.83	9.69	0.026
C-204	6.29 E-07	3.23 E-04	0.0527	2.82	9.67	0.026
Totals	2.51 E-03	1.51	21.1	834	2,030	387.0

HTWOS = Hanford Tank Waste Operations Simulator.

[1]Not included in HTWOS estimate, but calculated from isotopic uranium, which is included in HTWOS estimate.

Table 9. Concentration of Retrieval Fluid as Predicted by HTWOS Model.

Tank	Iodine-129	Technetium-99	Chromium	Nitrite	Nitrate	Uranium (Total)[1]
	Ci/L	Ci/L	g/L	g/L	g/L	g/L
C-101	5.48E-10	2.86E-07	1.23E-01	3.77E+00	2.52E+01	3.95E+00
C-102	6.80E-10	3.29E-07	1.83E-01	4.20E+00	1.82E+01	2.03E+00
C-103	9.88E-09	5.12E-06	1.29E-01	2.13E+00	2.09E-01	8.79E-01
C-104	2.50E-07	1.92E-05	4.84E-01	1.21E+01	6.50E+00	1.17E+01
C-105	1.50E-08	1.31E-05	6.65E-02	1.36E+00	1.31E+00	1.58E+00
C-106	1.50E-08	2.76E-06	5.44E-02	1.35E+00	6.77E-02	1.16E-01
C-107	2.23E-08	1.75E-05	4.29E-01	1.63E+01	2.20E+01	4.29E+00
C-108	1.41E-09	6.64E-06	2.49E-01	9.38E+00	1.68E+01	1.64E-01
C-109	1.66E-09	2.70E-05	9.83E-02	1.02E+01	1.50E+01	3.39E+00
C-110	9.07E-10	2.61E-05	3.45E-01	5.37E+00	8.06E+01	1.63E+00
C-111	1.55E-09	2.08E-06	6.57E-02	7.32E+00	1.33E+01	3.29E+00
C-112	2.96E-09	4.24E-05	9.67E-02	1.93E+01	2.59E+01	1.68E+01
C-201	7.23E-10	3.73E-07	6.05E-02	1.10E+00	6.00E+00	3.01E-02
C-202	7.55E-10	3.89E-07	6.31E-02	5.65E+00	1.69E+01	3.14E-02
C-203	4.80E-10	2.48E-07	4.02E-02	2.16E+00	7.38E+00	2.00E-02
C-204	3.09E-10	1.60E-07	2.60E-02	1.39E+00	4.76E+00	1.29E-02

HTWOS = Hanford Tank Waste Operations Simulator.

[1]Not included in HTWOS estimate, but calculated from isotopic uranium, which is included in HTWOS estimate.

Table 10. Inventory for an 8,000 Gallon Retrieval Leak.

Tank	Iodine-129	Technetium-99	Chromium	Nitrite	Nitrate	Uranium (Total)[1]
	Ci/L	Ci/L	g/L	g/L	g/L	g/L
C-101	1.7E-05	0.01	3.72	114.10	763.16	119.50
C-102	2.1E-05	0.01	5.53	127.25	551.18	61.41
C-103	3.0E-04	0.16	3.91	64.50	6.33	26.63
C-104	7.6E-03	0.58	14.67	366.72	196.92	354.02
C-105	4.5E-04	0.40	2.01	41.04	39.67	47.98
C-106	4.5E-04	0.08	1.65	40.82	2.05	3.52
C-107	6.8E-04	0.53	12.98	492.82	667.33	129.76
C-108	4.3E-05	0.20	7.54	283.94	510.05	4.97
C-109	5.0E-05	0.82	2.98	307.61	453.86	102.55
C-110	2.7E-05	0.79	10.45	162.70	2440.87	49.22
C-111	4.7E-05	0.06	1.99	221.74	404.22	99.51
C-112	9.0E-05	1.28	2.93	585.43	783.38	508.88
C-201	2.2E-05	0.01	1.83	33.44	181.58	0.91
C-202	2.3E-05	0.01	1.91	171.18	511.14	0.95
C-203	1.5E-05	0.01	1.22	65.33	223.44	0.60
C-204	9.4E-06	0.00	0.79	42.13	144.25	0.39
Total	9.8E-03	4.96	76.10	3120.74	7879.43	1510.80

HTWOS = Hanford Tank Waste Operations Simulator.

[1]Not included in HTWOS estimate, but calculated from isotopic uranium, which is included in HTWOS estimate.

Table 11. Inventory for an 20,000 Gallon Retrieval Leak.

Tank	Iodine-129	Technetium-99	Chromium	Nitrite	Nitrate	Uranium (Total)[1]
	Ci/L	Ci/L	g/L	g/L	g/L	g/L
C-101	4.2E-05	2.2E-02	9.3E+00	2.9E+02	1.9E+03	3.0E+02
C-102	5.1E-05	2.5E-02	1.4E+01	3.2E+02	1.4E+03	1.5E+02
C-103	7.5E-04	3.9E-01	9.8E+00	1.6E+02	1.6E+01	6.7E+01
C-104	1.9E-02	1.5E+00	3.7E+01	9.2E+02	4.9E+02	8.9E+02
C-105	1.1E-03	9.9E-01	5.0E+00	1.0E+02	9.9E+01	1.2E+02
C-106	1.1E-03	2.1E-01	4.1E+00	1.0E+02	5.1E+00	8.8E+00
C-107	1.7E-03	1.3E+00	3.2E+01	1.2E+03	1.7E+03	3.2E+02
C-108	1.1E-04	5.0E-01	1.9E+01	7.1E+02	1.3E+03	1.2E+01
C-109	1.3E-04	2.0E+00	7.4E+00	7.7E+02	1.1E+03	2.6E+02
C-110	6.9E-05	2.0E+00	2.6E+01	4.1E+02	6.1E+03	1.2E+02
C-111	1.2E-04	1.6E-01	5.0E+00	5.5E+02	1.0E+03	2.5E+02
C-112	2.2E-04	3.2E+00	7.3E+00	1.5E+03	2.0E+03	1.3E+03
C-201	5.5E-05	2.8E-02	4.6E+00	8.4E+01	4.5E+02	2.3E+00
C-202	5.7E-05	2.9E-02	4.8E+00	4.3E+02	1.3E+03	2.4E+00
C-203	3.6E-05	1.9E-02	3.0E+00	1.6E+02	5.6E+02	1.5E+00
C-204	2.3E-05	1.2E-02	2.0E+00	1.1E+02	3.6E+02	9.7E-01
Total	2.5E-02	12.40	190.26	7801.85	19698.57	3777.00

HTWOS = Hanford Tank Waste Operations Simulator.

[1]Not included in HTWOS estimate, but calculated from isotopic uranium, which is included in HTWOS estimate.

Table 12. Assumed Inventory for Ancillary Equipment.

Equipment	Total Volume	Current Waste Volume	Assumed Residual Volume	Iodine-129	Technetium -99	Chromium	Nitrite	Nitrate	Uranium (Total)
	gal[a]	gal	ft^3	Ci	Ci	kg	kg	kg	kg
Average Inventory per ft^3				3.60 E-06	0.001707	0.026859	0.87173	1.88964	0.493243
CR-244[b] TK-CR-001	50,000	2,000 (s)	27	9.73 E-05	0.046	0.725	23.54	51.0	13.32
CR-244[b] TK-CR-002	15,000	1,500 (s)	8	2.88 E-05	0.014	0.215	6.97	15.1	3.95
CR-244[b] TK-CR-003	15,000	4,200 (s)	8	2.88 E-05	0.014	0.215	6.97	15.1	3.95
CR-244[b] TK-CR-011	50,000	35,000 (l)	27	9.73 E-05	0.046	0.725	23.54	51.0	13.32
C-301[c]	35,000	9,016 (s) 1,470 (l)	19	6.85 E-05	0.032	0.510	16.56	35.9	9.37
Totals				3.21 E-04	0.152	2.390	77.580	168.100	43.910
Pipes Layers 1-3	1,000 ft^3	NA	250	0.0009	0.43	6.7	217.9	472.4	123.3

[a] Units are in gallons for tanks, and in cubic feet for pipes.

[b] CR-244 current waste volume from waste information data systems report, http://www.bhi-erc.com/eisdata/wids/.

[c] Tank C-301 current waste volume from *Engineering Study of 50 Miscellaneous Inactive Underground Radioactive Waste Tanks Located at the Hanford Site, Washington* (WHC-SD-EN-ES-040).

s = solids.

l = liquids.

NA = not applicable.

The post-retrieval tank waste residuals, also known as retrieved to HFFACO goal of 1%, are also given in DOE/ORP-2003-02. However, three sets of residual tank inventory values are given in DOE/ORP-2003-02. The three different sets use different assumptions to derive the post-retrieval inventory. The complete assumptions for the residual inventory are given in DOE/ORP-2003-02 and are briefly summarized here:

- Simple volume ratio (Table 8a). Multiply the existing total tank inventory by a ratio of the final tank volume to the current tank volume (not including retained gas).

- Volume ratio based on Selected Phase Removal (SPR) (Table 8b). This is similar to the simple volume ratio, but modified to take into account removal of selected phases (sludge, supernatant, etc.) of waste during retrieval.

- Hanford Tank Waste Operations Simulator (HTWOS) model output (*Single-Shell Tank Retrieval Sequence and Double-Shell Tank Space Evaluation* [RPP-8554]) (Table 8c) adjusted to the same final volume as the other two methods. This method represents HTWOS assumptions for water additions and incorporates wash/leach factors. The residual inventory is generally lower because of leaching of mobile constituents.

Comparing the inventory for the COCs for the tanks within WMA C shows there is very little difference between the simple volume ratio and the selected phase removal. The largest differences were for iodine-129 and chromium, with the total inventory for those constituents being 21%, and 28% higher for selected phase removal, respectively. However, comparing the residual inventory between selected phase removal and the HTWOS model, shows the HTWOS modeled total residual inventory for WMA C to be four to six times less for all COCs

Because the residual inventory is uncertain, the inventory chosen (simple volume, selected phase removal, or HTWOS) for this risk assessment is based on the estimate associated with the selected waste retrieval technology (sluicing or dry). It is expected that as the tank waste is retrieved, the tank waste residuals will be sampled and analyzed with the resulting residual inventory and risk estimates being updated as necessary.

Retrieval leak inventory can be calculated by multiplying the concentration in the leaked fluid by the amount that leaked. The concentration of the leaked fluid has been provided from the HTWOS run described in *Hanford Tank Waste Operations Simulator (HTWOS) Model Run Results for the Integrated Mission Acceleration Plan (IMAP) Unconstrained Case* (RPP-14302). The concentrations for the contaminants of concern, which are given in Table 9, are multiplied by a hypothetical retrieval leak volume (8,000 gal and 20,000 gal). The resulting inventories from that calculation are provided in Tables 10 (8,000 gal leak) and 11 (20,000 gal leak).

Preliminary WMA C risk assessment results were presented to the Ecology during a joint workshop on May 12, 2003. The preliminary risk assessment results did not include residuals left in ancillary equipment because the nature and amount of waste left in ancillary equipment is unknown. However, during the workshop, it was decided to include an assumed inventory for the waste left in the ancillary equipment to show the expected relative contribution of the tank ancillary equipment. The assumed inventory was calculated using the following methodology:

- The present waste volume in ancillary equipment is given in Table 12. It is assumed that the waste in ancillary equipment tanks (244-CR vault tanks and the C-301 catch tank) will be retrieved. Because these tanks are smaller than the 200-series tanks, the ancillary tank residual was calculated by multiplying the residual of the 200-series tanks by the ratio of the volume of the ancillary equipment tank to the 200-series tanks.

- The volume of pipes within the WMA was estimated by scaling off the drawings presented in *Historical Vadose Zone Contamination from A, AX, and C Tank Farms* (RPP-7494). A total of four layers of pipe have been added to the WMA. The first layer of pipe was installed between from 1943 to 1945 and was gravity fed to sup-port filling the tanks. The second layer was added to support bismuth phosphate and uranium recovery operations and was installed from 1946 to 1957. The third layer was in-stalled for waste fractionation operations from 1961 to 1978. The last layer was installed from 1975 to 2001 to support interim stabilization and isolation. For the residual volume estimate, it is assumed that none of the piping in the last layer is blocked because this piping is still being used. For the previous three layers of pipe, the total estimated length of pipe is approximately 20,000 ft. The typical diameter of pipe used in the WMA is 3 inches. The total volume of pipe that may contain blockages is

  $$20{,}000 \text{ ft (length)} \times 0.05 \text{ ft}^2 \text{ (cross-sectional area)} = 1{,}000 \text{ ft}^3.$$

  It is further assumed that of the 1,000 ft^3 of piping only 25% is blocked or has residual waste left in it. The pipelines in WMA C were drained and flushed after use; therefore, the amount of residual remaining in the pipelines is expected to be much smaller the 25% used in this estimate.

- The material left in the 244-CR vault tanks, C-301 catch tank, and pipelines is assumed to be similar in nature to what is left in the 100- and 200-series tanks. Therefore, to estimate the inventory left in the 244-CR vaults tanks, the C-301 catch tank, and the pipelines, the total residual inventory for each COC (selected phase BBI) was divided by the total residual volume (12 × 360 ft^3 [100-series tanks] + 4 × 30 ft^3 [200-series tanks] = 4,400 ft^3) to come up with an average inventory per cubic foot. The expected residual volume for the ancillary equipment was then multiplied by the average inventory per cubic foot. Table 12 provides the assumed inventory using these calculations.

The ancillary equipment inventory estimate is very conservative. Even using this estimate, the modeling results indicated that the risk associated with residual piping is minimal compared to the risk posed from other sources.

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4.0 LONG-TERM HUMAN HEALTH RISK ASSESSMENT MODELING RESULTS FOR WASTE MANAGEMENT AREA C

The results of the long-term human health risk assessment analysis for WMA C are discussed in this section. Fourteen cases (containing seven distribution coefficients) were simulated representing the four types of contaminant sources and two types of release mechanisms for residual wastes. The four types of contaminant sources and the numerous release mechanisms previously identified. In particular, three hypothetical release models were identified:

- Diffusion-dominated release: a stabilized waste form covered with grout*
- Advection-dominated release: an unstabilized waste form covered with backfill sand and gravel or a failed grout (i.e., the grout has cracked)
- Solubility-dominated release: a waste form bound in a material that releases risk-driving contaminants congruently with the dissolution of the material.

Salt cake releases are often simulated under the solubility-controlled release mechanism. The suite of modeling cases is intended to identify and demonstrate the relative importance of the input parameters upon the results (especially those parameters considered manageable), and provides a quantitative estimate of the expected impact.

In summary, results indicate that the primary long-term human health risk driver is the inventory associated with the past leak sources. The only parameter to affect the past and hypothetical waste retrieval leak results is the surface barrier efficiency. The modeling assumed a 500-year design life for the barrier

Results and Conclusions

- The primary contributors to groundwater contamination are contaminants contained in past leaks from tanks and ancillary equipment, and predicted leaks from tanks during waste retrieval.
- The placement of the surface barrier greatly reduces recharge through vadose zone contamination, which results in a decrease in the predicted peak concentration until the barrier degrades.
- Key parameters affecting the predicted groundwater contaminant concentrations resulting from tank residual waste releases are release rate (but only if the release extends beyond 3,000 years), contaminant mobility, and inventory.
- During the first 120 years after waste retrieval, technetium-99 concentration associated with past leaks is 497 pCi/L at the WMA C fenceline. The peak concentration of technetium-99 resulting from tank residual diffusion-dominated releases after waste retrieval is 60.4 pCi/L.
- During the first 120 years after waste retrieval, peak iodine-129 concentration associated with past leaks is 0.96 pCi/L at the WMA C fenceline. The peak concentration of iodine-129 resulting from tank residual diffusion releases after retrieval is 0.11 pCi/L.
- Contaminants with a $K_d \geq 0.6$ mL/g do not contribute appreciably to groundwater contamination over the 10,000-year simulation.
- Contaminants with a $K_d \geq 0.6$ mL/g exhibit increasing concentrations at the end of the 10,000-year simulation.
- If retrieved to the HFFACO goal of 1%, all peak concentrations for the COCs at calculation points downgradient of the WMA (200 Area core zone boundary and Columbia River) occur at levels below the contaminant's MCL.

* See Preface in *SST System Closure Plan* (RPP-13774).

with immediate resumption of shrub-steppe environment recharge upon barrier degradation. Key parameters affecting the predicted groundwater concentrations resulting from tank residual waste are the inventory, release rate mechanism for the residual waste, the hydraulic conductivity of the unconfined aquifer, and the mobility of the individual contaminants.

A number of the models examined the impacts to groundwater from different release rates for the residuals and the results were somewhat unexpected. When all of the mass was released in less time than it takes for water to move through the vadose zone and into the aquifer, approximately 2000 years, the peak concentration for those releases did not vary by much. For example, the difference between case 10, all of the mass was released in 5 years, and case 7, all of the mass was released in 1000 years, was approximately 37 pCi/L or 13.5 %. However, if the release rate was over 10,000 years instead of 10 years the difference was approximately an order of magnitude. However, the impacts continued for the entire period of the simulation; thus, measures taken to limit future releases from tank residuals must be effective over periods longer than 2,000 years to have a significant impact on groundwater.

The following specific aspects of the analyses are presented in subsequent sections:

- Overview of constituent transport simulations
- Unit inventory results
- Cumulative inventory results
- Sensitivity analysis.

4.1 OVERVIEW OF CONSTITUENT TRANSPORT SIMULATIONS

Estimated impacts to the groundwater resource have been simulated for the following four types of contaminant sources within WMA C:

- Past leaks from tanks
- Past leaks from tank ancillary equipment (i.e., past pipe leaks)
- Potential leaks during waste retrieval
- Residual waste in both tanks and tank ancillary equipment.

These sources were defined in the modeling data package (RPP-13310) and a series of numerical simulations were performed using the STOMP code (Section 3.3). A total of 14 individual simulation cases were prepared to provide a basis for evaluating the sensitivity of various closure decisions. Each case describes the behavior of seven surrogate contaminants of varying distribution coefficients under variable waste release modes for the selected sources at a unit inventory (inventory = 1.0 unit). The simulation cases are summarized in Table 4.

The potential contaminant sources associated with WMA C have been identified and cataloged to associate them with appropriate transport simulation cases. The conceptual physical model of WMA C (Figure 4) indicates how the major features within the WMA are organized into rows

and cross sections. This arrangement allows application of the principle of superposition as a method of calculating impacts from each source location on the basis of simulation of a single source within a cross section.

An estimate of the impact to groundwater posed by a waste inventory contained in a particular source can be calculated by multiplying the simulated unit-source result by the specific source inventory and then making an appropriate distribution of the resulting concentration along the fenceline. For all of the WMA C estimates presented in this section, the cumulative cross-sectional concentrations for the sources in the WMA are distributed uniformly along the length of the downgradient WMA C boundary, a length of approximately 233 m. Impact can be evaluated for individual sources or as cumulative impact for multiple sources.

The conceptual model for WMA C incorporates multiple sources within the WMA, including the primary waste storage tanks, as well as major (244-CR vault, C-301 catch tank, diversion boxes) and minor (piping systems) ancillary equipment and past leaks from components. Inventories were identified for all of the 100- and 200-series tanks in the WMA, one past tank leak, and three ancillary equipment leaks. Other potentially important sources within the WMA (such as waste tanks within the 244-CR vault, C-301 catch tank, and pipelines) currently do not have reliable inventory estimates; however, an assumption of the inventory associated with this ancillary equipment was made and applied to the ancillary equipment (see Section 3.5).

The risk assessment approach provides for analysis of sensitivities in risk estimates arising from uncertainties in waste constituent inventory, waste release scenarios, and waste retrieval efficacy. The results of the risk assessment provide a basis for evaluation of the following sensitivities:

- Residual waste inventory in tanks (range from [theoretical] zero residual to current BBI)
- Residual waste inventory constituents (individual or cumulative impacts for 239 constituents)
- Potential tank retrieval leaks (none, 8,000 gal, 20,000 gal)
- Residual tank waste inventory release mechanisms (arbitrary 5-, 10-, 100-, 1,000-, or 10,000-year release duration; advection-dominated, diffusion-dominated, and solubility-limited release models)
- Presence/absence of past leaks
- Presence/absence of residual inventory in ancillary equipment.

The primary radionuclides that contribute to long-term human health risk are those with relatively long half-lives that are also completely mobile.

4.2 UNIT INVENTORY RESULTS

A discussion of the results for the simulation cases, using unit inventory, is presented in this section. A unit inventory source term was used for the following reasons:

- Except for model runs assuming solubility release controls, model results (contaminant BTCs) can be scaled to inventories identified for contaminant source by multiplying the model results by the source's mass (non-radionuclides units are kg for source term) or activity estimate and decay rate (radionuclides units are curies for source term) for COCs.

- Model results from individual contaminant sources can be added using the principle of superposition to evaluate the impacts of multiple sources for a composite analysis for the entire WMA C.

- When additional information becomes available (updated or new inventory data) the impacts of the new data can quickly be assessed.

- The unit inventory method also provides a relative evaluation of parameter and release mechanism sensitivity independent of source inventory.

The resulting contaminant breakthrough curves for a mobile contaminant ($K_d = 0$), including simulated peak concentrations and arrival times, for each of the different source models given in Table 4, are presented in Figure 6.

4.2.1 Release Models

In examining the results shown in Figure 6 in terms of release models, the results can be broken into the following three categories:

- **Retrieval losses and past leaks.** As shown in Figure 6(a), the contaminant BTCs show a dual peak trend for Cases 1 through 4. The first concentration peak is the result of the leak occurring before the emplacement of a barrier and some, but not all, of the contaminant traveling through the vadose zone before the barrier becomes effective. Once the barrier becomes effective, the contaminant movement slows limiting release from the vadose until the barrier degrades 500 years into the future and the recharge changes from 0.5 to 3.5 mm/yr. Once the recharge rate increases, the remaining contaminant in the vadose zone is released, causing a second peak approximately 1,100 years after the first peak, with all of the contaminant being released from the vadose zone approximately 4,500 years after the initial release.

- **Fast Releases from Residual Waste.** The results for this category, which includes Cases 5, 6, 7, 9, and 10, are shown in Figure 6(b). For Cases 5, 6, 7, and 9, the release for the unit inventory was arbitrarily set to occur over a specified number of years; the residual waste release duration was less than 1,000 years for all four cases. Case 10 is the advection-dominated case and represents release from an unstabilized waste form covered with backfill sand and gravel or failed grout (RPP-13310). In all of these cases, the release duration is shorter than the vadose zone travel time (approximately 2,000 years), resulting in similar BTCs. For Case 7, the peak is a little broader because of the much longer release duration (1,000 years versus 100 years for Case 6).

- **Slow Releases from Residual Waste.** The results for this category are shown in Figure 6(c). The results correspond to Case 8 and Cases 11 through 14. For Case 8, the release rate was arbitrarily set to the length of the simulation time period (10,000 years).

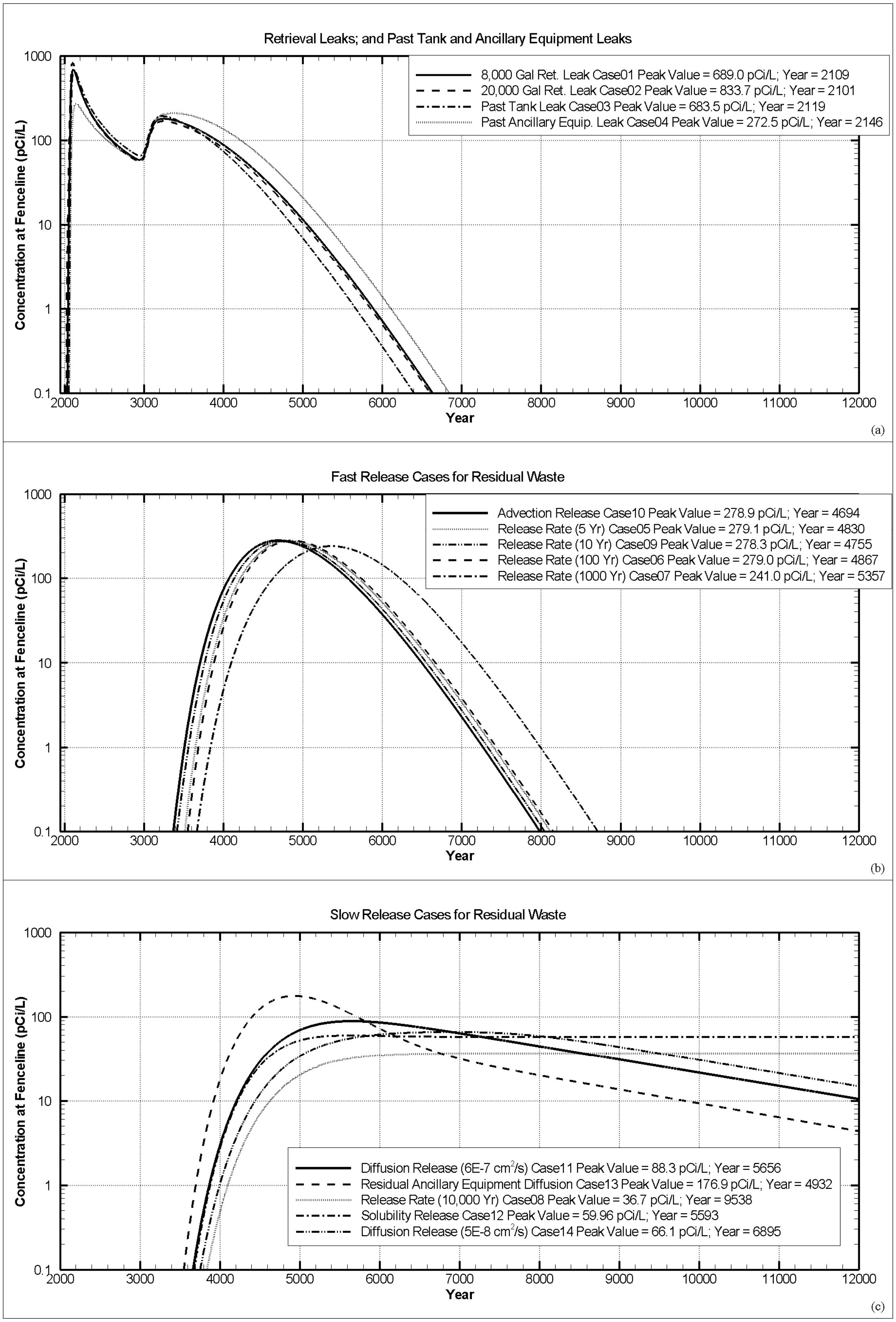
Cases 11, 13, and 14 represent diffusion-dominated release from stabilized, grouted waste form for both the residual tank waste (Cases 11 and 14) and ancillary equipment (Case 13). The differences shown in this figure between Cases 11 and 14 are the result of the use of a different distribution coefficient; the distribution coefficient for Case 11 is 6×10^{-7} cm^2/s, whereas Case 14 has a distribution coefficient of 5×10^{-8} cm^2/s. The differences in results for Cases 11 and 13 are because of the assumed footprint of the source inventory, which for Case 11 is the diameter of the tank (22 m) and for Case 13 is a diameter of 7 m between tanks. The solubility-controlled release model (Case 12) assumed congruent release of various contaminants, with the major constituent in the waste (sodium nitrate) controlling the release of all constituents. As the major constituent dissolves, all other constituents within the tank are released in proportion. The solubility of sodium nitrate was assumed to be 72 g/L in the tank solution. In all of these cases, the release duration is much longer than the travel time to groundwater. The fact that the actual solubility of the waste is currently unknown (WMA C tank wastes are not predominantly nitrate salts) is a major uncertainty of the solubility-controlled release model. Results are likely to vary depending on the actual release rate.

The simulation results suggest the following:

- Past leaks potentially have the largest impact (depending on inventory); however, a barrier emplacement can mitigate the impacts from leaks.
- The release duration from the tanks, if it is fast and occurs completely before any of the contaminants reach the groundwater, does not change the estimated peak groundwater concentration.
- The factors with the greatest impact on the results are the longevity of the closure barrier and the release duration of the residual waste if it is slow (takes longer than the vadose zone travel time).
- Which release model is appropriate for the tank residual waste is unknown at this time. Further laboratory work addressing residual waste release models is needed; however, to simulate the impact of a grout* fill material, the diffusional release model is considered.

* See Preface in *SST System Closure Plan* (RPP-13774).

Figure 6. Contaminant Breakthrough Curves for all Cases Using Unit Inventory (K_d = 0.0).



4.2.2 Bulk Distribution Coefficients

The contaminants simulated represent seven different measures of contaminant mobility through the use of distribution coefficients (K_d = 0, 0.01, 0.03, 0.1, 0.3, 0.6 and 1.0 mL/g). By using a range of distribution coefficients, a wide variety of contaminants can be examined by applying the appropriate inventory and decay rate to the unit results for the contaminant of interest. Figure 7 was prepared to illustrate how a small change in the mobility (K_d = 0.0 vs. K_d = 0.1 mL/g) can dramatically change the results especially for waste retrieval leaks (Figure 7a) and past leaks (Figure 7b). The second peak value for K_d = 0.1 mL/g dropped approximately by a factor of 2 over that for K_d = 0 mL/g, with the arrival of the peak delayed by approximately 2,800 years. Additionally, the peak for the less mobile contaminant is broader and appears to be very similar to the peak caused by a slow release mechanism for the residual waste.

The cross-sectional views in Figure 8, based on the tank row center-line concentrations, illustrate how the contaminants are predicted to move through the vadose zone. The figure shows the location of the plumes resulting from 8,000-gal waste retrieval leaks after 100 years for contaminants (K_d = 0.0 mL/g in Figure 8a, K_d = 0.1 mL/g in Figure 8b). The waste retrieval leaks from all tanks are released simultaneously. While the likelihood of all of the tanks failing simultaneously during waste retrieval may be remote, the results from the advection-dominated release sensitivity cases indicated that the resultant concentration at the fenceline is virtually unaffected by the release rate or timing, when the release is completed within about 100 years of closure. The plumes emanating from the tanks appear to be almost identical. The plumes from the four tanks co-mingle, although the areas of highest concentration remain distinct as the plumes migrate into groundwater. The plumes enter the aquifer almost simultaneously, and contaminant transport through the aquifer to the fenceline occurs almost instantaneously. The simultaneous release, co-mingling of the plumes, and instantaneous transport of the contaminants through the aquifer to the fenceline result in the concentration at the fenceline being essentially cumulative for different sources.

Figure 7. Comparison of Breakthrough Curves between a Mobile Contaminant (K_d = 0.0) and a Slightly Mobile Contaminant (K_d = 0.1) for Waste Retrieval Leaks and Past Leaks.

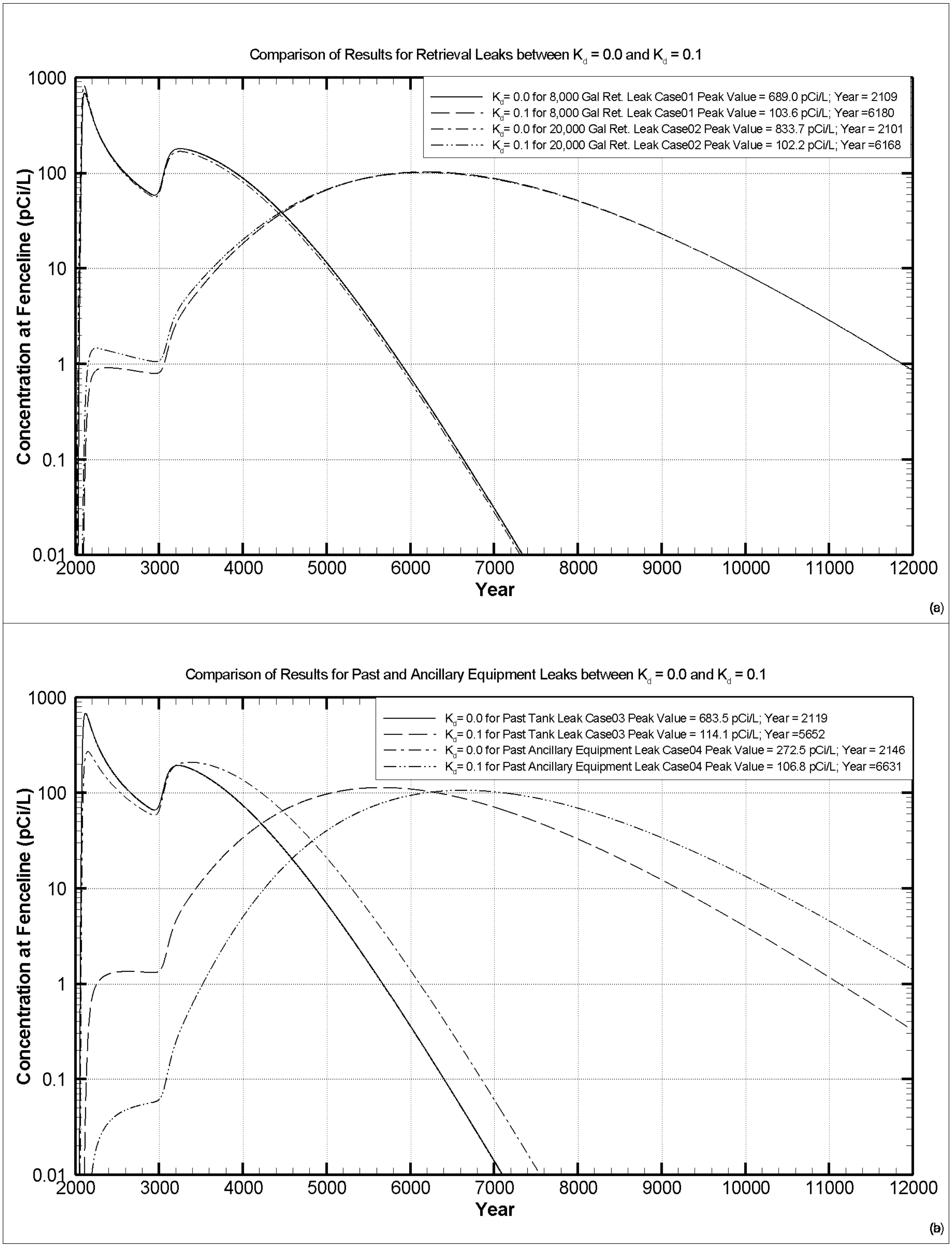
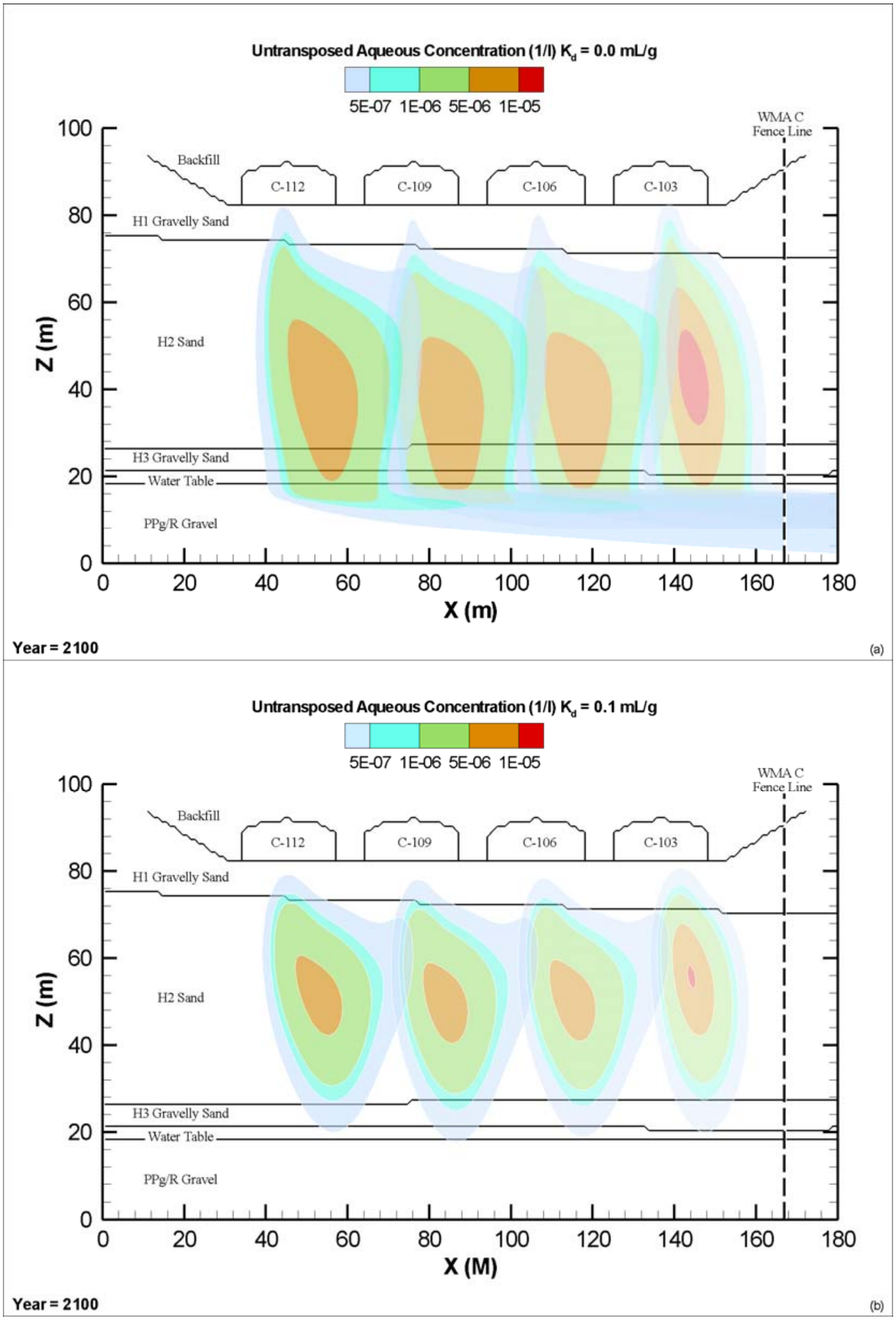


Figure 8. Untransposed Model Contaminant Transport Results for an 8,000-gal Waste Retrieval Leak for K_d = 0.0 mL/g and K_d = 0.1 mL/g.



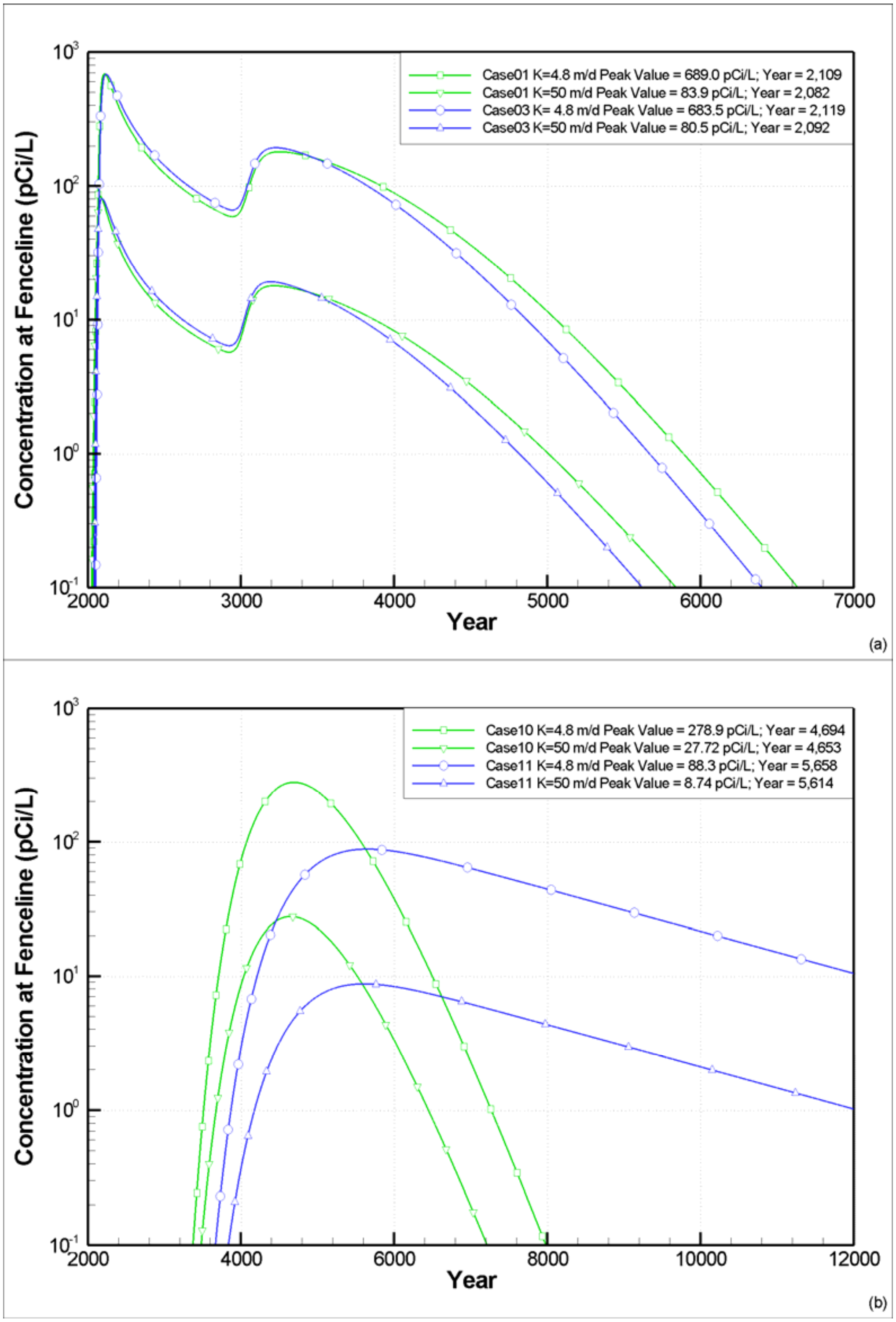
4.2.3 Hydraulic Conductivity of the Unconfined Aquifer

The results for all 14 cases were provided with the hydraulic conductivity of the unconfined aquifer set to 4.8 m/day. Although this laboratory-measured hydraulic conductivity value is consistent with undifferentiated Plio-Pleistocene/Ringold gravels, it is inconsistent with the large-scale hydraulic conductivities for the unconfined aquifer reported within the 200 East Area, which are typically higher by at least factor of 10.

Presently, all wells in the vicinity of WMA C are completed at the water table and the underlying geology is inferred from wells further away. As part of the RCRA Groundwater Monitoring Program, four additional wells are being drilled in the vicinity of WMA C in the summer of 2003. For one of these wells, drilling is scheduled to penetrate to the base of the aquifer, thereby providing additional geologic information. Following drilling, the well will be developed. During the development cycle, a more representative number for the hydraulic conductivity of the unconfined aquifer in the vicinity of WMA C will be obtained. This proposed new well is located northeast of C-204 just outside of WMA C.

To address the uncertainty in hydraulic conductivity values until additional data is obtained, Cases 1, 3, 4, 10, and 11 were also simulated with a hydraulic conductivity of 50 m/day. Figure 9 shows the comparison between the two hydraulic conductivities for these cases. Figure 9(a) compares the results between the different hydraulic conductivities for Cases 1 (8,000-gal leak) and 3 (tank leak), while Figure 9(b) compares the results between the different hydraulic conductivities for Cases 10 (advection-dominated release) and 11 (diffusion-dominated release). For Cases 1 and 3, the results indicate that increasing the hydraulic conductivity by an order of magnitude decreases the concentration by a factor of approximately 8.5 and decreases the travel time to the fenceline by 27 years. For Cases 10 and 11, reducing the hydraulic conductivity by a factor of 10 decreases the concentration at the fenceline by approximately the same amount and decreases the travel time to the fenceline by approximately 41 and 44 years, respectively. The difference between the factor of 8.5 and the factor of 10 for the leak cases compared to the residual cases is because of a different hydraulic gradient present at the time the contaminants reach the groundwater. The leak cases occur when the recharge rate is 100 mm/yr, which causes a slightly higher hydraulic gradient in the unconfined aquifer. For the residual cases, release occurs far enough into the future that recharge reverts back to pre-Hanford values (3.5 mm/yr) and the hydraulic gradient at that time reverts back to pre-Hanford conditions and remains constant.

Figure 9. Comparison of Results using Hydraulic Conductivity of 4.8 m/day and 50.0 m/day for the Unconfined Aquifer. (Upper figure presents the results for retrieval leaks and past tank leaks. Lower figure presents the results for advection- and diffusion-dominated release from residuals.)



4.3 CUMULATIVE INVENTORY RESULTS

The preceding results are based on unit source inventory. In this section, the impacts of the COCs (Section 3.5) are assessed. To estimate the predicated impacts for the COCs, BTCs for the unit source inventory are multiplied by a contaminant inventory to obtain a BTC for each of the identified sources shown on Figure 2. The BTCs for each individual source were then summed to produce a composite BTC for WMA C. Before applying the contaminant inventories, a base case must be defined for WMA C. The base case describes the assumed post-retrieval conditions, which are based on current waste retrieval plans. Table 13 provides a listing of the selected conditions, constituents, and source terms. When a cumulative total is given for WMA C, the base case condition is used.

Table 13. Features of Waste Management Area C Base Case (2 Pages).

Hydraulic conductivity of unconfined aquifer	50 m/day
Release model for residual waste	Diffusion (coefficient 6 E-07 cm^2/s)
COCs and distribution coefficients	Technetium-99, iodine-129, chromium, nitrate, nitrate, and uranium Uranium = 0.6 mL/g; All other COCs = 0.0 mL/g

Inventory and Source Terms							
Tank Sources	**Retrieval Method[a]**	**Residual Volume/ Inventory Used**	**Vadose Zone Contamination associated with Past Tank Leak[b]**	**Hypothetical Retrieval Leak**	**Inventory[c]**		
					Residual	**Past Tank Leak**	**Retrieval Leak**
C-101	Sluicing	360 ft^3/SPR[d]	No	Yes	Table 8b		Tables 10 and 11
C-102	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-103	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-104	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-105	Sluicing	360 ft^3/SPR	Yes	Yes	Table 8b	Table 6	Tables 10 and 11
C-106	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-107	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-108	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-109	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-110	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-111	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-112	Sluicing	360 ft^3/SPR	No	Yes	Table 8b		Tables 10 and 11
C-201	Vacuum	30 ft^3/SPR	No		Table 8b		
C-202	Vacuum	30 ft^3/SPR	No		Table 8b		
C-203	Vacuum	30 ft^3/SPR	No		Table 8b		
C-204	Vacuum	30 ft^3/SPR	No		Table 8b		

Table 13. Features of Waste Management Area C Base Case (2 Pages).

Past UPR Sources[f]	**Inventory**[c]
UPR-200-E-81	see Table 6
UPR-200-E-82	see Table 6
UPR-200-E-86	see Table 6

Ancillary Equipment Sources	**Residual Vol./Type**	**Inventory** [c]
244-CR TK-CR-001	27 ft^3/SPR	see Table 12
244-CR TK-CR-002	8 ft^3/SPR	see Table 12
244-CR TK-CR-003	8 ft^3/SPR	see Table 12
244-CR TK-CR-011	27 ft^3/SPR	see Table 12
C-301	19 ft^3/SPR	see Table 12
Piping	250 ft^3/SPR	see Table 12

[a] Retrieval Method from RPP-15588 *Hanford Tank Waste Operations Simulator (HWTOS) Model Run Results for the Proposed Baseline Change Request (BCR) Case* (Table A-1E) Vacuum and Crawlers are considered dry retrieval technologies. Minimal water will be used with these technologies as opposed to sluicing which uses large volumes of water to retrieve.

[b] Past Tank Leaks,only tanks with verfied vadose zone contamination were included in the model. Vadose contamination was either verified by either by borehole sampling or geophysical logging.

[c] Inventory Tables are from Section 3.6 of this document

[d] SPR = Selected Phase Removal inventory after the retrieval of tank wastes as reported in *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA: Inventory and Source Term Data Package.*

[e] HTWOS = Hanford Tank Waste Operation Simulator (HTWOS) Model Output *Single-Shell Tank Retrieval Sequence and Double-Shell Tank Space Evaluation* (RPP-8554), modeled inventory after retrieval simulating differential dissolution of waste constituents in high volume retrieval (Please note after this risk analysis was completed, the retrieval technology selected for C-106 was changed from modified sluicing to acid dissolution. An inventory analysis has not been completed for tank residuals using acid dissolution) Subsequent risk assessments will address acid-dissolution for this tank.

[f] Past leaks and hypothetical retrieval leaks are simulated using advective transport through the vadose zone.

4.3.1 Results for Technetium-99

The results of the WMA C composite analysis for technetium-99, representing all sources, are given in Table 14 and Figure 10. In this figure, the following six BTCs are shown:

- **Source – Hypothetical Retrieval Leaks** (Figure 10): Hypothetical retrieval leaks were modeled for all C-100 Series tanks, since the expected retrieval methodology is thought to be sluicing. The retrieval methodology for the C-200 series tanks is a dry vacuum. A retrieval leak was not applied to these tanks.

  The total estimated inventory for retrieval leaks is 5.0 Ci. The inventory from waste retrieval leaks was applied to simulation Case 1 (Table 4) with the higher hydraulic conductivity for the unconfined aquifer and then summed to estimate impacts of waste retrieval leaks from all C-100 series tanks. Although retrieval leaks are included in the cumulative curve, it is unrealistic to assume all tanks will leak 8,000 gal. The waste retrieval leaks peak breakthrough occurs approximately 80 years after retrieval with a peak concentration of 430 pCi/L, which is below the MCL derived constituent concentration of 900 pCi/L. The Hanford Advisory Board (HAB) Consensus Advice #132 states that the core zone will have an industrial scenario for 150 years after site closure. At that time the concentration will have dropped to approximately175 pCi/L. Following the emplacement of a barrier, contaminant levels would drop until the barrier degrades. After the barrier degrades, a second peak arrives approximately 1,135 years after the first peak with a peak value of 88 pCi/L.

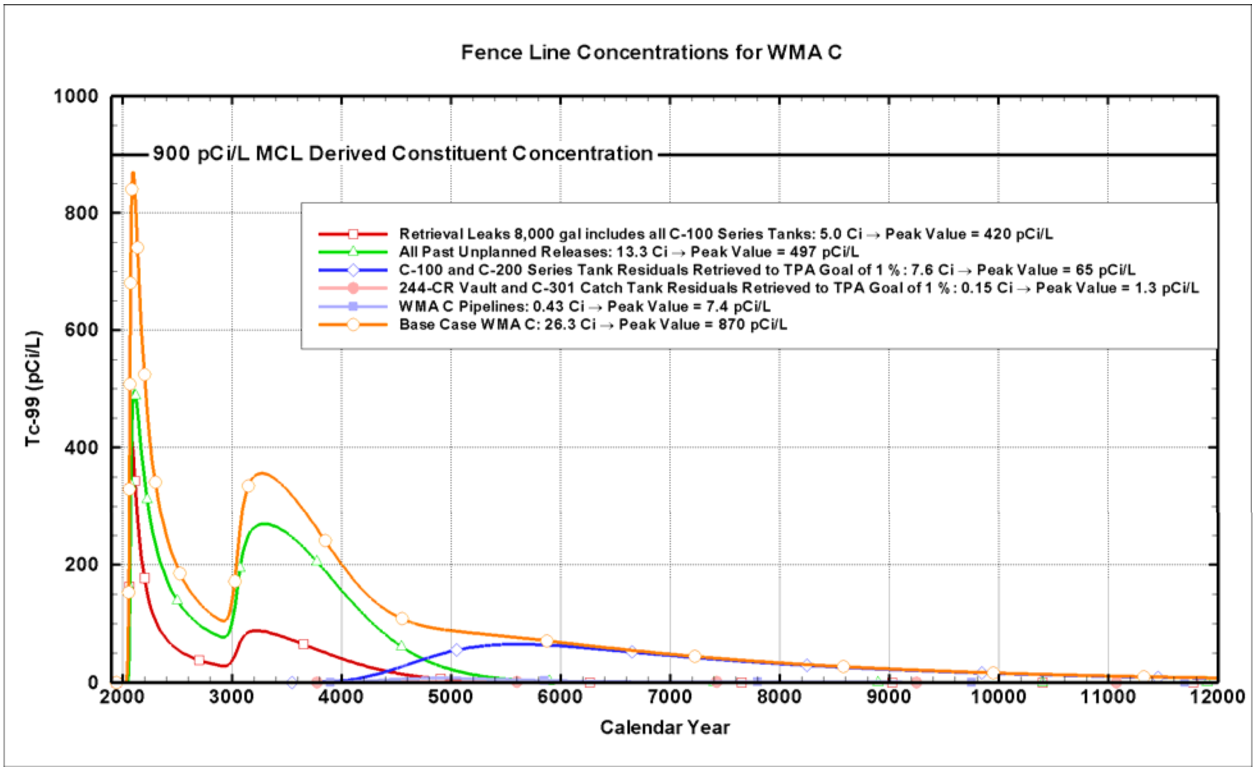
- **Source – Unplanned Releases** (Figure 10): Estimated inventory for technetium-99 from past leaks from C-105 and the ancillary equipment is 1.9 Ci and 11.3, respectively (total 13.26 Ci). This inventory was applied to the simulation Case 3 (Table 4, tank C-105 past tank leaks) and Case 4 (Table 4, ancillary equipment leaks) with the higher hydraulic conductivity for the unconfined aquifer. The simulations were then summed to estimate the concentrations for both tank ancillary equipment leaks. The simulated peak concentration from these sources is 497 pCi/L occurring approximately 110 years after the leak. This is slightly under the MCL derived constituent concentration of 900 pCi/L. Like the waste retrieval leaks, concentrations decrease following the emplacement of a barrier. After the barrier degrades, concentrations rise reaching a peak approximately 1,180 years after the first peak, with a peak value of 270 pCi/L.

Table 14. Simulated Peak Concentrations [a] (pCi/L) and Arrival Times (year) for Technetium-99 at Various Boundaries.

Simulation	**WMA C Fenceline Boundary**		**Proposed Core Zone Boundary**		**Columbia River**	
	Time	**Conc.**	**Time**	**Conc.**	**Time**	**Conc.**
No-Action (i.e., no retrieval) Tank Residuals						
Unretrieved Tank Waste Advection-dominated release [simulation case 10] [b]	4653	9639	4676	1520	4883	560
Unretrieved Tank Waste Diffusion-dominated release [simulation case 11]	5614	3030	5637	480	5839	178
Base Case Post-Retrieval [b]						
Retrieved Tank Residuals Advection-dominated release[simulation case 10] [b]	4653	208	4676	32	4883	12
Retrieval leak (8,000 gal) [simulation case 1]	2082	420	2107	67	2324	22
Past tank leaks [simulation case 3]	2092	156	2117	25	2333	9
Past ancillary equipment leaks (UPR) [simulation case 4]	2117	353	2141	56	2355	20
Retrieved Tank Residuals Diffusion-dominated release [simulation case 11]	5614	65	5637	10	5839	4
Residuals in 244-CR vault and catch-tank release limited to diffusion [simulation case 11]	5614	1	5637	0.2	5839	0.08
Residuals in ancillary pipeline release limited to diffusion [scaled simulation case 13]	4891	7.4	4925	1.2	5130	0.4

[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.
[b] Not part of the base case; only added for comparison purposes between release models.
UPR = unplanned release
WMA = waste management area

Figure 10. Technetium-99 Results for Hypothetical Retrieval Leaks, Past Unplanned Releases, and Tank and Ancillary Equipment Residuals (Diffusion-Dominated Release).



- **Source – C Farm 100- and C-200-Series Tank Residual Waste Releases** (Figure 10): Total technetium-99 inventory left in the residual waste within the tanks is 7.6 Ci using selected phase removal for all tanks. The inventory from these sources was applied to Case 11 (Table 4) with the higher hydraulic conductivity for the unconfined aquifer. The diffusion-dominated release model results for residuals are presented. Again, such a release model represents release from a stabilized waste form covered with grout* or cementitious grout*. If diffusion is the correct release mechanism, the release of contaminants from the tank residuals is not expected to exceed the MCL derived constituent concentration. The simulated peak for residual waste in all tanks is 65 pCi/L occurring approximately 3,500 years after closure.

- **Source – Ancillary Equipment CR-Vaults and C-301 Catch Tank Residual Releases** (Figure 10): This assumes the waste in the CR-vaults and C-301 catch tank will be retrieved to approximately the HFFACO goal. Assumed inventory for technetium-99 for this ancillary equipment is 0.15 Ci. The inventory from these sources was applied to Case 11 (Table 4) with the higher hydraulic conductivity for the unconfined aquifer. These sources were modeled the same as the C farm 100- and 200-series tanks, with a

* See Preface in *SST System Closure Plan* (RPP-13774).

diffusion-dominated release model (a waste form covered with grout*). The simulated peak for residual waste in these tanks is 1.3 pCi/L occurring 3,500 years after closure.

- **Source – Ancillary Equipment: Pipeline Residual Release** (Figure 10): This assumes an ancillary equipment inventory of 0.43 Ci for technetium-99. The inventory from this source was applied to a scaled Case 13 (Table 4), Case 13 was modeled with a diffusion-dominated release model assuming a waste form in which the pipelines are filled with grout*. With the assumed inventory for residual in pipelines, the simulated peak is 7.5 pCi/L. The arrival time for the peak occurs approximately 2,850 years after closure. The residual in the pipeline represents approximately 12% of cumulative impacts at the peak arrival time for release from the pipeline, which occurs 700 years before the impacts due to tank residual waste.

- **Source – Cumulative Impacts from all Sources within WMA C** (Figure 10): The BTCs for the five sources listed above were summed to calculate a total technetium-99 concentration at the fenceline. The total technetium-99 inventory for the release to the surrounding environment would be 26.3 Ci. The peak simulated technetium-99 concentration for the composite WMA C is 870 pCi/L occurring approximately 100 years into the future. This peak is slightly under the 900 pCi/L MCL derived constituent concentration for technetium-99. The principal driver for the peak concentration is from the past leaks and hypothetical retrieval leaks which occurs during the time in which the core zone use is considered industrial. Once the barrier is emplaced, the concentrations drop to 105 pCi/L. Once the barrier degrades, concentrations rise to a second peak value of 356 pCi/L approximately 1,180 years after the first peak.

The results of the WMA C cumulative analysis indicate the following:

- The primary contributors to groundwater contamination are contaminants contained in past leaks from tanks and ancillary equipment and the hypothetical retrieval leaks.

- The highest contaminant concentration in groundwater occurs within 100 years of retrieval, and within the time periode in which the core zone is considered industrial.

- The placement of the surface barrier greatly reduces recharge through vadose zone contamination, which results in a decrease in the predicted groundwater concentration until the barrier degrades.

- During the first 120 years after waste retrieval, technetium-99 concentration associated with past leaks is 497 pCi/L, which is approximately half of the MCL derived constituent concentration, followed by hypothetical retrieval leaks at 420 pCi/L The peak concentration of technetium-99 resulting from tank residual diffusion releases after waste retrieval is 65 pCi/L which occurs approximately 3500 years after site closure.

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* See Preface in *SST System Closure Plan* (RPP-13774).

No-Action and Post-Retrieval Residual Technetium-99 Results: Figure 11 shows the simulated fenceline concentrations for technetium-99 for both no-action and post-retrieval. Figure 11(a) presents the no-action technetium-99 results for the WMA C 100- and 200-series tanks. The total technetium inventory for these tanks before retrieval is 350.8 Ci. Figure 11(b) shows simulated post-retrieval technetium-99 results (note the vertical scale has been increased by a factor of two over the upper figure). The total technetium inventory for these tanks after retrieval is 7.6 Ci. Included in each of the figures is a comparison between the advection- and diffusion-dominated release mechanisms.

- If the release is advection-dominated (from a sand or gravel fill material for the tank), the peak concentration at the fenceline is approximately 9,640 pCi/L for the present day BBI. However, if the tank is filled with a stabilizing agent (grout or concrete) and the release is diffusion-dominated, the resulting concentration drops by approximately 70% to 3,030 pCi/L.

- Retrieving to HFFACO goals reduces the technetium-99 concentration from 9,640 to 192 pCi/L for the advection-dominated release model. However, if the release is diffusion-dominated, the concentration at the fenceline is reduced from 3,030 to 65 pCi/L.

Comparison of no-action tank waste inventory and post-retrieval inventory results for a fast release model (advection-dominated) versus a slow release model (diffusion-dominated) shows the following:

- Retrieval of tank residual waste to HFFACO goals can reduce fenceline concentrations to below the MCL.

- Work to establish the type of release from residual tank waste is important in direct proportion to the amount of waste that remains in the tank after waste retrieval. The more waste left behind, the more important the release model becomes.

Individual Tanks: Evaluation of the tanks individually (Figure 12 for advection-dominated release, Figure 13 for diffusion-dominated release) indicates that when the wastes are retrieved to the HFFACO goal, none of the tanks are projected to contain a residual inventory capable of resulting in a peak concentration greater than the MCL, regardless of the release mechanism.

Figure 11. Advection- and Diffusion-Dominated Technetium-99 Release Model Results for all C Farm 100- and 200-Series Tanks using both Pre- and Post-Retrieval Inventories.

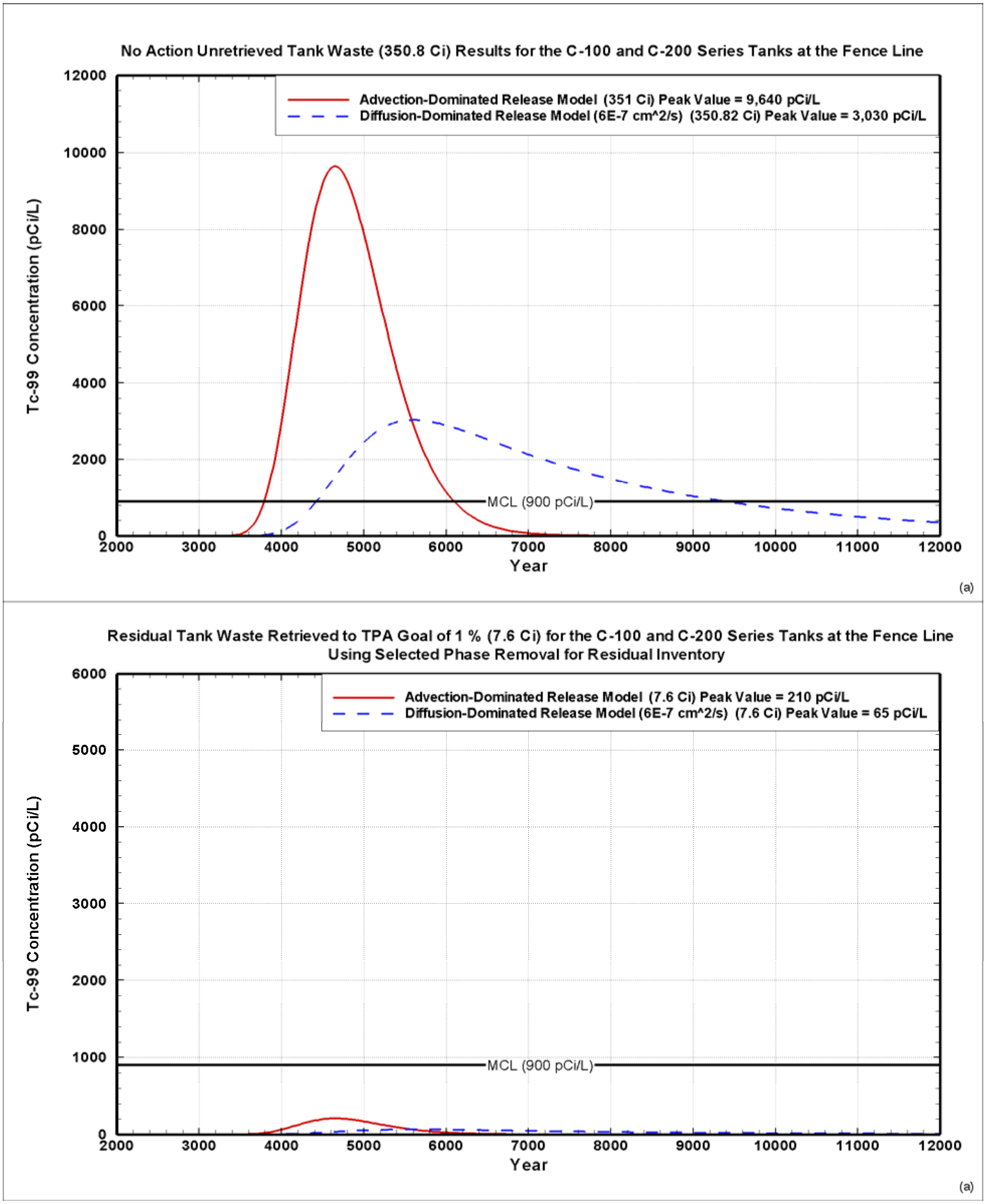


Figure 12. Post-Retrieval Technetium-99 Advection-Dominated Release Model Results for Individual C Farm 100-Series Tanks.

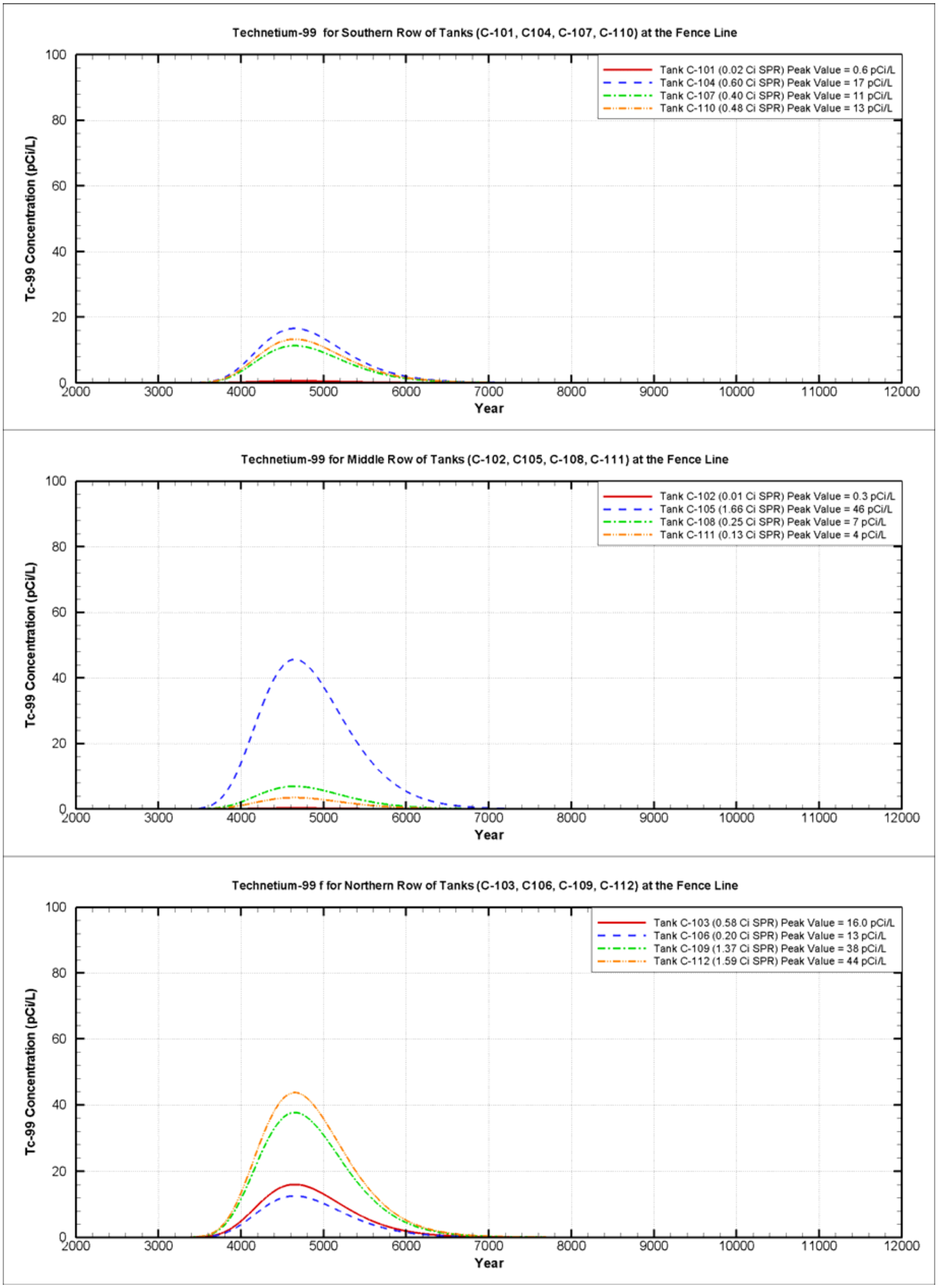
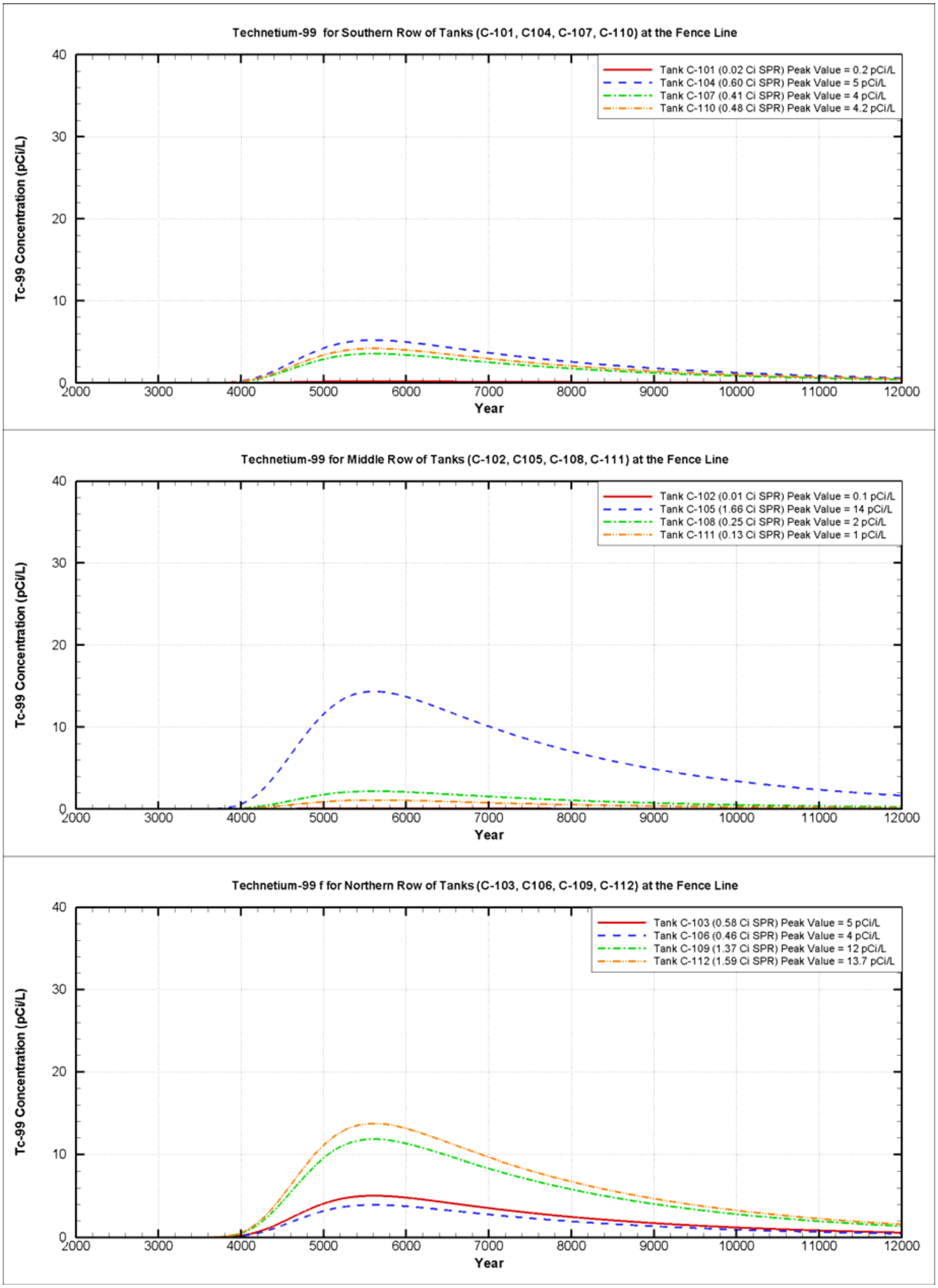


Figure 13. Post-Retrieval Technetium-99 Diffusion-Dominated Release Model Results for Individual C Farm 100-Series Tanks.



Hypothetical Retrieval Leaks: Three types of retrieval technologies have been identified for WMA C (RPP-15588). *Waste Retrieval and Storage Data Package* (DOE/ORP-2003-06) provides detailed descriptions of the retrieval methodologies. For all 200-series tanks, a vacuum system is used to retrieve waste. All 100 series tanks will be sluiced. This is essentially a dry technology in which a crawler moves the waste to a riser from which it will be vacuumed out. The crawler may spray some water onto the waste to help move it, but the amount of water used for waste retrieval is minimized. Modified sluicing was originally identified as the retrieval technology for C-106[5] however, the most recent waste retrieval technology for this tank is an acid wash. Because a post-retrieval inventory has not been associated with an acid wash, for this analysis C-106 will be treated as if its waste were being retrieved with modified sluicing. Sluicing requires the introduction of water under pressure to remove the waste. A waste retrieval leak could occur when waste material is being sluiced. Figure 14 presents the results for a hypothetical retrieval leak of 8,000 gal from all C-100 series tanks. Breakthrough Curves for C-112; C-109 and C-110 show the highest peak concentrations (108 pCi/L, 69 pCi/L and 66 pCi/L, respectively). The arrival time for the peak concentration occurs 82 years after waste retrieval. Results from unit source analysis (Figure 6), indicate that if a 20,000 gal leak were to occur, the resulting peak concentration would be approximately 20% higher.

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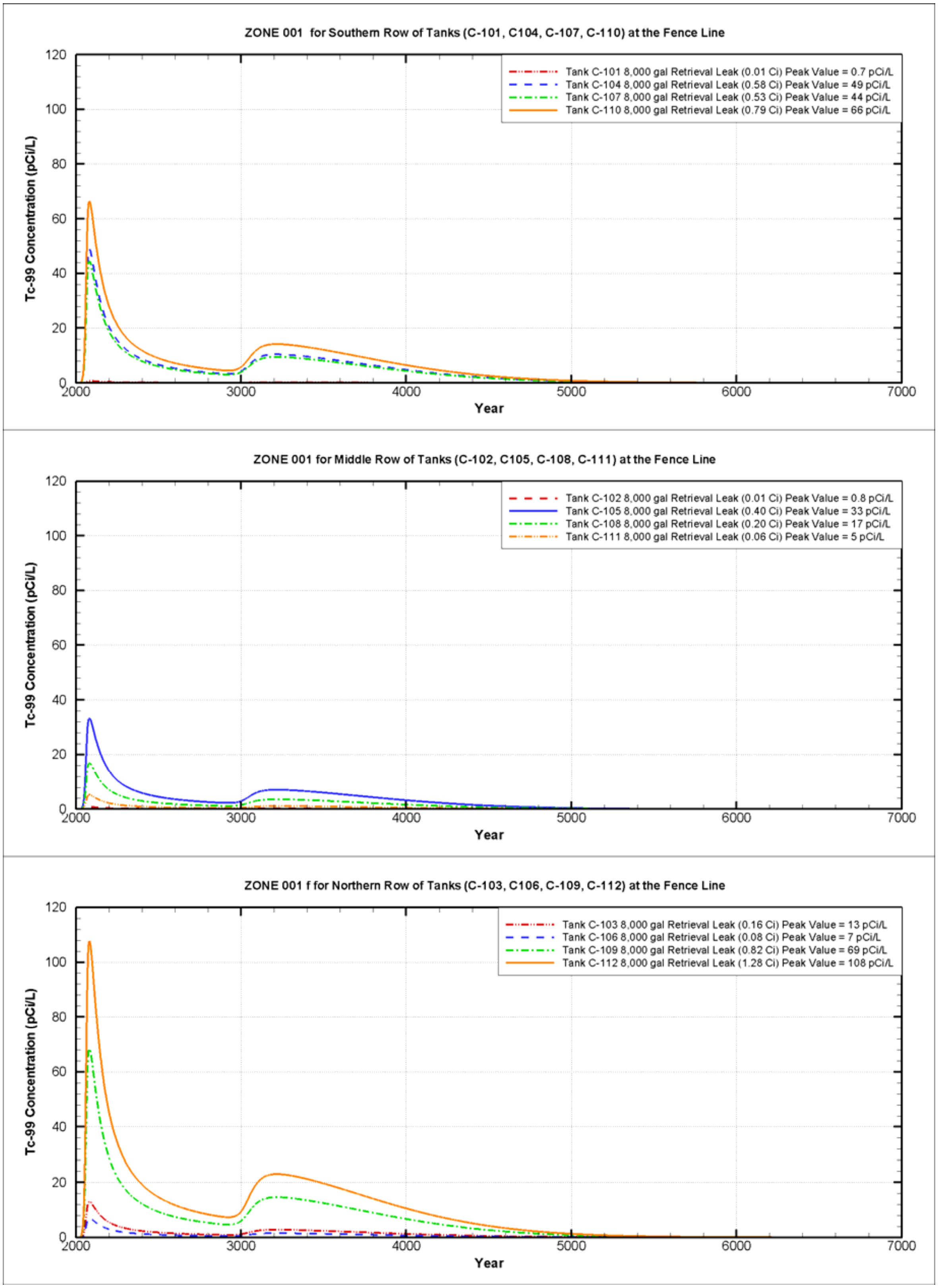
[5]Oxalic acid will be neutralized by the carbonate minerals naturally present in the soil and, given the amount and concentration of acid in an 8,000 gallon leak of 1M oxalic acid and the percent level of carbonate minerals in the soil, it is likely that the soil will neutralize the acid a short vertical distance (tens of feet or less) below the leak. The neutralized pH will likely be in the range of 7 to 8. Oxalic acid is fully deprotonated at a pH of about 4; therefore, above this pH all of the oxalate will be present in solution as the oxalate anion ($C_2O_4^{2-}$). This anion will complex with uranium (uranium oxalate stability constant → log K = +6.36 (*NIST Critically Selected Stability Constants of Metal Complexes Database*,[Smith and Martell 2003]), although no where near as strongly as with other organic complexes such as EDTA (uranium EDTA stability constant → Log K = 9.28 [Smith and Martell (2003]). PNNL found that the formation of the uranium oxalate complex did not reduce the adsorption of uranium onto Hanford soils compared to an oxalate-free solution. However, PNNL was not using 1M oxalate solutions so the results are not directly comparable; however, it is possible that the presence of oxalate will not significantly increase the mobility of uranium through the vadose zone.

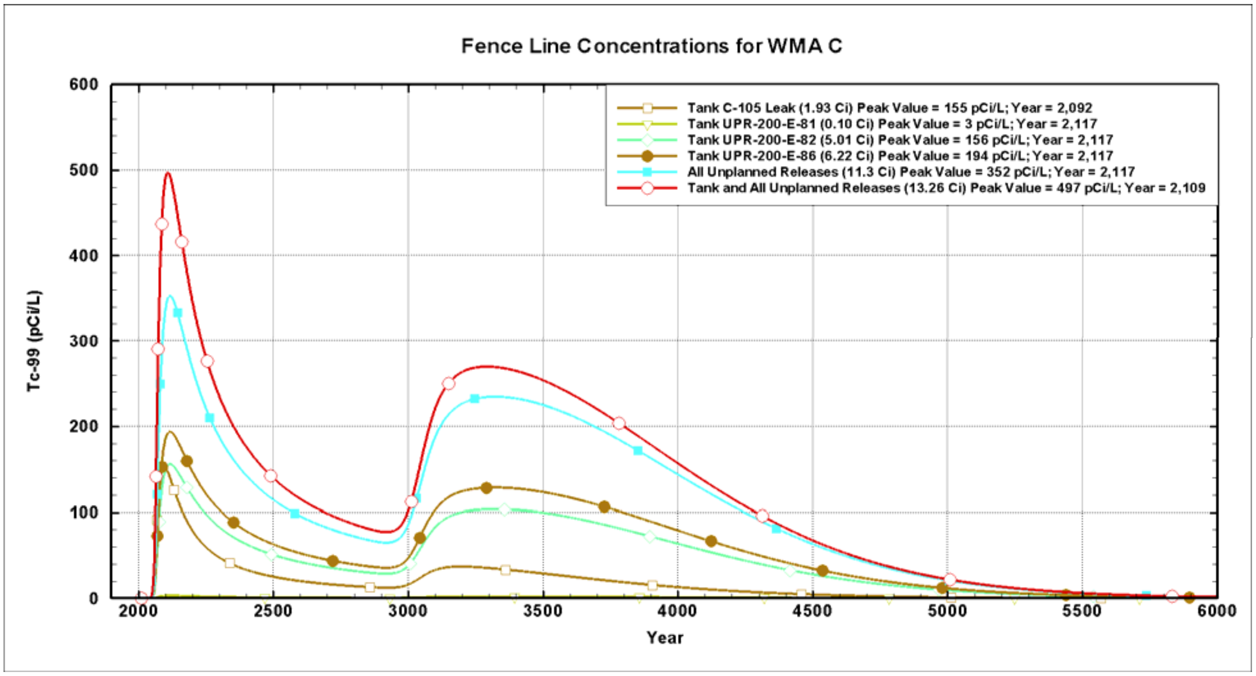
Additionally, no specific contaminants were used in the fate and transport model. Instead specific contaminants are modeled by assigning it to a sorption coefficient (K_d) bin. Contaminants like iodine-129 and technetium-99 were assigned a K_d of 0.0 ml/g, while uranium was assigned a K_d of 0.6 ml/g. If appropriate, the K_d for uranium could be adjusted.

Figure 14. Results for a Waste Retrieval Leak
of 8,000 gal for C-100 Series Tanks.



Past Leaks: Figure 15 presents the results for all past leaks. The tank leak is simulated by the placement of the leak deeper in the vadose zone (Case 3, Table 4), compared to ancillary equipment releases (Case 4, Table 4); hence, the higher impact for a leak from tank C-105 per curie of inventory than the ancillary equipment releases. The tank C-105 leak released 1.93 Ci with a resulting peak concentration of 155 pCi/L. There are three unplanned releases from tank ancillary equipment (pipelines). UPR-200-E-81, UPR-200-E-82, and UPR-200-E-86 released 0.1, 5.01, and 6.22 Ci of technetium-99, respectively, with resulting peak concentrations of 3 pCi/L, 156 pCi/L, and 197 pCi/L. A dual peak is observed on all of these curves because of the installation of a barrier, which effectively limits the movement and the contaminants remain in the vadose zone until the barrier degrades. Once the barrier degrades, a smaller second peak is observed.

Figure 15. Results for All Past Unplanned Releases.



4.3.2 Results for Other Contaminants of Concern

The results presented thus far were for the long-lived mobile radionuclide technetium-99. The transport of other highly mobile contaminants (such as iodine-129, nitrate, nitrite, and hexavalent chromium) is expected to be similar to that for technetium-99, with the resulting risk contribution to the overall cumulative risk dependent upon the contaminant inventory. Tables 15 through 19 illustrate the simulated peak concentrations and arrival times for all COCs and all sources. Included in these tables are the results for residuals at BBI and retrieved to HFFACO goals with both advection- and diffusion-dominated release models. Solubility-limited release model results are not presented here because of considerable uncertainty about its applicability to tank waste releases and appropriate solubility values to use in contaminant migration analyses. The WMA fenceline results for other selected COCs are summarized below:

- **Iodine-129** (Table 15 and Figure 16). For retrieval leaks of 8,000 gal at C-106 and C-107, previous tank leaks, and previous unplanned releases, the simulated peak concentrations are 0.82, 0.30, and 0.68 pCi/L, respectively, which are under the MCL derived constituent concentration of 1 pCi/L. For pre-retrieval residuals, both the advection- and diffusion-dominated release models have peak concentrations well over the MCL derived constituent concentration. For retrieval to HFFACO goals, the peak concentration for the advection-dominated release is 0.43 pCi/L; however, if the release mechanism is diffusion, the peak concentration is 0.14 pCi/L. For the base-case composite analysis of the WMA (Figure 16), the concentration (1.7 pCi/L) is higher than the MCL derived constituent concentration. However, this peak concentration is due to past leaks (tanks and operational) and hypothetical retrieval leaks. Peaks due to the residuals in tanks and pipelines are observed at 3,500 and 2,900 years past closure, respectively, and are approximately one (tank residuals) and two (pipeline residuals) orders of magnitude less than those for past leaks and hypothetical retrieval leaks.

Table 15. Simulated Peak Concentrations[a] (pCi/L) and Arrival Times (year) for Iodine-129 at Various Boundaries.

Simulation	WMA C Fenceline Boundary		Proposed Core Zone Boundary		Columbia River	
	Time	Conc.	Time	Conc.	Time	Conc.
No-Action (i.e., no retrieval) Tank Residuals						
Unretrieved Tank Waste Advection-dominated release [simulation case 10][b]	4653	27	4676	4.3	4883	1.6
Unretrieved Tank Waste Diffusion-dominated release [simulation case 11]	5614	8.7	5637	1.4	5839	0.50
Base Case Post-Retrieval [b]						
Retrieved Tank Residuals Advection-dominated release [simulation case 10][b]	4653	0.43	4676	0.05	4883	0.025
Retrieval leak (8,000 gal) [simulation case 1]	2082	0..82	2107	0.11	2324	0.055
Past tank leaks [simulation case 3]	2092	0.30	2117	0.05	2333	0.02
Past ancillary equipment leaks (UPR) [simulation case 4]	2117	0.68	2141	0.11	2355	0.04
Retrieved Tank Residuals Diffusion-dominated release [simulation case 11]	5614	0.14	5637	0.025	5839	0.012
Residuals in 244-CR vault and catch-tank release limited to diffusion [simulation case 11]	5614	0.003	5637	4.4 E-04	5839	1.6 E-04
Residuals in ancillary pipeline release limited to diffusion [Scaled simulation case 13]	4891	0.015	4925	2.5 E-03	5130	9E-04

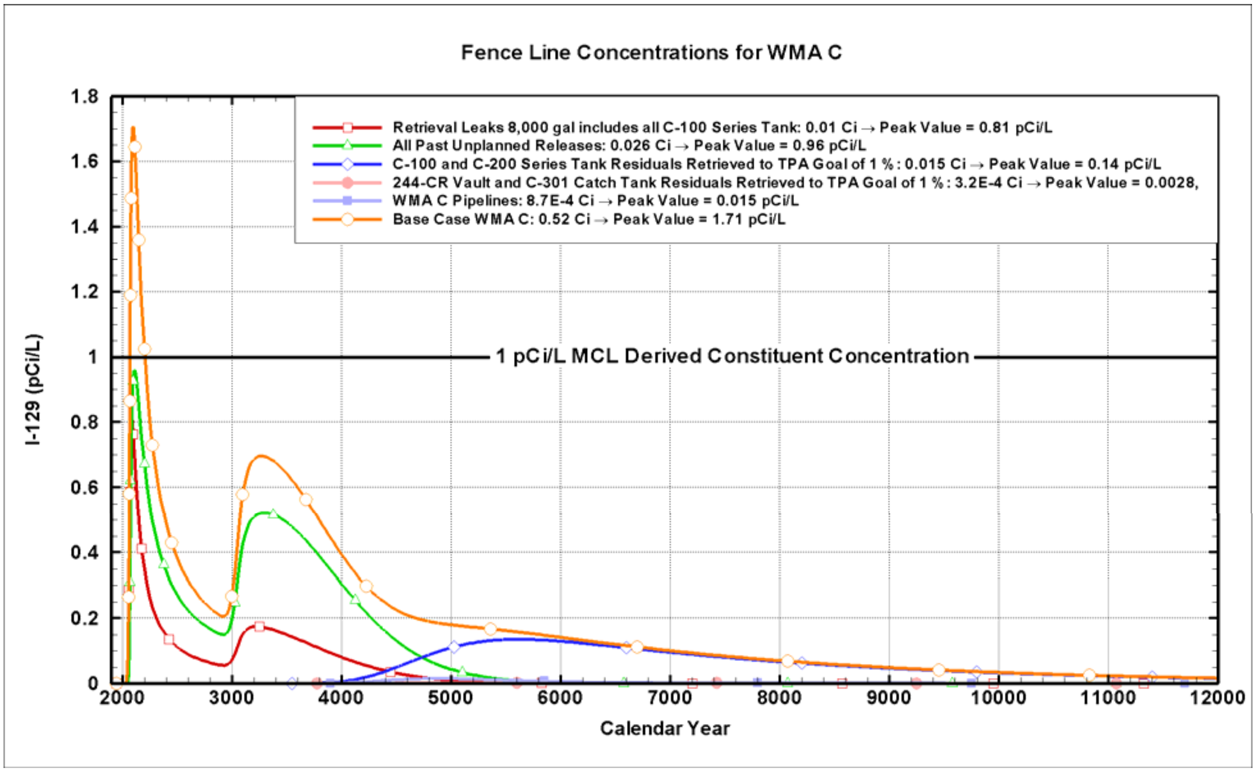
[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.

[b] Not part of the base case; only added for comparison purposes between release models.

UPR = unplanned release

WMA = waste management area

Figure 16. Iodine-129 Composite Waste Management Area C Fenceline Results for Past Unplanned Releases, Tank Residuals (Diffusion-Dominated Release Model) and Retrieval Leaks.



- **Nitrate** (Table 16 and Figure 17). For all sources and release models, the simulated peak concentration is below the MCL (45 mg/L, nitrate as nitrate). For the base-case composite analysis (Figure 17), the peak (0.8 mg/L) is approximately a factor of 50 less than the MCL with the hypothetical retrieval leaks contributing 80 % of the peak concentration. It should be noted that no sources came close to exceeding the MCL.

Table 16. Simulated Peak Concentrations[a] (mg/L) and Arrival Times (year) for Nitrate at Various Boundaries.

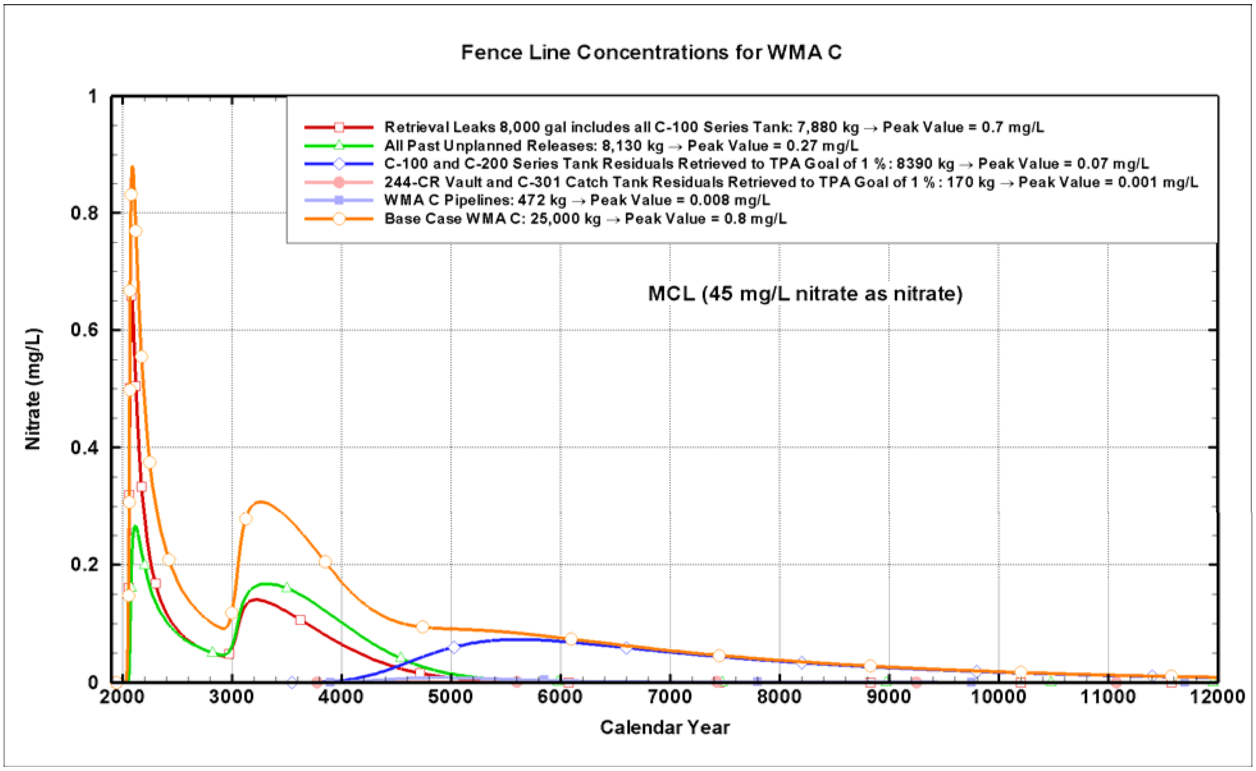
Simulation	WMA C Fenceline Boundary		Proposed Core Zone Boundary		Columbia River	
	Time	**Conc.**	**Time**	**Conc.**	**Time**	**Conc.**
No-Action (i.e., no retrieval) Tank Residuals						
Unretrieved Tank Waste Advection-dominated release [simulation case 10] [b]	4653	11	4676	1.7	4883	0.64
Unretrieved Tank Waste Diffusion-dominated release [simulation case 11]	5614	3.5	5637	0.55	5839	0.20
Base Case Post-Retrieval [b]						
Retrieved Tank Residuals Advection-dominated release [simulation case 10] [b]	4653	0.22	4676	0.03	4883	0.01
Retrieval leak (8,000 gal) [simulation case 1]	2082	0.66	2107	0.1	2324	0.05
Past tank leaks [simulation case 3]	2092	0.03	2117	4E-03	2333	1.4 E-03
Past ancillary equipment leaks (UPR) [simulation case 4]	2117	0.24	2141	0.04	2355	0.01
Retrieved Tank Residuals Diffusion-dominated release [simulation case 11]	5614	0.07	5637	0.01	5839	4E-03
Residuals in 244-CR vault and catch-tank release limited to diffusion [simulation case 11]	5614	0.0015	5637	2E-04	5839	8E-05
Residuals in ancillary pipeline release limited to diffusion [Scaled simulation case 13]	4891	0.008	4925	0.0013	~5130	~5E-04

[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.

[b] Not part of the base case; only added for comparison purposes between release models.

~ = approximately
UPR = unplanned release
WMA = waste management area

Figure 17. Nitrate Composite Waste Management Area C Results for Past Unplanned Releases, Tank Residuals (Diffusion-Dominated Release Model) and Retrieval Leaks



- **Nitrite** (Table 17 and Figure 18). For all sources and release models, the simulated peak concentration is below the MCL (3.3 mg/L, nitrite as nitrite). For the base-case composite analysis (Figure 18), the peak (0.36 mg/L) is approximately one order of magnitude less than the MCL with hypothetical retrieval leaks account for approximately 60 % of the peak and ancillary equipment accounting for 30 % of the peak.

- **Chromium** (Table 18 and Figure 19). For the base-case composite analysis, the peak concentration (0.009 mg/L) is one order of magnitude less than the MCL (0.1 mg/L). For pre-retrieval residual waste, the advection-dominated release model has a peak concentration of 0.16 mg/L (Table 18), approximately a factor of 1.5 over the MCL; and diffusion-dominated release model has a peak concentration of 0.05 mg/L, which is at 0.5 of the MCL.

- **Uranium** (Table 19 and Figure 20). For all sources and releases (simulated with K_d = 0.6 mL/g, [*Hanford Contaminant Distribution Coefficient Database and Users Guide*,{PNNL-13895, Rev.1}]), did not result in concentrations above the MCL (0.03 mg/L) over the simulation time period regardless of the release mechanism or initial inventory. The source provides the greatest contribution to the total concentration is the hypothetical retrieval leak by the end of the simulation, and that concentration is a factor of 250 below the MCL. The next largest contributor is the unplanned releases which are a factor of approximately 3500 below the MCL. Uranium, primarily due to past leaks and retrieval leaks, does not arrive at the fenceline until approximately 8,000 years into the future. Future revisions of this document or will examine the sensitivity of the results to lower K_ds for uranium.

Table 17. Simulated Peak Concentrations[a] (mg/L) and
Arrival Times (Year) for Nitrite at Various Boundaries.

Simulation	**WMA C Fenceline Boundary**		**Proposed Core Zone Boundary**		**Columbia River**	
	Time	**Conc.**	**Time**	**Conc.**	**Time**	**Conc.**
No-Action (i.e., no retrieval) Tank Residuals						
Unretrieved Tank Waste Advection-dominated release [simulation case 10] [b]	4653	5.3	4676	0.82	4883	0.3
Unretrieved Tank Waste Diffusion-dominated release [simulation case 11]	5614	1.7	5637	0.26	5839	0.1
Base Case Post-Retrieval [b]						
Retrieved Tank Residuals Advection-dominated release [simulation case 10] [b]	4653	0.11	4676	0.02	4883	0.006
Retrieval leak (8,000 gal) [simulation case 1]	2082	0.26	2107	0.05	2324	0.01
Past tank leaks [simulation case 3]	2092	0.02	2117	0.0034	2333	0.0012
Past ancillary equipment leaks (UPR) [simulation case 4]	2117	0.12	2141	0.02	2355	0.0070
Retrieved Tank Residuals Diffusion-dominated release [simulation case 11]	5614	0.03	5637	0.005	5839	0.002
Residuals in 244-CR vault and catch-tank release limited to diffusion [simulation case 11]	5614	7E-04	5637	1E-04	5839	4E-05
Residuals in ancillary pipeline release limited to diffusion [Scaled simulation case 13] [c]	4891	0.004	4925	6E-04	5130	2E-04

[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.

[b] Not part of the base case; only added for comparison purposes between release models.

UPR = unplanned release
WMA = waste management area

Figure 18. Nitrite Composite Waste Management Area C Results for Past Unplanned Releases, Tank Residuals (Diffusion-Dominated Release Model) and Retrieval Leaks.

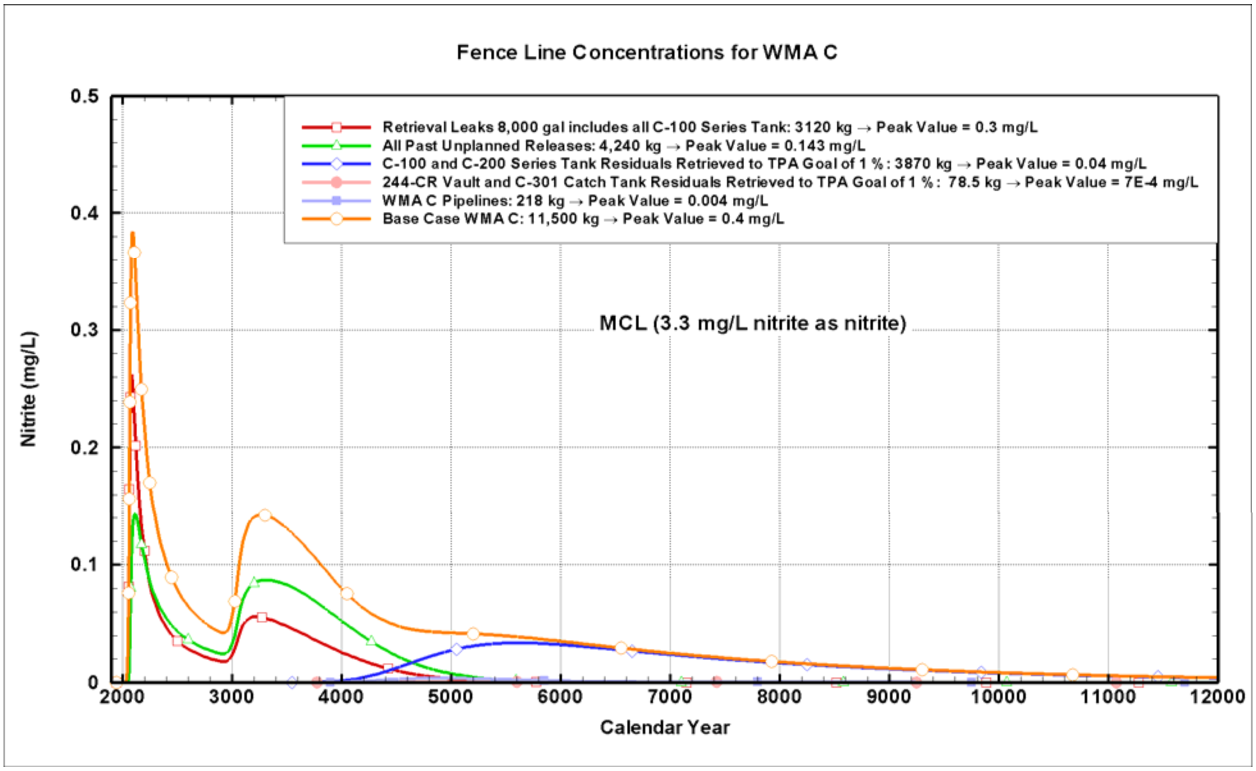


Table 18. Simulated Peak Concentrations a (mg/L) and Arrival Times (Year) for Chromium+6 at Various Boundaries. (2 Pages)

Simulation	WMA C Fenceline Boundary		Proposed Core Zone Boundary		Columbia River	
	Time	Conc.	Time	Conc.	Time	Conc.
Pre-Retrieval Cases						
Unretrieved Tank Waste Advection-dominated release [simulation case 10] [b]	4653	0.16	4676	0.02	4883	0.009
Unretrieved Tank Waste Diffusion-dominated release [simulation case 11]	5614	0.05	5637	0.008	5839	0.003
Base Case Post-Retrieval [b]						
Retrieved Tank Residuals Advection-dominated release [simulation case 10] [b]	4653	0.003	4676	4E-04	4883	1E-04
Retrieval leak (8,000 gal) [simulation case 1]	2082	0.0064	2107	1E-03	2324	3E-04
Past tank leaks [simulation case 3]	2092	8E-04	2117	1E-04	2333	4E-05
Past ancillary equipment leaks (UPR) [simulation case 4]	2117	0.003	2141	5E-04	2355	2E-04

Table 18. Simulated Peak Concentrations a (mg/L) and Arrival Times (Year) for Chromium+6 at Various Boundaries. (2 Pages)

Simulation	WMA C Fenceline Boundary		Proposed Core Zone Boundary		Columbia River	
	Time	**Conc.**	**Time**	**Conc.**	**Time**	**Conc.**
Retrieved Tank Residuals Diffusion-dominated release [simulation case 11]	5614	0.001	5637	1.6E-04	5839	6E-05
Residuals in 244-CR vault and catch-tank release limited to diffusion [simulation case 11]	5614	2E-05	5637	3E-06	5839	1E-06
Residuals in ancillary pipeline release limited to diffusion [Scaled simulation case 13][c]	4891	1E-04	~4925	2E-05	~5130	7E-06

[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.
[b] Not part of the base case; only added for comparison purposes between release models.
[c] Scaled results are approximate; see discussion in text for scaling methodology.
~ = approximately
UPR = unplanned release
WMA = waste management area

Figure 19. Chromium Composite Waste Management Area C Results for Past Unplanned Releases, Tank Residuals (Diffusion-Dominated Release Model) and Retrieval Leaks.

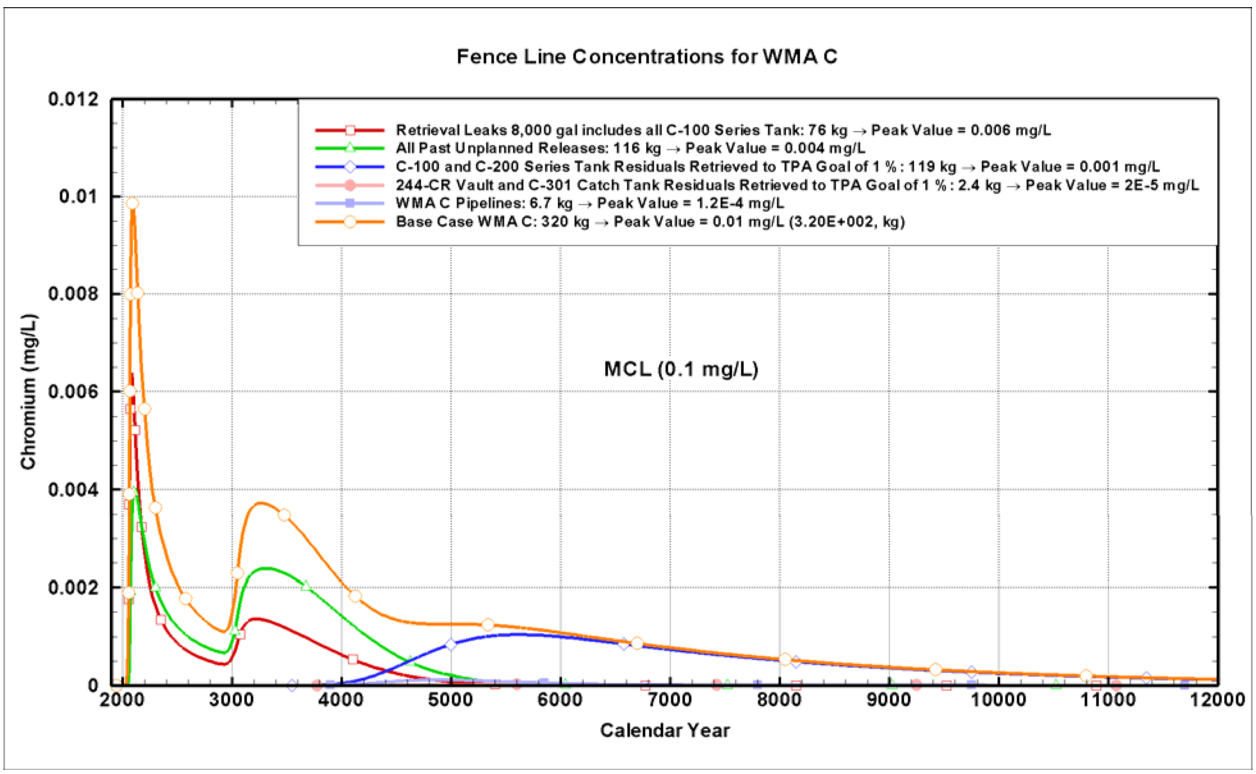
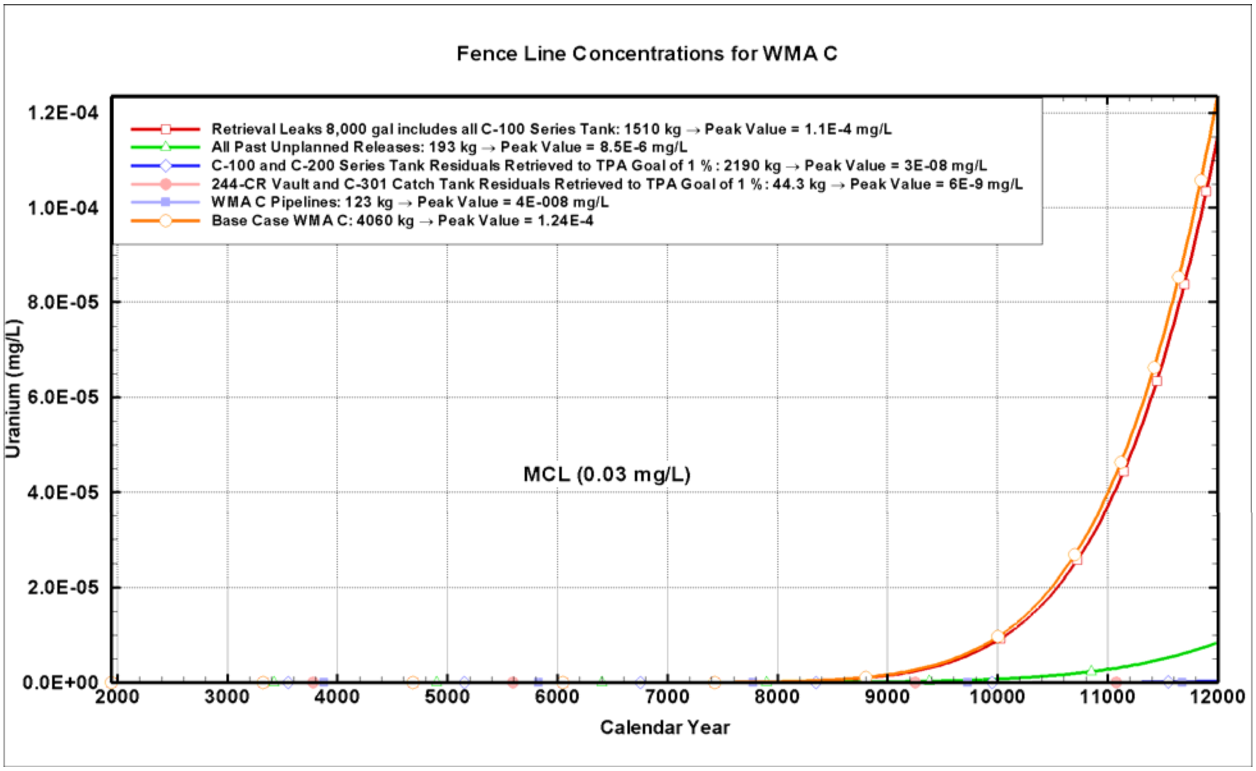


Table 19. Simulated Peak Concentrations[a] (mg/L) and Arrival Times (Year) for Uranium at Various Boundaries.

Simulation	**WMA C Fence Line Boundary**		**Proposed Core Zone Boundary**		**Columbia River**	
	Time	**Conc.**	**Time**	**Conc.**	**Time**	**Conc.**
No-Action (i.e., no retrieval) Tank Residuals						
Unretrieved Tank Waste Advection-dominated release[b]	12000	3E-04	12000	1.6E-04	12000	<1 E-05
Unretrieved Tank Waste Diffusion-dominated release	12000	1.5E-05	12000	<1E-05	12000	<1 E-05
Base Case Post-Retrieval [b]						
Retrieved Tank Residuals Advection-dominated release[b]	12000	<1 E-05	12000	<1 E-05	12000	<1 E-05
Retrieval leak (8,000 gal)	12000	1.2E-05	12000	8E-05	12000	<1 E-05
Past tank leaks	12000	<1 E-05	12000	<1 E-05	12000	<1 E-05
Past ancillary equipment leaks (UPR)	12000	<1 E-05	12000	<1 E-05	12000	<1 E-05
Retrieved Tank Residuals Diffusion-dominated release	12000	<1 E-05	12000	<1 E-05	12000	<1 E-05
Residuals in 244-CR vault and catch-tank release limited to diffusion	12000	<1 E-05	12000	<1 E-05	12000	<1 E-05
Residuals in ancillary pipeline release limited to diffusion	12000	<1 E-05	12000	<1 E-05	12000	<1 E-05

[a] Solubility-limited release model results are not presented here because of considerable uncertainty about the applicability of this particular release model.
[b] Not part of the base case; only added for comparison purposes between release models.
UPR = unplanned release
WMA = waste management area

Figure 20. Total Uranium Composite Waste Management Area C Results for Past Unplanned Releases, Tank Residuals (Diffusion-Dominated Release Model) and Retrieval Leaks.



4.3.3 Downgradient Concentrations

As contaminants move through an aquifer, the concentration decreases because of adsorption, dispersion, and diffusion processes. Adsorption refers to the process of contaminants binding to soil particles rather than continuing to travel in the groundwater. Dispersion and diffusion refer to the processes of contaminants spreading in the aquifer and consequently becoming more dilute. Dispersion occurs because the contaminants travel along different paths and at different velocities in the aquifer. The different paths and velocities, often referred to as the aquifer tortuosity, result from the structure of the porous media comprising the aquifer deflecting and diverting the water from a straight line. Diffusion occurs across concentration gradients as contaminants move from areas of high to low concentration. To estimate the concentration of contaminants at locations downgradient from a source, Domenico and Schwartz (1990) developed a three-dimensional analytical equation. The contaminant transport properties required to estimate the concentration of a plume through an aquifer include contaminant-specific distribution coefficients, which describe a contaminant's affinity to adsorb to soil particles, and soil bulk density, effective porosity, and longitudinal and transverse dispersivity coefficients. A description of the model equation and the properties used to simulate the transport of the contaminants through the aquifer is contained in *2003 Initial Assessments of Closure for the C Tank Farm: Numerical Simulations* (PNNL-14334).

In addition to the BTCs presented in Sections 4.3.1 and 4.3.2, the analytical stream tube solution (Domenico and Schwartz 1990) was used to model groundwater flow and transport to various

points of calculation downgradient from the WMA. The results from the stream tube model are summarized in Tables 14 through 19. The concentrations in groundwater are expected to attenuate as the contaminants move from the WMA C fenceline. For the base case model (Table 13), the results indicated that none of the COCs are expected to be found at concentrations exceeding their respective MCL or MCL derived constituent concentration at the proposed core boundary (2,900 m from the WMA C fenceline) or at the Columbia River (14,300 m from the WMA C fenceline), regardless of the inventory or release mechanism.

At the currently proposed core zone boundary for the 200 Areas, only the concentration of iodine-129 resulting from the advection- and diffusion-dominated releases without retrieval (4.3 pCi/L and 1.4 pCi/L, respectively [Table 15]) and the concentration of technetium-99 resulting from the advection-dominated release case without waste retrieval (1,520 pCi/L [Table 14]) may exceed the MCL derived constituent concentration. Including the effects of inventory reduction associated with retrieval to the HFFACO limits for the advection- and diffusion- dominated releases reduce the predicted iodine-129 concentrations to 0.05 pCi/L and 0.025 pCi/L (Table 15), respectively. For technetium-99, concentration for the advection-dominated release is reduced to 32 pCi/L. When calculations are extended to the river, the calculated concentrations of all of the contaminants for all of the release and inventory cases decrease to levels below their respective MCL and MCL derived constituent concentration levels, except for iodine-129 (1.6 pCi/L, pre-retrieval inventory with advection-dominated release [Table 15]). As the uranium releases did not result in concentrations above the MCL at the fenceline, uranium is not expected to impact more distant points.

4.4 SENSITIVITY RESULTS

Selected variables were analyzed to identify the degree of sensitivity in WMA C fenceline groundwater concentration estimates to variations in input values. Sensitivity refers to the relative incremental change in the result of the estimate caused by an incremental change in a given input value for a selected system element. System elements are considered to be sensitive if variations in input values (within the range of realistic possibility) result in substantial variation in the estimated result. System elements that exhibit small changes in results when input values vary over the range of possible inputs are considered to be nonsensitive. The following variable inputs were identified for sensitivity analysis:

- Residual waste inventory in tanks (current BBI or retrieval to 360 ft^3 [30 ft^3 for 200-series tanks])
- Residual waste release mode (advection- or diffusion-dominated release)
- Past leak contribution to cumulative effects (presence and absence of past leaks)
- Ancillary equipment residual waste inventory (presence/absence of residual waste volume with estimated inventory)
- Computational approach (use of simulated unit source results from a single source location, tank C-112, as a surrogate to represent all source locations in WMA C)
- Aquifer hydraulic conductivity and resultant groundwater flow velocity
- Distribution coefficient of waste constituents in the vadose zone and aquifer system.

The effect of these input variations on groundwater constituent concentrations was selected for the sensitivity analysis because all of the long-term human health risk metrics are derived from the constituent concentration in groundwater downgradient of the WMA. The results of selected sensitivity analyses are shown in Figures 21 and 22. The sensitivities analyzed and their relative magnitudes are presented in Table 20.

Figure 21. Waste Management Area C Simulated Groundwater Technetium-99 Concentration Resulting from Residual Tank Waste as Modified by Variations in Inventory (Retrieval) and Waste Release Mode.

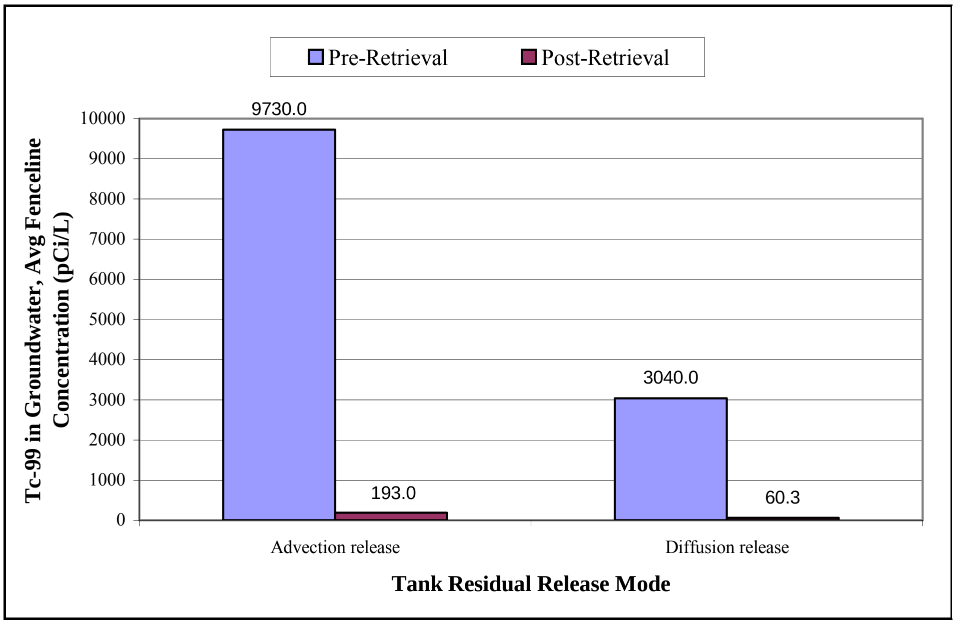


Figure 22. Waste Management Area C Simulated Technetium-99 in Groundwater Resulting from Addition of Past Releases to Residual Tank Waste as Modified by Variations in Tank Residual Release Mode for Unretrieved and Post-Retrieval Inventory.

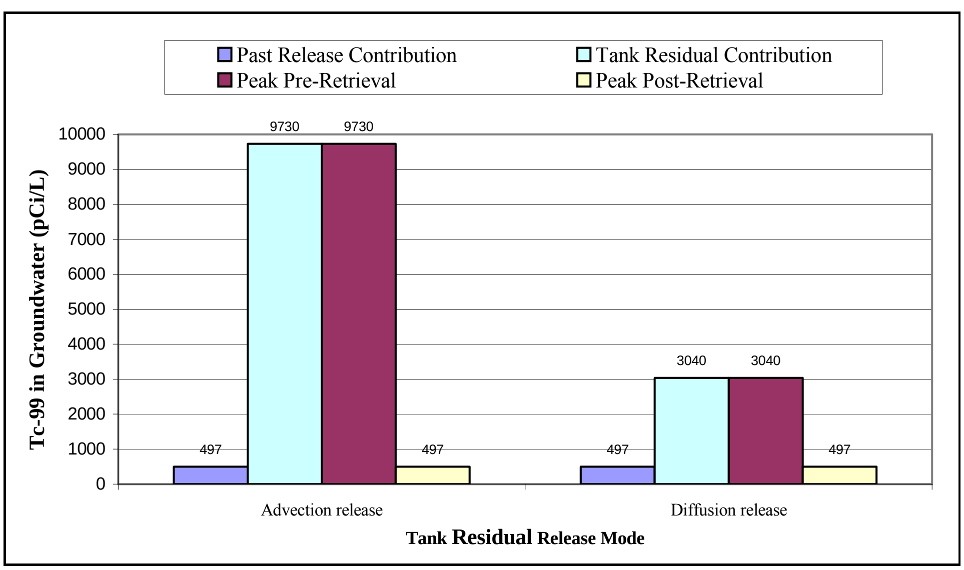


Table 20. Summary of Sensitivity Analysis of Impacts of Selected Input Parameters on Resultant Base Case WMA C Fenceline Groundwater Concentrations.

Parameter Analyzed	Type of Sensitivity [a]	Approximate Magnitude of Sensitivity	Apparent Conservatism of Approach Presented
Residual tank inventory after retrieval	Direct relationship	Retrieval to HFFACO maximum goal reduces concentration by factor of about 50.	Conservative if retrieval exceeds goal, nonconservative if retrieval does not meet goal.
Time to release waste constituents from residual tank waste	Direct relationship	Diffusion-dominated release from waste form reduces concentration by factor of about 3 over advection-dominated release.	Conservative if actual waste release is slower than diffusion-limited case, nonconservative if actual release is faster than diffusion case.
Contribution of past leaks in WMA C	Direct relationship	Past leaks account for approximately half of the concentration after retrieval of tank waste.	Conservative. Estimated major past leak inventory is included in quantitative risk estimates.
Contribution of ancillary equipment residual inventory	Direct relationship	Magnitude of sensitivity depends on waste inventory. Currently there is no sound basis to estimate inventory located in major ancillary equipment components.	Estimated ancillary equipment inventory included in quantitative risk estimates. No basis to assess conservatism due to lack of inventory data for ancillary equipment.
Computational extrapolation of a single unit source location to represent all sources in WMA C	Not sensitive	Not sensitive	Not sensitive: Approach appears representative.
Aquifer gradient and hydraulic conductivity	Inverse relationship	As aquifer gradient or hydraulic conductivity increase, fenceline concentration decreases at a rate of approximately 1 to 1 (e.g., 10x increase in gradient yields 10x decrease in concentration.	Conservative. Aquifer hydraulic conductivity may be as much as one order of magnitude higher than estimated.
Waste constituent Bulk Distribution Coefficient	Inverse relationship	As K_d increases from 0.0, fenceline peak concentrations decrease by about 5% for each 0.01 increase in K_d within a small range of values near zero.	Conservative. Low K_d values were selected for constituents of interest from ranges of measured and/or estimated values.

[a] Direct = resultant concentration increases as input parameter value increases.
Inverse = resultant concentration decreases as input parameter value increases.

HFFACO = *Hanford Federal Facility Agreement and Consent Order*.

K_d = distribution coefficient.

WMA = waste management area

Waste Retrieval and Post-Retrieval Tank Inventory: The inventory of target waste constituents contained in residual waste in the tanks is a highly-sensitive parameter. As shown in Figure 11, a substantial reduction in resultant groundwater concentration for technetium-99 (approximately two orders of magnitude) is attained by retrieving waste to the HFFACO goal of 1 % (i.e., achieve a maximum residual of 360 ft^3 in the 100-series tanks and 30 ft^3 in the 200-series tanks). This reduction is apparent for each of the three selected tank residual release modes. The magnitude of reduction in resultant groundwater concentration is a function of both the volume of waste in each tank and the concentration of constituents in the tank waste.

Residual Tank Waste Release Mechanism: The mode of release of the tank residual waste constituents is the second most sensitive input parameter. Within a wide range of relatively rapid release scenarios, the peak concentration is not sensitive when release occurs within 1,000 years of site closure. As shown in Figure 21, the resultant peak concentration is reduced by approximately a factor of three (before and after waste retrieval) by a diffusion-limited release mode compared with the advection-dominated release.

Past Leaks, Unplanned Releases: Based on evaluation of the four past releases for which preliminary inventory estimates were established, the resultant groundwater concentration of technetium-99 following retrieval of tank wastes to 360 ft^3 residual was found to be highly sensitive to the effects of past leaks. As shown in Figure 22, the past leak element contributed to the majority of the cumulative resultant concentration for technetium-99 in groundwater for both tank residual release modes.

Residual Waste in Ancillary Equipment: As discussed in Sections 4.4.1 and 4.4.2, long-term groundwater impacts are highly sensitive to the waste inventory remaining in the WMA. Estimates for residual ancillary equipment waste inventory contain substantial uncertainty because retrieval of waste from ancillary equipment, such as the C-301 catch tank, which is currently classified as a miscellaneous underground storage tank (MUST), is not yet formally linked to tank waste retrieval and WMA closure.

Detailed inventory data are unavailable for ancillary equipment components. A sensitivity analysis of potential contribution to long-term groundwater impacts from ancillary equipment residues used the following set of assumptions for selected component inventory:

- 244-CR vault tanks are assumed to be retrieved to residual volumes similar to those required for the 100- and 200-series tanks. The residual inventories are calculated as the product of the residual volume and the averaged contaminant-specific contribution from the combined contents of the 100- and 200-series tank solids.

- C-301 catch tank is assumed to be retrieved to a residual volume similar to that of the 200-series tanks. The residual inventories are calculated as the product of the residual volume and the averaged contaminant-specific contribution from the combined contents of the 100- and 200-series tank solids.

- WMA C piping system comprises multiple layers of waste transfer piping that were installed within WMA C with new piping being installed as old pipes were found to leak, became plugged, or otherwise became unserviceable. An estimated total volume of

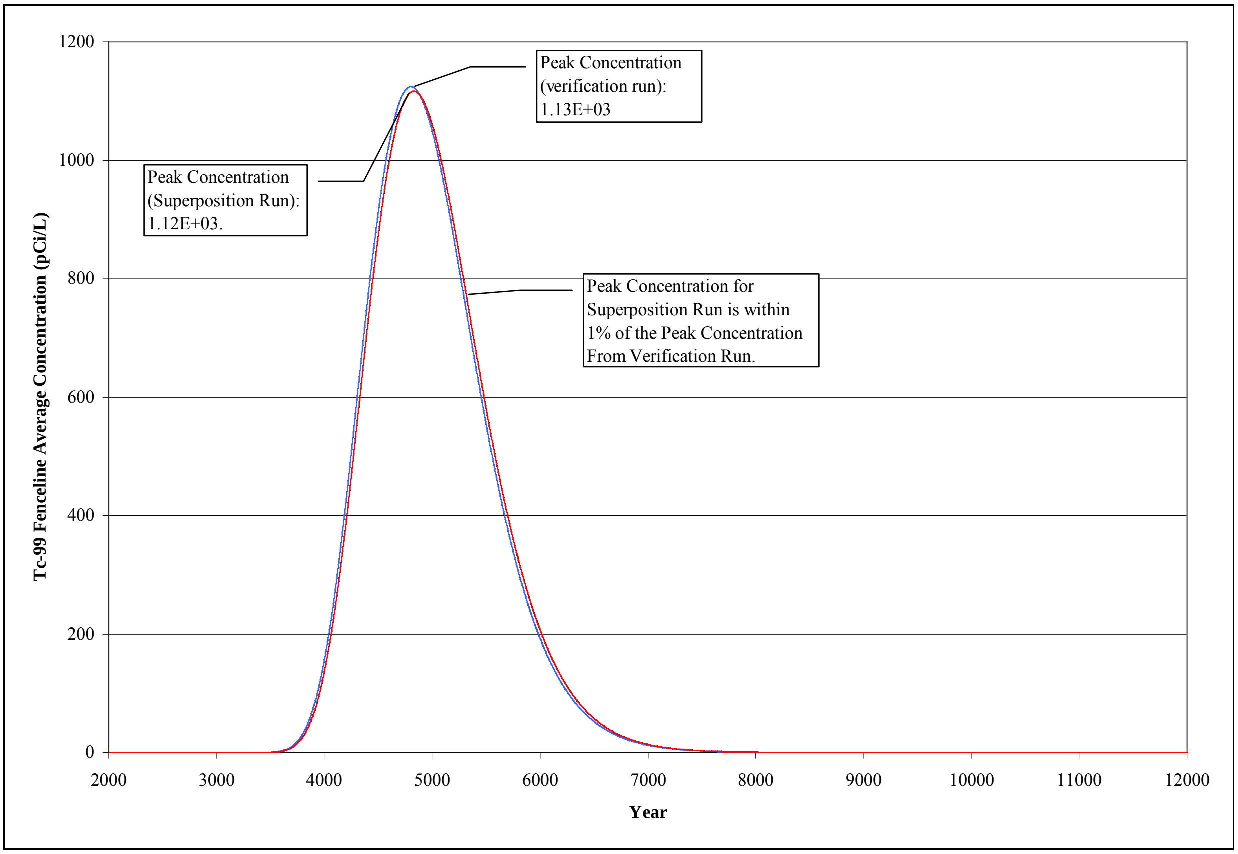
1,000 ft^3 of waste transfer pipe was assumed for this analysis. To estimate a residual waste inventory related to the piping system, 25% of the pipe (250 ft^3) was assumed to be plugged and filled with residual solids whose contaminant concentrations were calculated from the combined contents of the 100- and 200-series tank waste solids. The ancillary equipment inventory estimate is very conservative. Even using this estimate, the modeling results indicated that the risk associated with residual piping is minimal compared to the risk posed from other sources.

- WMA C diversion boxes were designed to drain to waste storage tanks; spill and leaks within the diversion boxes were routed to the C-301 catch tank. Although substantial surface contamination is expected to remain in the diversion boxes, no substantial quantity of residual waste is attributed to them for this analysis.

Under the defined simulation conditions, tank ancillary equipment effects on groundwater are observed at the same time as the 100- and 200-series residual tank waste. Pipeline ancillary equipment impacts on groundwater are observed approximately 600 years before the 100- and 200-series residual tank waste. Including the estimated retrieved waste volume in ancillary equipment results in approximately 10% increase in the peak concentration after 4500 AD.

Extrapolation of Single Unit Source to Multiple Sources (Superposition Approach): Sensitivity impacts of a fundamental computational approach used in estimation of cumulative impacts of multiple sources in the WMA were evaluated. The initial approach to extrapolation of simulated fate and transport results was based on the concept of super-positioning. This involves performing transport simulations using unit sources loaded into only one source location in the WMA conceptual model. The source location selected initially was tank C-112, located in the most upgradient row of tanks in the WMA. Applying the simulation from a single location to multiple locations via super-positioning provides for increased computational efficiency in the simulations, thus providing the project with latitude to perform additional simulation cases for sensitivity and uncertainty analysis. Verification tests for all 14 cases were performed in which sources were present at all four tank locations in one cross-section (i.e., the row containing tanks C-112, C-109, C-106, and C-103) and compared against the case with source for tank C-112 only. The verification tests included simulations for $K_d = 0$ and 0.03. The results for $K_d = 0$ are presented below. Comparison of the results of resultant fenceline concentrations of technetium-99 in groundwater using the superposition and verification runs for WMA C indicate a difference of less than 1% in peak arrival time and peak concentration. The results of the comparison are shown in Figure 23.

Figure 23. Cumulative Waste Management Area C Fenceline Average Technetium-99 Concentration Comparison Between Verification Run and Superposition (C-112) Run (Case 05, Post-Retrieval Inventory, K_d = 0.0)



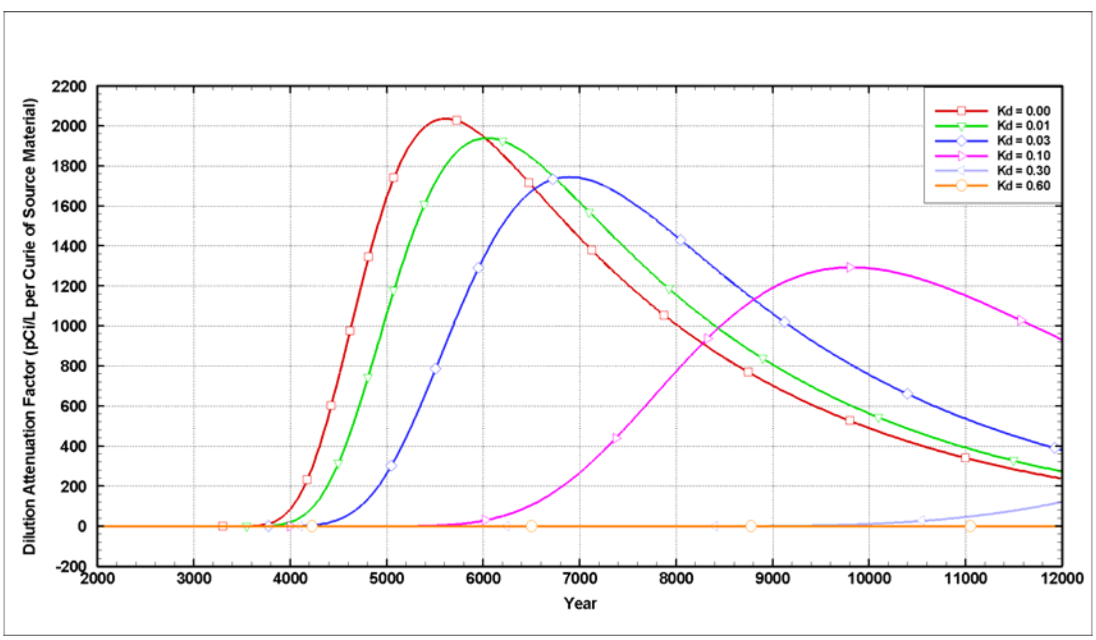
Aquifer Saturated Hydraulic Conductivity: The concentration of constituents in groundwater projected to the WMA C fenceline is also sensitive to the velocity of groundwater flowing beneath the WMA. Under the site's arid conditions, the rate at which constituents migrate from near-surface source terms to the aquifer at the water table is much slower that the rate at which those constituents travel from the point of aquifer entry to the downgradient fenceline. The groundwater velocity is a function of the hydraulic gradient and hydraulic conductivity of the underlying aquifer. The aquifer gradient (i.e., 4.5×10^{-4} m/min.) selected for use in the transport simulations presented in this document was extrapolated from Hindcast water table calculations and was selected to represent expected post-Hanford groundwater conditions at WMA C. The current gradient is very flat as a result of the dissipation of the historical groundwater mound from B Pond.

The aquifer hydraulic conductivity value used in the simulations was selected from typical formation values at the Hanford Site. The actual hydraulic conductivity of the aquifer underlying WMA C is not defined. Existing groundwater monitoring wells were not extended through the full thickness of the aquifer, so description of the formation below the water table is not available. Aquifer hydraulic conductivity may be as much as one order of magnitude higher that the estimate used in the simulations.

The estimated groundwater concentration beneath the WMA is inversely proportional to the groundwater gradient and hydraulic conductivity if other inputs are fixed (i.e., as resultant groundwater velocity increases, fluid volume through the aquifer system increases, and the resultant constituent concentration decreases). Comparative simulation runs indicate that calculated fenceline groundwater concentrations at WMA C will decrease by nearly an order of magnitude for each order of magnitude increase in aquifer hydraulic conductivity. The comparison simulations were done using saturated hydraulic conductivity values of 4.8 and 50 m/day. The 50 m/day value was selected for use in the quantitative risk estimates for this risk assessment. Measured hydraulic conductivity of the aquifer at other locations in the 200 East Area are as high as 500 m/day. The estimated WMA C fenceline concentrations, and resultant performance metrics, are, therefore, expected to be conservative (i.e., biased high) by the application of the selected hydraulic conductivity over the course of the simulation period.

Constituent K_d Assignment. The K_d is used to describe the relative interaction of constituents with the geologic materials through which the constituents are transported from the point of release to the point of measurement. The movement of constituents with higher K_d values is more highly retarded than constituents with relatively lower K_ds. Highly mobile constituents exhibit K_d values near zero for the geologic formations in the simulation domain. As K_d values for constituents increase in the current simulations, the resultant peak concentration in groundwater at the fenceline decreases in magnitude and occurs later in time relative to the peak of non-retarded (i.e., $K_d = 0$) constituents. The relative effect of varying K_d of constituents is shown in Figure 24. This figure displays the relative peak effects in terms of dilution-attenuation factors derived from the transport simulations using unit sources (i.e., source of 1 Ci) for surrogate constituents with K_d ranging from zero to one. Note that constituents with K_d greater than 1.0 for the geologic materials in the conceptual model do not appear at the fenceline during the 10,000-year simulation period.

Figure 24. Relative Effects of Variations in Distribution Coefficient on Resultant Constituent Peak Groundwater Concentration and Arrival Time for Residual Waste Constituents.



Constituents of interest for this risk assessment exhibit a range of K_ds under varying chemical conditions. The results of the risk assessment quantitative estimates is sensitive to assignment of K_d to COCs for the following reasons:

- As the K_d for a single constituent increases, the resultant peak groundwater concentration decreases.
- Multiple constituents with the same, or similar, K_ds produce additive effects during the time period that they are present in mixtures in the groundwater.

The magnitude of effects of change in peak concentration effects and peak arrival time are shown in Table 21.

Table 21. Summary of Relative Effects of Variability in Constituent Distribution Coefficient.

Constituent K_d (mL/g)	**Peak DAF[a] ([pCi/L]/Ci)**	**First Arrival Time (year AD)**	**Peak Arrival Time (year AD)**	**Relative Change in Peak DAF from K_d = 0**
0.00	2105	3199	5614	0
0.01	2005	3299	6042	- 5%
0.03	1804	3496	6896	-14%
0.10	1337	4199	9819	-35%
0.30	124[a]	6283	12000[a]	-94%
0.60	0.03[a]	9499	12000[a]	-99.9%
1.00	0.00[a]	Does not appear	Does not appear	Not applicable

[a] Simulated DAFs for constituents with K_ds of 0.30 and greater are still increasing at the end of the 10,000-year simulation period. Constituents with K_ds of 1.00 and greater do not arrive in the groundwater at the WMA C fenceline during the simulation period. Individual Dilution Attenuation Factors (DAF) represent the ratio between the initial concentration of the contaminant in the tank or vadose and the resulting concentration in the aquifer at some groundwater assessment point. As contaminants move through the vadose zone or an aquifer, the concentration decreases because of adsorption, dispersion, and diffusion processes, as well as (in some cases) environmental and radioactive decay.

DAF = dilution-attenuation factor
K_d = distribution coefficient
WMA = waste management area

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5.0 HUMAN HEALTH AND DOSE ESTIMATION

A variety of human health and dose estimates will be completed as part of this risk evaluation. Specific exposure scenarios, summarized below and described in greater detail in HNF-SD-WM-TI-707 Rev. 3, are constructed to estimate human health impacts from exposure to radionuclides and harmful chemicals present at a waste site that allows comparison with specific regulatory requirements (e.g., performance objectives in Table 2). These scenarios have been evaluated in numerous performance and risk assessment activities completed previously at the Hanford Site and have been extensively reviewed by the Hanford Site regulatory community. Quantitative risk and dose estimates for selected exposure scenarios are presented in Section 7.0 based on the simulated constituent concentrations presented in Section 4.3

Exposure scenarios are organized as a function of water infiltration and receptor location. Water infiltration is divided into two basic categories. The first category assumes very limited contact between water and waste, thereby preventing groundwater contamination from the waste source in question (e.g., the no-water infiltration case). Typically, an engineered barrier system is assumed to limit waste/water interactions. The second category assumes sufficient water infiltration to leach waste and drive contaminants into the underlying aquifer. In this analysis, infiltration from natural sources is assumed and effective infiltration rates are determined from the combination of average precipitation rates mitigated by engineered cover infiltration controls (e.g., the low water infiltration case). Potential receptors are either at the waste site (i.e., an onsite receptor) or at least 100 m away from the waste site (i.e., an offsite receptor). The onsite receptor is an inadvertent intruder who is deterred from entering the site for at least 100 years and is exposed primarily by contact with the waste. The offsite receptor can be exposed anytime after site closure and is exposed primarily by using contaminated groundwater.

Table 22 is a general summary of exposure scenarios that have been analyzed in Hanford Site risk and performance assessments in terms of onsite versus offsite receptors. Table 23 summarizes exposure scenarios for no-water infiltration cases. The first two receptors do not directly exhume waste but are exposed in various ways to radionuclides that reach the surface by vapor migration. The second two receptors are exposed when they exhume waste. Table 24 summarizes exposure scenarios for low-water infiltration cases. Only offsite receptors are considered and all exposures stem from the use of contaminated groundwater. Both individuals and area populations can be considered in offsite receptor calculations.

Depending on the scenario, up to three types of health impacts are calculated. These include dose from radionuclide exposure, ILCR from radionuclide, ILCR from carcinogenic chemical exposure, or toxic health effects (quantified as Hazard Index) from exposure to noncarcinogenic chemicals. Dose from radionuclide exposure (mrem/yr) is compared to performance objectives defined in DOE O 435.1[6]. ILCR from radionuclide and carcinogenic chemicals and the Hazard Index from noncarcinogenic chemicals are compared to the health standards (cancer risk of 10^{-5} and a unit value of 1, respectively) in WAC 173-340. Dose, ILCR, and Hazard Index are

[6] *Implementation Guide* for use with DOE M 435.1-1, July 9, 1999, Chapter IV, Section IV.P.(1) through IV.P.(4).

calculated as the product of waste concentrations in soil, air, or water (as appropriate) and the appropriate unit conversion factor (e.g., mrem per pCi/L for dose).

To provide a comprehensive estimate of potential human health effects that addresses all performance objectives in Table 2, a total of eight scenarios have been considered in this analysis. The scenarios and type of human health effects considered include the following:

- **Onsite Receptors (i.e., within the WMA)** – Two scenarios are considered, the well driller and the post-intrusion resident. Both are exposed to contaminated soils resulting from drilling a well within the WMA. Dose by radionuclide exposure is calculated for comparison with DOE O 435.1[7] inadvertent intruder performance objectives. Intruder scenarios were not considered in this document. However, in the future, DOE Order 435.1 based intruder calculations will be provided to Ecology as part of a performance assessment. Based on preliminary discussions on implementing the recently proposed TPA Closure Process, performance assessments will replace risk assessments. The performance assessments will be designed to meet DOE, Ecology, and EPA's needs in this area. The performance assessment will become a central document in the effective integration of each agencies regulations and guidelines. The performance assessment document's contents will generally follow the DOE Order 435.1 but with modifications based on local discussions among Ecology, EPA, and DOE.

- **Offsite Receptors (i.e., outside the WMA) –** Six scenarios are considered. The all pathways farmer lives 100 m downstream of the waste site and uses contaminated well water. Dose by radionuclide exposure is calculated for comparison with general public protection performance objectives in DOE O 435.1[8]. The Native American uses contaminated well water at the WMA C fenceline or Columbia River water and additional cultural activities increase exposure for the same amount of environmental contamination compared to the non Native American resident. Dose, ILCR, and Hazard Index are calculated for comparison with general public protection performance objectives in DOE O 435.1[9] and WAC-173-340. The final four scenarios are defined in DOE/RL-91-45, *Hanford Site Risk Assessment Methodology*, and include the industrial worker (industrial scenario), the recreational shoreline user (the recreational scenario), the resident (the resident scenario), and the subsistence farmer (the agricultural scenario). Of these, risk calculations are not presented in this analysis for the recreational user. Dose, ILCR, and Hazard Index to the receptor are calculated for radionuclides and chemicals that contaminate groundwater.

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[7] *Implementation Guide* for use with DOE M 435.1-1, July 9, 1999, Chapter IV, Section IV.P.(1) through IV.P.(4).

[8] See footnote 6

[9] See footnote 6.

Table 22. General Features of Performance Assessment Exposure Scenarios.

Feature	Onsite Receptor	Offsite Receptor
Time delay following site closure	No less than 100 years	Any time after site closure
Receptor location	Directly over the waste disposal site	No closer than 100 m from the edge of the buried waste
Sources of exposure	Gases and vapors that migrate upward from the waste Direct radiation exposure Well water Exhumed waste	Gases and vapors carried by the wind to the offsite location Well water
Exposure scenarios	Well driller – person actually drilling through the waste Residential – person living near the well spreads soil cuttings from well into a small garden Farmer with rural pasture for dairy spreads soil cuttings from well into a pasture Commercial farmer spreads soil cuttings from well into a field for growing a food crop	Industrial – people working at some commercial enterprise Recreational – people who spend time near the site doing typical recreational activities Residential – person living near the well Farmer – subsistence farming operation that provides a portion of the individual diet (includes All-Pathways Farmer) Native American Indian

Table 23. Exposure Scenarios for the No-Water Infiltration Case

Offsite Farmer – Gas/vapor emanations from the disposal site are carried downwind to a subsistence farm
▸ Inhalation of plume ▸ Ingestion (plants and animals) ▸ External radiation exposure from plume ▸ Dermal absorption from air
Onsite Resident – Gas/vapor emanations into the basement of a residence located over the disposal site
▸ Inhalation (higher concentrations in a dwelling) ▸ External radiation exposure (from buried waste and air) ▸ Dermal absorption (from air)
Intruder – Individual present while a well is being drilled through the waste disposal site
▸ Inhalation (resuspended dust and gaseous emissions) ▸ Ingestion (trace amounts of soil) ▸ External radiation exposure ▸ Dermal absorption (contact with soil)
Post-Intrusion Resident – Spreads the exhumed waste into a vegetable garden
▸ Inhalation (resuspended dust and gaseous emissions) ▸ Ingestion (trace amounts of soil and garden produce) ▸ External radiation exposure (working in garden) ▸ Dermal absorption (contact with soil)

Notes: "Dermal absorption" refers to materials on the skin being absorbed into the body by passage through the skin. The first scenario applies any time after site closure, while the other 3 require a delay of at least 100 years before they can occur.

Table 24. Exposure Pathways for the
Low-Water Infiltration Case

(1) Drinking the well water (also cooking with it)
▸ Ingestion
(2) Showering and bathing with the well water
▸ Inhalation (sprays) ▸ Ingestion (small amounts) ▸ External radiation exposure (immersion) ▸ Skin absorption (contact with water)
(3) Irrigating a garden
▸ Inhalation (sprays and resuspended dust) ▸ Ingestion (produce and trace amounts of soil) ▸ External radiation exposure (while in garden) ▸ Skin absorption (contact with soil)
(4) Drinking water for house pets and livestock
▸ Ingestion (eggs, poultry, milk) ▸ External radiation exposure (proximity to animal)
(5) Irrigating livestock pastures
▸ Inhalation (sprays and resuspended dust) ▸ Ingestion (beef and milk) ▸ External radiation exposure (while in pasture)
(6) Sweat lodge/wet sauna
▸ Inhalation (steam) ▸ Skin absorption (contact with steam) ▸ External radiation exposure (soil, walls, steam)

5.1 EXPOSURE SCENARIOS, MEDIA, AND PATHWAYS

The exposure scenarios, media, and pathways selected for the Hanford tank waste risk assessments given in HNF-SD-WM-TI-707 Rev. 3 are shown in Tables 25 and 26. Table 25 summarizes the exposure pathways for the typical performance assessment scenarios. There are eight scenarios presented in Table 25. The first four are the waste intruder cases, namely, the well driller and the post-intrusion residents. The next four are individuals exposed to a contaminated water source, either a well to groundwater or the Columbia River.

The intruder scenarios (the Well Driller, Suburban Garden, Rural Pasture, and Commercial Farm) consider only the impact of radionuclides. For the Well Driller, the total effective dose equivalent (TEDE) is calculated based on a unit concentration averaged over all the material removed from the well hole. For the other post-intrusion cases, the TEDE is calculated during the first year after the well is drilled. The dose is based on a unit quantity of activity removed from the well and spread on the ground in either a garden, a cow pasture, or an agricultural field.

The next two exposure scenarios have individuals who are users of contaminated water. The contaminated water may be obtained from either a well or the Columbia River. When the Columbia River is the source of contaminated water, the risk calculations include the fish pathway and exposure to shoreline sediments. Otherwise, they are identical. This situation occurs long in the future, when the hazardous materials have migrated into the groundwater and the Columbia River. The two individuals are the All Pathways Farmer and the Native American. The All Pathways Farmer is a representative average individual who grows much of his own food. His intakes of food and water, for example, are population averages. The Native American represents a bounding individual, particularly with regard to fish consumption.

Table 26 summarizes the exposure scenarios, and media and exposure pathways for the HSRAM scenarios (DOE/RL-91-45 Rev 3) used to assess human health risks associated with specific waste disposal options. The scenarios are consistent with EPA guidance and the Tri-Party Agreement. The final two columns in Table 26 also shows the exposure pathways used for the State of Washington groundwater and surface water cleanup calculations (WAC 173-340 Part VII -- Cleanup Standards). Method B is a residential setting, while Method C uses an occupational setting.

Table 25. Exposure Pathway Summary for Standard Performance Assessment Scenarios.

←Media	Exposure Scenarios →	Standard Performance Assessment Exposure Scenarios							
		Waste Intruders				All Pathways Farmer		Native American	
	Exposure Pathways ↓	Driller	Suburban Garden	Rural Pasture	Com-mercial Farm	GW	River	GW	River
Water	Ingestion					●	●	●	●
	Vapor Inhalation					●	●	●	●
	Shower, dermal					●	●	●	●
	Swimming, dermal								●
	Sweat Lodge, inhalation							●	●
Shore Sediments	Ingestion						●		●
	Inhalation								
	Dermal Contact						●		●
	External Radiation Dose						●		●
Soil	Ingestion	●	●	●	●	●	●	●	●
	Inhalation	●	●	●	●	●	●	●	●
	Dermal Contact					●	●	●	●
	External Radiation Dose	●	●	●	●	●	●	●	●
	Tritium Vapor Inhalation		●			●	●	●	●
Food Chain	Garden Produce		●			●	●	●	●
	Grains								
	Beef & Milk			milk only		●	●	●	●
	Poultry & Egg					●	●	●	●
	Fish						●		●
	Wild Game								●

The annual total effective dose equivalent (TEDE) (in mrem) is calculated for all of the exposure scenarios shown on this table. Radiological dose is the only risk metric used for the waste intruders. The other exposure scenarios (All-Pathways and Native American) also include ILCR from a lifetime exposure to both radionuclides and chemicals, and Hazard Index for non-radioactive chemicals.

Table 26. Exposure Pathway Summary for HSRAM and MTCA Scenarios.

←Media	Exposure Scenarios → / Exposure Pathways↓	Hanford Site Risk Assessment Methodology (HSRAM)							WAC 173-340	
		Indus-trial	Recreational		Residential		Agricultural		MTCA B & C	
			GW	River	GW	River	GW	River	GW	River
Water	Ingestion	•	•	•	•	•	•	•	•	•
	Vapor Inhalation	•	•	•	•	•	•	•		
	Shower, dermal	•	•	•	•	•	•	•		
	Swimming, dermal			•		•		•		
	Sweat Lodge, inhalation									
Shore Sediments	Ingestion			•		•		•		
	Inhalation									
	Dermal Contact			•		•		•		
	External Radiation Dose			•		•		•		
Soil	Ingestion	•	•	•	•	•	•	•		
	Inhalation	•	•	•	•	•	•	•		
	Dermal Contact	•	•	•	•	•	•	•		
	External Radiation Dose	•	•	•	•	•	•	•		
	Tritium Vapor Inhalation	•	•	•	•	•	•	•		
Food Chain	Garden Produce				•	•	•	•		
	Grains									
	Beef & Milk						•	•		
	Poultry & Egg									
	Fish			•		•		•		•
	Wild Game			•				•		

The annual TEDE (in mrem) is not calculated for the exposure scenarios shown on this table. The risk quantifiers for these scenarios are incremental cancer risk from a lifetime exposure to both radionuclides and chemicals, and hazard index for non-radioactive chemicals.

6.0 LIMITATIONS AND UNCERTAINTIES

This risk assessment was developed to show our present understanding of the risks associated closure of WMA C as a landfill. However, significant limitations and uncertainties exist in this preliminary risk assessment of WMA C. Figure 4-2 of the *Framework Plan for Single Shell System Closure Plan* (RPP-13774) conceptually shows how this uncertainty is addressed through a series of circles that represent uncertainty with the circles becoming smaller as more data is collect and the uncertainty about a parameter is reduced. Since this is a preliminary risk assessment, an understanding of this uncertainty is necessary before proceeding to Section 7.0 which compares the results of the risk assessment against the performance objectives. To deal with the uncertainty in this first iteration of the risk assessment, the parameters, for the most part, have been biased to yield higher risk numbers. It is expected, that as retrieval progresses, new information will become available that can potentially lower the risk. Table 27 lists the uncertainties associated with this risk assessment and how this uncertainty could impact the results.

Table 27. Uncertainties Associated with the Preliminary Risk Assessment Results

Uncertainty		Uncertainty Description	Impact on Results (if known)
Inventory Uncertainty	Best Basis Inventory	All results are based on some derivation of the best basis inventory. It does not contain all contaminants of concern and it is based on process knowledge with limited sampling.	**UKNOWN** until post-retrieval sampling results confirm BBI. Additional contaminants of potential concern will be analyzed[(1)]
	No Retrieval	Risk assessment examined using existing Best Basis Inventory instead of Selected Phase Removal inventory without any retrieval	**INCREASE** → The residential ILCR for residual tank waste will increase by a factor of approximately 50.
	Simple Volume Ratio	Risk assessment uses retrieved inventory based on simple volume ratio (Section 3.6.1) instead of Selected Phase Removal (i.e. inventory for technetium-99 is slightly lower for simple volume)	**DECREASE** → The residential ILCR risk for residual tank waste will decrease by 5 %
	Selected Phase Removal	Risk assessment used residual inventory based on Selected Phase Removal. This is conservative because if sluicing is used for the C-100 Series tanks, the HTWOS residual inventory would be more appropriate	**NO CHANGE**
	HTWOS	Risk assessment uses retrieved inventory based on HTWOS projected inventory (Section 3.6.1) instead of Selected Phase Removal (i.e. inventory for technetium-99 is a factor of 5 greater for Select Phase Removal)	**DECREASE** → The residential ILCR for residual tank waste will decrease by a factor of approximately 5
	Pipeline Residuals	Risk assessment estimated the amount inventory left in pipelines by calculating the number of linear feet of pipe and assumed that approximately 25 % of it was blocked by waste (Section 3.6.1).	**UNKNOWN**, but as part of the RFI/CMS process pipelines will be examined for residual waste[(1)].

Table 27. Uncertainties Associated with the Preliminary Risk Assessment Results

	Uncertainty	Uncertainty Description	Impact on Results (if known)
Inventory Uncertainty	8,000 gal Retrieval Leaks	Inventory used for retrieval leaks is calculated from concentrations supplied by HTWOS model runs based on either 5 molar sodium nitrate solution or 10 wt % solids (Section 3.6.1)	**UNKNOWN**, because it is dependent upon leak volume and leak concentration. Model uses constant 8,000 gal retrieval for all C-100 Series tanks. However, present results are believed to be highly conservative. In reality, some tanks may not leak at all and some tanks may leak more than 8,000 gal. It is expected that a number of the tanks will be equipped with a Leak Detection Monitoring system, from which leak volume estimates will be made[(1)]
Inventory Uncertainty	20,000 gal Retrieval Leak	Risk assessment uses a 20,000 gal leak for all C-100 Series tanks instead of 8,000 gal leak	**INCREASE →** The residential ILCR for retrieval leaks will increase by a factor of approximately 3
Inventory Uncertainty	Unplanned Releases	This risk assessment made estimates about the amount of contaminants lost through unplanned releases (either from tanks or ancillary equipment. These estimates are documented in Section 3.6.1 and in RPP-15317. However, the estimates are only as good as the available data (processed records, borehole sampling and logging, etc.) Some unplanned releases have excellent records, but others do not. For those that have good records the inventory is probably correct; for those that do not, the inventory could be an order of magnitude off.	**UNKNOWN**, however additional wells are being drilled in WMA C to determine the characteristics of past unplanned releases[(1)].
Release Mechanism Uncertainty	Advection-Dominated Release Rate Model	In absence of characterization data for release models, an advection-dominated release model was used to simulate unstablized waste form covered with backfill and gravel, this would also cover a grout that fails.	**INCREASE →** The residential ILCR for residual tank waste will INCREASE by a factor of approximately 3
Release Mechanism Uncertainty	Diffusion-Dominated Release Rate Model	In absence of characterization data for release models, an diffusion-dominated release model was used to simulate a stabilized waste form covered with grout. It used a relatively high diffusion coefficient 6E-7 cm^2/s.	**DECREASE →**, however, additional work is being done on evaluating diffusion-dominated release of grout. It is expected the diffusion coefficient will go decrease with additional testing of grout. Reducing diffusion coefficient by a factor of 10 decreases ILCR by 20 %[(1)]

Table 27. Uncertainties Associated with the Preliminary Risk Assessment Results

Uncertainty		Uncertainty Description	Impact on Results (if known)
Release Mechanism Uncertainty	Steel Liner	Risk assessment for conservative purposes assumes the steel liner instantaneously fails in the year 3050. In reality, the steel liner would probably last much longer.	**UNKNOWN,** if deemed necessary, work needs to be developed that addresses the decomposition of the steel liner for residual waste
Release Mechanism Uncertainty	Release Mechanism for Contaminants from Residual Waste	The risk assessment assumes the waste is not strongly bound to the solid matrix and all of it is available for transport	Waste constituent studies have been started on sludge from tank AY-102 (sludge originally from C-106). Preliminary results indicate the release of technetium to groundwater flow is much slower than previously believed. Work is on-going and will cover additional contaminants of concern(1)
	Modified RCRA Subtitle C Barrier	This barriers design life is 500 years (see section 3.2.1) at which time it instantaneously fails. In reality barrier would degrade slowly over time	**UNKNOWN** → Barrier could either degrade faster or last longer than the design life. Sensitivity runs will be made to show the impacts of barrier degradation or increased design life
	Recharge Rates	The model used recharge rates of 3.5 mm/yr (pre-Hanford) 100 mm/yr (Hanford Operational Period), 0.5 mm/yr (barrier design life for 500 years), 3.5 mm/yr (post-barrier). However in *Recharge Data Package for the Immobilized Low-Activity Waste 2001 Performance Assessment* (PNNL-13033) should be 0.9 mm/yr (pre-Hanford) 60 mm/yr (Hanford Operational Period), 0.1 mm/yr (barrier design life for 500 years), 0.9 mm/yr (post-barrier). Recharge estimates were made higher than recommended for this area bias the results to higher risk estimates	**DECREASE** → similar analysis for the B/BX/BY Field Investigation report indicates lowering the recharge rate by ½ reduces the risk by 1/2. Additional, sensitivity cases will be made show the impact of varying recharge rates(1)
	Hydraulic Conductivity of the Unconfined Aquifer	Reported results use a hydraulic conductivity of 50 m/day, but 5 m/day and 1,000 m/day were also examined. Recent RCRA drilling just to the north outside the WMA C found open framework gravels to basalt and oscillatory place the hydraulic conductivity in this region to between 1,000 to 6,000 m/day for two test intervals.	**DECREASE** → increasing the hydraulic conductivity by a factor of 10 decreases the concentrations by almost but not quite the same amount (i.e going from 50 to 1,000 m/d decrease the concentration by a factor of 18.5)(1).
	2-D Modeling vs. 3-D Modeling	To account for the three-dimensional aspects, the calculated 2-D fenceline concentration was scaled by dividing by the length of the WMA C fenceline perpendicular to the flow direction.	**INCREASE** → recent sensitivity results a 3D S/SX model indicates the 2-D to 3-D dilution factor used here is factor of 5 to 7 higher than it should be.

Table 27. Uncertainties Associated with the Preliminary Risk Assessment Results

Uncertainty		Uncertainty Description	Impact on Results (if known)
Chemical Uncertainty	Bulk Distribution Coefficients	Bulk distribution coefficient determine how well a contaminant adsorbs onto the soil. This risk assessment used a bulk distribution coefficient of 0.0 mL/g for all contaminants except uranium for uranium it used 0.6 mL/g	**DECREASE →** since all contaminants except uranium were modeled with a K_d = 0.0 mL/g would reduce the impact for those contaminants **INCREASE/DECREASE →** for uranium *Hanford Contaminant Distribution Coefficient Database and User's Guide* (PNNL-13985), recommends using a range from 0.2 to 4. Therefore, the impacts due to uranium could increase if a lower K_d is used. Future iterations of this risk assessment will examine different K_d for uranium[(1)]
	Chromium	This risk assessment assumed all chromium was chromium^{+6}. Chromium^{+6} was analyzed because it provides the greatest risk for ILCR. However, only the slope factors for inhalation are available, chromium is assumed to be inhaled through shower, sprinklers, and/or dust contaminated with it.	**DECREASE →** If all chromium is chromium^{III}, then the ILCR for non-radionuclide chemicals goes down by several orders of magnitude
Exposure Scenario Uncertainty	Risk parameters	Inputs for overall risk prediction per exposure scenario are also uncertain and potentially sensitive. These other inputs might include various models (e.g., food chain model, toxicokinetic model) and model parameters (e.g., food chain transfer factors, exposure factors, dose factors, risk factors)	**UNKNOWN →**These inputs are applied after prediction of groundwater concentrations and are not trivial.
	Exposure Scenarios	The Section 6.0 describes the various exposure scenarios. All Pathways Farmer are representative (average) individuals. The Native American represents a bounding individual. Numerous variations of these basic exposure scenarios are possible.	**VARIES GREATLY→** The radionuclide ILCR for resident scenario for tank residual waste is factor of 22 higher than the industrial scenario, while the Native American scenario is a factor of 15 over the residential scenario

(1) Indicates ongoing work either laboratory, modeling or field analysis to reduce the radius of uncertainty given in Figure 4-2 of the *Framework Plan for Single Shell System Closure Plan* (RPP-13774).

7.0 QUANTITATIVE PERFORMANCE METRIC ESTIMATES FOR WASTE MANAGEMENT AREA C CLOSURE SCENARIO

Dose and risk estimates are provided in this section for various exposure scenarios. In these scenarios a human receptor is exposed when that receptor uses groundwater contaminated by tank waste sources in WMA C. In Section 4.3 a series of quantitative estimates for technetium-99, iodine-129, nitrate, nitrite, and chromium(VI) groundwater concentrations over time were generated assuming different waste sources and their associated release and migration characteristics. However, technetium-99 was chosen as a representative contaminant to evaluate because it is highly mobile in the subsurface and is a primary risk-generating constituent in tank waste. Using the technetium-99 results as a template, additional mobile constituents were also considered as contributors to dose and risk estimates. To calculate dose and risk values for a given waste source and exposure scenario, the peak groundwater concentration from the corresponding waste source analysis was multiplied by the appropriate dose and/or risk conversion factor appropriate for the specific type of exposed individual. The appropriate dose and/or risk conversion factor is provided in HNF-SD-WM-TI-707.

Section 6.1 and 6.2 describe the selected constituents of potential concern and selected points of calculation for evaluation of possible groundwater contamination resulting from closure conditions at WMA C.

Dose and Risk Estimates Conclusions

- The DOE/RL-91-45 industrial and residential exposure scenarios were selected for detailed analysis.
- The primary contributors to long-term radiological dose due to groundwater contamination by residual tank waste, past leaks, and hypothetical retrieval leaks are technetium-99 and iodine-129.
- The major contributors to long-term incremental cancer risk are technetium-99 and iodine-129. The major contributors to cumulative Hazard Index are nitrate, nitrite, and hexavalent chromium.
- Following retrieval of tank waste to meet the maximum residual specified in the HFFACO, known past leaks are responsible for the largest peak values for dose, cancer risk, and Hazard Index, followed by hypothetical retrieval leaks.
- Cumulative Radiological dose (effective dose equivalent) resulting did not exceed the performance objective of 25 mrem/yr at the WMA C fenceline.
- For the Industrial Scenario, cumulative (i.e. all source terms) radiological ILCR exceeded the target value of 1.0 E-05 at the WMA fenceline (Figure 25). This is due to hypothetical retrieval leaks, if hypothetical retrieval leaks are not included, ILCR falls below the target value. For residual tank waste, total radiological ILCR exceeded the 1.0 E-05 for the residential scenario at the fenceline, but not at the core zone boundary. While for past leaks and hypothetical retrieval leaks, total radiological ILCR exceeded the 1.0 E-05 for the residential scenario at the fenceline and core zone boundary. Corresponding risks were not exceeded for the industrial scenario. Technetium-99 accounts for most of the risk.
- Hazard Index was not exceeded (< 1.0) at the WMA C fenceline for any of the sources.
- Dose-based primary drinking water standards (MCL) are exceeded for cumulative iodine-129 but not for technetium-99 although it is very close to the MCL. The past leak and hypothetical retrieval leaks cause exceedence of the dose MCL for iodine-129 at the fenceline.

Sections 6.3, 6.4, and 6.5 describe the relative impacts to groundwater from the following source terms:

- Residual tank waste following retrieval to a maximum of 360 ft^3 in each 100-series tank (30 ft^3 in each 200-series tank)
- Estimated inventory of past leaks from tanks and ancillary equipment
- Hypothetical releases of retrieval solutions during water-based waste retrieval.

These resultant groundwater effects of these source terms are evaluated at the following locations:

- The downgradient WMA C fenceline (average concentration)
- Nearest boundary of the proposed 200 Area Plateau core zone (2,900 m from the WMA C fenceline)
- Downgradient groundwater immediately before discharge of the aquifer into the Columbia River (14,300 m east of the WMA C fenceline).

Radiological dose from groundwater contaminants is presented in terms of effective dose equivalent (EDE) in Sections 6.3, 6.4, 6.5, and 6.6, along with estimated ILCR and non-carcinogenic Hazard Index. The calculation of dose using the EDE method is consistent with previous work prepared for the immobilized low-activity waste disposal facility.

A graphical illustration of the cumulative effects of multiple source terms on the ICLR is presented in Section 6.7. This evaluation indicates the high sensitivity of the risk estimate to the impacts of hypothetical retrieval solution releases and past leaks. The estimated impacts of the hypothetical retrieval leaks is extremely conservative due to the assumptions that (1) all of the tanks selected for sluicing retrieval methods will leak the same quantity of material during retrieval (i.e., 8,000 gal), and (2) all of the most-soluble constituents in the tanks (e.g., technetium-99, iodine-129, nitrate) dissolve in a given volume of retrieval solution and subsequently 8,000 gal of that solution is released during retrieval. Actually, only tanks that are considered to be structurally sound are considered for the high-volume wet retrieval systems.

The national primary drinking water standards, as codified in "National Primary Drinking Water Regulations" (40 CFR 141), were also identified as performance objective metrics for assessment of tank closure. Section 7.8 presents a summary comparing the estimated groundwater impacts to the respective numerical (i.e., MCLs) standards for the selected preliminary contaminants of potential concern. Although meeting the primary drinking water standards in groundwater at WMA C is expected to be protective, the standards are not strictly applicable to WMA C groundwater because it cannot be used as a source of drinking water until the existing plumes have either been remediated or have naturally attenuated. Use of WMA C groundwater as a drinking water source (i.e. existing plumes have been remediated or naturally attenuated) most likely will not occur before the peak concentration from past unplanned releases or hypothetical retrieval leaks arrive at the groundwater, but should occur before contaminants from tank residuals arrive at the groundwater.

Comparison of dose and risk estimates with performance objectives show that performance objectives are satisfied in many, but not all cases. Larger groundwater concentrations are associated with source terms containing the largest inventories of mobile constituents (e.g., past leaks) and for groundwater evaluated closest to the source (i.e., at the WMA C fenceline).

7.1 PRELIMINARY CONTAMINANTS OF POTENTIAL CONCERN

In the analyses presented in the following sections, an engineered cover, or cap, is assumed to be placed over the entire WMA at the time of facility closure. The cover is assumed to retain its effectiveness in controlling infiltration through the site for 500 years, after which infiltration control is degraded. The contributions from three discrete types of source terms (residual tank waste, past leaks, and hypothetical retrieval leaks) were evaluated because differences in release behavior of constituents are assumed for each source. Residual tank waste will likely be present after retrieval and inventory estimates were based on the target residual volume. To gauge sensitivity to variable residual volume, the effects of pre-retrieval inventories on dose/risk estimates were also evaluated. The diffusion-limited waste release case (simulation Case 11) was used to describe the residual waste releases. To estimate the impact of the retrieval leak source, a hypothetical leak of 8,000 gal was assumed for the two tanks in WMA C that will be retrieved using high-volume wet methods.

Table 10 of Section 4.3 provides the base case conditions for this risk assessment. Note the following conditions:

- Residual tank waste volume is assumed to be present at a maximum of 360 ft^3 for the 100-series tanks and 30 ft^3 for the 200-series tanks.
- Hypothetical retrieval leaks are applied only to tanks that are scheduled for waste retrieval using past-practice or modified sluicing techniques. Tanks being retrieved by dry (e.g., vacuum) methods, or using the mobile retrieval system do not have a retrieval leak source term applied.
- Quantitative source terms are not included for individual WMA components for which no basis has been identified to support a preliminary inventory.
- Quantitative source terms are not included for past leaks and areas of known or suspected vadose zone contamination for which no basis has been identified to support a preliminary inventory.

Dose and risk estimates were calculated for the following constituents identified as preliminary contaminants of potential concern at post-retrieval inventories:

- Technetium-99
- Iodine-129
- Total Uranium
- Nitrate
- Nitrite

- Chromium.

The evaluation of simulation results is given in Table 28 indicates that these constituents will provide the majority of the long-term risk and dose impacts related to WMA C. Table 28 does not include hypothetical retrieval leaks, because the results for hypothetical retrieval leaks would be similar to residuals, since the inventory used to calculate the residuals and the hypothetical retrieval leaks is the same. Table 27 provides the individual contaminant's contribution to the particular exposure scenario and the percentage of that contaminant's contribution to the total for the exposure scenario. The total for the exposure scenario includes all contaminants presently given in *Inventory and Source Term Data Package* (DOE/ORP-2003-02). The inventory for these constituents is variable between sources, and is uncertain due to the variety of approaches used to derive the inventories (e.g., sampling and analysis, process evaluations). This inventory uncertainty will be systematically reduced through sampling and analysis of residual waste following retrieval. Final selection of COCs will be performed after completion of residual waste sampling and analysis and the DQO process.

Table 28. Percentage of Individual Contaminant to Total for Exposure Scenario.

	ILCR Industrial		**ILCR Residential**		**HI Industrial**		**HI Residential**		**All-Pathways Farmer**	
COPC	**ILCR**	**Percentage of ILCR**	**ILCR**	**Percentage of ILCR**	**HI**	**Percentage of HI**	**HI**	**Percentage of HI**	**Dose mrem/y**	**Percentage of Dose**
	Tank Residuals									
Tc-99	9.0E-07	90.0%	2.2E-05	95.6%	N/A	N/A	N/A	N/A	0.115	59.3%
I-129	1.0E-07	9.9%	5.2E-07	2.3%	N/A	N/A	N/A	N/A	0.071	36.7%
Nitrite	N/A	N/A	N/A	N/A	3.4E-03	35.6%	2.2E-02	37.7%	N/A	N/A
Nitrate	N/A	N/A	N/A	N/A	4.5E-04	4.8%	2.9E-03	5.1%	N/A	N/A
Chromium^{+6}	2.8E-08	100%	6.3E-08	100%	4.5E-03	47.8%	2.5E-02	43.7%	N/A	N/A
Uranium	N/A	N/A	N/A	N/A	4.8E-06	0.1%	3.4E-05	0.1%	N/A	N/A
Total Radionuclides	1.0E-06		2.3E-05		N/A		N/A		0.194	
Total Non Radionuclides	2.8E-08		6.4E-08		9.4E-03		5.7E-02		N/A	
	All Past Unplanned Releases									
Tc-99	6.9E-06	84.6%	1.7E-04	95.4%	N/A	N/A	N/A	N/A	0.87	50.6%
I-129	7.1E-07	8.8%	3.7E-06	2.1%	N/A	N/A	N/A	N/A	0.51	29.7%
Nitrite	N/A	N/A	N/A	N/A	1.4E-02	42.8%	9.1E-02	45.8%	N/A	N/A
Nitrate	N/A	N/A	N/A	N/A	1.7E-03	5.0%	1.1E-02	5.3%	N/A	N/A
Chromium^{+6}	1.1E-07	100%	2.4E-07	100%	1.7E-02	52.4%	9.7E-02	48.5%	N/A	N/A
Uranium	N/A	N/A	N/A	N/A	1.4E-04	0.4%	9.8E-04	0.5%	N/A	N/A
Total Radionuclides	8.1E-06		1.8E-04		N/A		N/A		1.72	
Total Non Radionuclides	1.1E-07		2.4E-07		3.3E-02		2.0E-01		N/A	

7.2 SELECTED EXPOSURE SCENARIOS AND POINTS OF CALCULATION

Two receptor scenarios were selected for the following analysis of ILCR and Hazard Index: industrial worker scenario and residential scenario. Both scenarios are developed from scenarios described in DOE/RL-91-45. For information, additional exposure scenarios were evaluated, including Native American receptors and receptors exposed to a surface water source. The industrial and residential scenarios are summarized in the following sections.

The analysis presented in this section includes extrapolation of groundwater concentrations to selected distances downgradient from the WMA C fenceline. These estimates assume that groundwater will ultimately assume a pre-Hanford flow direction and that groundwater from beneath WMA C will flow generally east from the site toward the Columbia River. These distances were selected as follows:

- The proposed core zone boundary surrounding the 200 Areas. This boundary is not yet fully defined and is subject to negotiation in terms of its actual location and also its applicability to any particular groundwater metric. The boundary location selected for this preliminary analysis is located 2,900 m east of WMA C.

- The Columbia River east of the 200 Areas was also selected as a point of calculation. The distance from WMA C to the Columbia River to the east is approximately 14,300 m. This calculation point is reported as Columbia River (groundwater) and the concentration of groundwater is evaluated just before it enters the Columbia River. Another scenario would actually include the Columbia River surface water, which includes such activities as swimming and eating fish from the river. This scenario is being evaluated as part of the composite analysis (which includes a Columbia River model), described in Section 4.0 of the *Framework Plan for Single Shell Tank System Closure* (RPP-13774).

An analytical model was applied to the results of the numerical simulations at the WMA C fenceline to estimate reduction in concentration with distance downgradient from the WMA. These estimated downgradient concentrations were then used to estimate risk and dose metrics at distance.

The industrial scenario was chosen because Hanford Advisory Board Advice recommends the industrial scenario for the 200 Core Zone Boundary for the next 150 years. This also makes sense in light of the results. The highest contamination from WMA C occurs within the next 150 years and is due to past leaks and hypothetical retrieval leaks. The groundwater within the 200 Area Core Zone boundary cannot be used as a drinking water source until the existing plumes have either been remediated or have naturally attenuated. The residential scenario is presented because it is unrealistic to assume that an industrial scenario is appropriate once the existing plumes have been remediated or have naturally attenuated, which is expected to occur before contamination from residuals left in the tanks arrive at groundwater. Therefore a residential scenario should be used for tank residuals. The WMA C results of the analyses for both of the selected scenarios and the supplemental exposure scenarios are presented in this section and in Addendum C2.

7.3 RESIDUAL TANK WASTE SOURCE TERM IMPACTS

The residual waste remaining in tanks at the time of WMA closure is an important element for two primary reasons: (1) it represents a potentially high mass of constituents at the highest possible concentration, and (2) it is subject to management of mass and/or modification of final characteristics through implementation of selected in-tank treatment and stabilization technologies.

The base case scenario presented in this section incorporates the impacts of the preliminary constituents of potential concern present in residual waste at concentrations derived from the BBI. For all tanks,, the post-retrieval waste volume is estimated by removing the liquid, or supernate, fraction of the BBI and then reducing the volume of the remaining solid fraction to the maximum volume allowable under the HFFACO (i.e., 360 ft^3 for 100-series tanks and 30 ft^3 for 200-series tanks). This estimated inventory is representative of the residual waste remaining after retrieval by dry, or low water volume, methods such as the mobile retrieval system. .

In addition to the twelve 100-series tanks and four 200-series tanks in WMA C, residual waste impacts were evaluated for the C-301 catch tank and 244-CR vault. Currently there is no BBI inventory associated with these ancillary tanks. For evaluation purposes, these tanks were assigned inventories based on the average BBI minus liquids inventory for the entire WMA C. See Section 3.5 for the description of how residual waste volumes and inventories were estimated for the C-301 catch tank and 244-CR vault.

The constituents in the residual waste are assumed to release from the tank through a diffusion-controlled process. This process is simulated by applying the results of simulation Case 11. The diffusion-controlled release presents a representative result based on the assumption that the waste is released by diffusion through a monolithic waste form (e.g., cement grout[*]). Release from a grouted mass[*] is realistic based on the existence of the current concrete tank structure and preliminary plans to utilize cement grout[*] as part of the final tank fill.

The residual tank waste contributions to estimated dose, cancer risk, and Hazard Index values are presented in Tables 29, 30, and 31, respectively. These values are calculated as cumulative fenceline average concentrations over the entire length of the downgradient fenceline of WMA C. The concentration of constituents related to the residual tank waste source term peaks at approximately 5614 AD, in the middle range of the 10,000-year simulation period. The constituent concentration exhibits a very slow decline over time, consistent with the diffusion release scenario.

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[*] See Preface in *SST System Closure Plan* (RPP-13774).

Table 29. Residual Tank Waste Contribution to Radiological Dose from Exposure to Groundwater and Drinking Water for Technetium-99 and Iodine-129.

Constituent	WMA Fenceline		Proposed Core Zone Boundary		Columbia River (Groundwater)[a]	
	Time (yr AD)	**Dose (mrem/yr)**	**Time (yr AD)**	**Dose (mrem/yr)**	**Time (yr AD)**	**Dose (mrem/yr)**
All Pathways Farmer (compare to <25 mrem/yr target)						
Technetium-99	5610	1.2 E-01	5637	1.8 E-02	5839	6.8 E-03
Iodine-129	5614	7.1 E-02	5637	1.1 E-02	5839	4.2 E-03
Cumulative[a]		1.9 E-01		3.0 E-02		1.1 E-02
Native American Groundwater (compare to <25 mrem/yr target)						
Technetium-99	5610	2.8 E-01	5637	4.3 E-02	5839	1.6 E-02
Iodine-129	5614	1.7 E-01	5637	2.6 E-02	5839	9.8 E-03
Cumulative[a]		4.6 E-01		7.1 E-02		2.7 E-02
Residential -- Drinking Water (compare to <4 mrem/yr EDE target)[b]						
Technetium-99	5610	6.9 E-02	5637	1.1 E-02	5839	3.8 E-03
Iodine-129	5614	2.6 E-02	5637	4.0 E-03	5839	1.4 E-03
Cumulative[a]		9.7 E-02		1.5 E-02		5.3 E-03

NA = not applicable. Risk metric does not apply to this constituent.
WMA = waste management area

[a] Cumulative includes all COPCs from *Inventory and Source Term Data Package* (DOE/ORP-2003-02) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).
[b] Based on 2L/day ingestion

Table 30. Residual Tank Waste Contribution to Incremental Lifetime Cancer Risk from Exposure to Groundwater for Selected Constituents.

Constituent	WMA Fenceline		Proposed Core Zone Boundary		Columbia River (GW)	
	Time (yr AD)	Risk	Time (yr AD)	Risk	Time (yr AD)	Risk
HSRAM Industrial Scenario – Risk (compare to <1.0 E-05 target)						
Technetium-99	5610	9.0 E-07	5637	1.4 E-07	5839	5.2 E-08
Iodine-129	5614	1.0 E-07	5637	1.6 E-08	5839	5.8 E-09
RAD TOTAL[a]		1.0 E-06		1.6 E-07		6.0 E-08
Chromium^{+6} [b]	5614	2.8 E-08	5637	4.4 E-09	5839	1.6 E-09
Nitrate	NA		NA		NA	
Nitrite	NA		NA		NA	
Uranium	NA		NA		NA	
Non-RAD Total[a]	5614	2.8 E-08	5637	4.4 E-09	5839	1.7 E-09
HSRAM Residential Scenario – Risk (compare to <1.0 E-05 target)						
Technetium-99	5610	2.2 E-05	5637	3.4 E-06	5839	1.3 E-06
Iodine-129	5614	5.2 E-07	5637	8.2 E-08	5839	3.0 E-08
RAD TOTAL[a]		2.3 E-05		3.5 E-06		1.3 E-06
Chromium^{+6} [b]	5614	6.3 E-08	5637	9.8 E-09	5839	3.6 E-09
Nitrate	NA		NA		NA	
Nitrite	NA		NA		NA	
Uranium	NA		NA		NA	
Non-RAD Total[a]	5614	6.3 E-08	5637	9.8 E-09	5839	3.6 E-09

HSRAM = Hanford Site Risk Assessment Methodology (DOE/RL-91-45).
NA = not applicable. Risk metric does not apply to this constituent.
WMA = waste management area

[a] Cumulative includes all COPCs from *Inventory and Source Term Data Package* (DOE/ORP-2003-02) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).

[b] For conservative purposes, all chromium is assumed to be in the +6 valence state. Additionally, when calculating ILCR, only the slope factors for inhalation are available, hexavalent chromium is assumed to be inhaled through shower, sprinklers, and/or dust contaminated with it

Table 31. Residual Tank Waste Contribution to Hazard Index from Exposure to Groundwater for Selected Constituents.

Constituent	WMA Fenceline		Proposed Core Zone Boundary		Columbia River (Groundwater)	
	Time (yr AD)	Hazard Index	Time (yr AD)	Hazard Index	Time (yr AD)	Hazard Index
HSRAM Industrial Scenario – Hazard Index (compare to < 1.00 target)						
$Chromium^{+6}$	5614	4.5 E-03	5637	7.0 E-04	5839	2.6 E-04
Nitrate	5614	4.5 E-04	5637	7.1 E-05	5839	2.6 E-05
Nitrite	5614	3.4 E-03	5637	5.2 E-04	5839	1.9 E-04
Uranium	12000	4.8 E-06	12000	2.8 E-06	12000	<1E-6
Cumulative[a]		9.4 E-03		1.5 E-03		5.6 E-04
HSRAM Residential – Hazard Index (compare to < 1.00 target)						
$Chromium^{+6}$	5614	2.5 E-02	5637	3.9 E-03	5839	1.5 E-03
Nitrate	5614	2.9 E-03	5637	4.6 E-04	5839	1.7 E-04
Nitrite	5614	2.2 E-02	5637	3.4 E-03	5839	1.2 E-03
Uranium	12000	3.3 E-05	12000	2.0 E-05	12000	<1E-6
Cumulative[a]		5.7 E-02		8.9 E-03		3.4 E-03

NA = not applicable. Risk metric does not apply to this constituent.
HSRAM = Hanford Risk Assessment Methodology (DOE/RL-91-45).
WMA = waste management area

[a] Cumulative includes all COPCs from *Inventory and Source Term Data Package* (DOE/ORP-2003-02) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).

The following key summary points were identified with respect to the residual waste source term:

- Cumulative groundwater dose originating from post-retrieval residual tank waste is below the target maximum value of 25 mrem in a year performance objective for the all pathways farmer and Native American exposure scenarios at all locations evaluated. For the industrial and residential drinking water scenarios, doses were calculated using conversion factor based on a 1 and 2 L/day ingestion rate, respectively. Calculated doses for both scenarios are below the target maximum value of 4 mrem/yr (Table 2). Dose contributions from technetium-99 and iodine-129 are approximately of equal magnitude (Table 29).

- Cumulative risk is below the target maximum value of 1×10^{-5} (Table 2) at all evaluation points for the DOE/RL-91-45 industrial exposure scenario. Target maximum value is exceeded for the residential exposure scenario at the WMA C fenceline only. Risk from technetium-99 accounts for greater than 95% of the total risk (Table 30).

- Cumulative Hazard Index is less than the target maximum value of one (Table 2) for all evaluation points for both exposure scenarios. Contribution from uranium is shown for information only and is not included in the cumulative value as it arrives much later than the other constituents. Hexavalent chromium and nitrite are the primary contributors and are of approximately equal magnitude (Table 31).

7.4 PAST LEAKS SOURCE TERM IMPACTS

A number of past leaks have occurred within WMA C. These include both leaks from a tank (i.e., tank C-105) and from ancillary equipment (i.e., pipes) associated with WMA operations. Past leaks are important to long-term human health risk estimates because of their potential to migrate to groundwater relatively quickly under the current assumed infiltration conditions at the WMA. One tank leak and three ancillary equipment leaks have been populated with estimated inventories at this time. WMA monitoring activities have detected the presence of widespread shallow radionuclide contamination, along with deeper contamination in the eastern portion of the tank farm. However, the expected inventory from these other sources is expected to be much smaller than for the sources analyzed and would provide only a small contribution of the total risk (see Section 3.5). Inventory data for remaining vadose zone contamination in WMA C will be generated as site characterization and closure activities are performed.

The past leak source term was simulated using simulation Cases 3 and 4 to represent past leaks from tanks and from ancillary equipment, respectively. The primary difference in the two simulation cases is the assumed placement of the source in the vadose zone at the start of the simulation (i.e., a past tank leak is assumed to be present deeper in the vadose zone than a release from ancillary equipment). As suggested by the depth of placement at the start of simulation, the past tank leak results in arrival of a peak groundwater concentration slightly faster than a corresponding ancillary equipment leak; however, the peaks are very close in time and are considered to be coincidental for this analysis.

The past leaks source term contribution to estimated dose, cancer risk, and Hazard Index values are presented in Tables 32, 33, and 34, respectively. These values are calculated as cumulative fenceline average concentrations over the entire downgradient length of the fenceline of WMA C. The concentration of constituents related to the past leak source term peaks at approximately 2117 AD, in the early portion of the 10,000-year simulation period. This peak is largely due to the migration of mobile constituents (e.g., technetium-99, iodine-129, nitrate, nitrite, and chromium). Because of the separation in arrival time of peak groundwater concentration, the peak values related to the past leaks source term are not additive to the peak(s) related to the residual tank waste source term. These constituents appear to move through the simulation domain (i.e., they leave the WMA area) within the period of the simulation.
A secondary impact due to moderately retarded constituents (e.g., uranium) is observed to begin at about 6900 AD and is still rising at the end of the simulation period.

The following key summary points were identified with respect to the past leak source term:

- Cumulative groundwater dose attributed to past leaks does not exceed the target performance objective of 25 mrem in a year for any scenario at the WMA C fenceline or

any distant evaluation point. Technetium-99 accounts for nearly 65% of the total drinking water dose (Table 32).

- Cumulative risk evaluated exceeds the target maximum value at the WMA C fenceline for the residential exposure scenario. Cumulative risk does not exceed the maximum target value for the Industrial scenario at the fenceline. Cumulative risk is above the target value at the fenceline, 200 Area Core Zone Boundary and at the Columbia River for the Residential Scenario. Technetium-99 accounts for approximately 85% of the total risk for the industrial scenario, and 95 % of the risk for the residential scenario (Table 33).

- Hazard Index values are less than the target value of 1 for both exposure scenarios at all evaluation points. Hexavalent chromium and nitrite are the primary contributors (Table 34).

Table 32. Past Leak Contribution to Radiological Dose from Exposure to Groundwater and Drinking Water for Technetium-99 and Iodine-129.

Constituent	WMA Fenceline		Proposed Core Zone Boundary		Columbia River (Groundwater)	
	Time (yr AD)	Dose (mrem/yr)	Time (yr AD)	Dose (mrem/yr)	Time (yr AD)	Dose (mrem/yr)
All Pathways Farmer (compare to <25 mrem/yr target)						
Technetium-99	2117	8.7 E-01	2141	1.4 E-01	2355	5.1 E-02
Iodine-129	2117	5.1 E-01	2141	7.8 E-02	2355	3.0 E-02
Cumulative[a]		1.7 E+00		2.7 E-01		1.0 E-01
Native American Groundwater (compare to <25 mrem/yr target)						
Technetium-99	2117	2.1 E+00	2141	3.3 E-01	2355	1.2 E-01
Iodine-129	2117	1.2 E+00	2141	1.8 E-01	2355	7.0 E-02
Cumulative[a]		4.1 E+00		6.4 E-01		2.4 E-01
Residential Drinking Water Dose (compare to <4 mrem/yr EDE target[b])						
Technetium-99	2117	5.2 E-01	2141	8.2 E-02	2355	2.9 E-02
Iodine-129	2117	1.8 E-01	2141	2.8 E-02	2355	1.0 E-02
Cumulative[a]		8.0 E-01		1.3 E-01		4.4 E-02

NA = not applicable. Risk metric does not apply to this constituent.
WMA = waste management area

[a] Cumulative includes all COPCs from *241-C Waste Management Area Inventory Data Package* (RPP-15317) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).
[b] Based on 2 L/day ingestion

Table 33. Past Leak Contribution to Incremental Lifetime Cancer Risk from Exposure to Groundwater for Selected Constituents.

Constituent	**WMA Fenceline**		**Proposed Core Zone Boundary**		**Columbia River (Groundwater)**	
	Time (yr AD)	**Risk**	**Time (yr AD)**	**Risk**	**Time (yr AD)**	**Risk**
HSRAM Industrial Scenario – Risk (compare to <1.0 E-05 target)						
Technetium-99	2117	6.9 E-06	2141	1.1 E-06	2355	3.8 E-07
Iodine-129	2117	7.1 E-07	2141	1.1 E-07	2355	4.0 E-08
RAD TOTAL[a]		8.1 E-06		1,3 E-06		4.5 E-07
Chromium[+6 b]	2117	1.1 E-07	2141	1.7 E-08	2355	6.1 E-09
Nitrate	NA		NA		NA	
Nitrite	NA		NA		NA	
Uranium	NA		NA		NA	
Non-RAD Total[a]		1.1 E-07		1.7 E-08		6.1 E-09
HSRAM Residential Scenario – Risk (compare to <1.0 E-05 target)						
Technetium-99	2117	1.7 E-04	2141	2.6 E-05	2355	1.0 E-05
Iodine-129	2117	3.7 E-06	2141	5.7 E-07	2355	2.1 E-07
RAD TOTAL[a]		1.8 E-04		2.8 E-05		1.0 E-05
Chromium[+6 b]	2117	2.4 E-07	2141	3.8 E-08	2355	1.5 E-08
Nitrate	NA		NA		NA	
Nitrite	NA		NA		NA	
Uranium	NA		NA		NA	
Non-RAD Total[a]		2.4 E-07		3.8 E-08		1.5 E-08

HSRAM = Hanford Site Risk Assessment Methodology (DOE/RL-91-45).
NA = not applicable. Risk metric does not apply to this constituent.
WMA = waste management area

[a]Cumulative includes all COPCs from *241-C Waste Management Area Inventory Data Package* (RPP-15317) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).
[b] For conservative purposes, all chromium is assumed to be in the +6 valence state. Additionally, when calculating ILCR, only the slope factors for inhalation are available, hexavalent chromium is assumed to be inhaled through shower, sprinklers, and/or dust contaminated with it.

Table 34. Past Leak Contribution to Hazard Index from Exposure to Groundwater for Selected Constituents[a].

Constituent	WMA Fenceline		Proposed Core Zone Boundary		Columbia River (Groundwater)	
	Time (yr AD)	Hazard Index	Time (yr AD)	Hazard Index	Time (yr AD)	Hazard Index
HSRAM Industrial Scenario - Hazard Index (compare to < 1.00 target)						
Chromium[+6]	2117	1.7 E-02	2141	2.7 E-03	2355	1.0 E-03
Nitrate	2117	1.7 E-03	2141	2.6 E-04	2355	9.5 E-05
Nitrite	2117	1.4 E-02	2141	2.2 E-03	2355	8.1 E-04
Uranium	12000	1.4 E-04	12000	9.6 E-05	12000	8.0 E-06
Cumulative[b]		3.3 E-02		5.3 E-03		2.0 E-03
HSRAM Residential – Hazard Index (compare to < 1.00 target)						
Chromium[+6]	2117	9.7 E-02	2141	1.5 E-02	2355	5.5 E-03
Nitrate	2117	1.1 E-02	2141	1.6 E-03	2355	6.1 E-04
Nitrite	2117	9.1 E-02	2141	1.4 E-02	2355	5.3 E-03
Uranium	12000	9.8 E-04	12000	6.7 E-04	12000	5.6 E-05
Cumulative[b]		2.0 E-01		3.2 E-02		1.2 E-02

[a] Contributions from past tank leak (tank C-105) and three unplanned releases are summed and are reported as single peak contribution at a single time. Detailed results of the simulation indicate that the past tank leak contaminants arrive approximately 26 years ahead of the past ancillary equipment leaks.

[b] Cumulative includes all COPCs from *241-C Waste Management Area Inventory Data Package* (RPP-15317) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).

HSRAM = Hanford Site Risk Assessment Methodology (DOE/RL-91-45).
NA = not applicable. Risk metric does not apply to this constituent.
WMA = waste management area

7.5 POTENTIAL RETRIEVAL LEAKS SOURCE TERM IMPACTS

Leaks of residual waste and retrieval solution may occur under some tank waste retrieval scenarios. This could be the case if high-volume water systems are used to retrieve waste (e.g., high-volume sluicing) in tanks with poor structural integrity. Potential impacts from retrieval leaks, as discussed in this section, could be dramatically reduced or eliminated by selection of either low water volume (e.g., simultaneous sluice and pump operations) or dry (e.g., vacuum) waste retrieval technologies. The potential impacts of waste retrieval leaks were evaluated in this risk assessment because the use of water-based systems remains a feasible and very practical method of retrieving tank wastes. The hypothetical waste retrieval leak source term is applied to all C-100 series tanks. It was not applied to the C-200 series tanks because those tanks are using a dry retrieval methodology.

Waste retrieval leaks were simulated using simulation Cases 1 and 2 for hypothetical leaks of 8,000 gal and 20,000 gal, respectively. The 8,000-gal waste retrieval leak case was selected for this analysis. Current awareness of the potential for retrieval leaks and the intent to implement retrieval mechanisms that will minimize the potential for leaks indicates that the 8,000-gal leak scenario is appropriate. Waste retrieval leak inventories will vary according to the pre-retrieval inventory of the tank being retrieved.

The retrieval leaks source term contribution to estimated dose, cancer risk, and Hazard Index values are presented in Tables 35, 36, and 37, respectively. These values are calculated as cumulative fenceline average concentrations over the entire downgradient length of the fenceline of WMA C. The concentration of constituents related to the waste retrieval leak source term peaks at approximately 2082 AD, in the early portion of the 10,000-year simulation period. Because of the separation in arrival time of peak groundwater concentration, the peak values related to the waste retrieval leak source term are not additive to the peak(s) related to the residual tank waste source term. They are, however, additive to the peaks related to the past leaks source term.

The following key summary points were identified with respect to the hypothetical retrieval leak source term:

- Cumulative groundwater dose from technetium-99 and iodine-129 attributed to hypothetical waste retrieval leaks does not exceed the target maximum performance objective of 25 mrem in a year for any of the exposure scenarios at any evaluation point. The dose resulting from a single waste retrieval leak will be uniquely determined by the inventory of the specific tank. The impact of waste retrieval leaks is magnified by the fact that their risk impacts would be largely additive with respect to past leaks (Table 35).

- Cumulative risk exceeds the target maximum value at the WMA C fenceline and at the core zone boundary for the residential exposure scenario. Cumulative risk does not exceed the maximum target value for the industrial scenario at the fenceline. Cumulative risk is below the target maximum value for both scenarios at all downgradient evaluation points. Technetium-99 is the primary contributor to risk, accounting for greater than 87% of the total risk for the industrial scenario, and 99 % of the risk for the residential scenario (Table 36).

- Hazard Index values are less than the target value of one for both exposure scenarios at all evaluation points. Hexavalent chromium and nitrite are the primary contributors (Table 37).

Table 35. Hypothetical Retrieval Leak Contribution to Radiological Dose from Exposure to Groundwater and Drinking Water for Technetium-99 and Iodine-129.

Constituent	WMA Fenceline		Proposed Core Zone Boundary		Columbia River (Groundwater)	
	Time (yr AD)	Dose (mrem/yr)	Time (yr AD)	Dose (mrem/yr)	Time (yr AD)	Dose (mrem/yr)
All Pathways Farmer (compare to <25 mrem/yr target)						
Technetium-99	2082	7.3 E-01	2107	1.2 E-01	2324	3.9 E-02
Iodine-129	2082	4.3 E-01	2107	6.9 E-02	2324	2.3 E-02
Cumulative[a]		1.24 E-00		2.0 E-01		6.6 E-02
Native American Groundwater (compare to <25 mrem/yr target)						
Technetium-99	2082	1.8 E-00	2107	2.8 E-01	2324	9.3 E-02
Iodine-129	2082	1.0 E-00	2107	1.6 E-01	2324	5.4 E-02
Cumulative[a]		3.0 E-00		4.7 E-01		1.6 E-01
Industrial – Drinking Water (compare to <4 mrem/yr target)						
Technetium-99	2082	1.5 E-01	2107	2.4 E-02	2324	8.0 E-03
Iodine-129	2082	5.5 E-02	2107	8.7 E-03	2324	2.9 E-03
Cumulative[a]		2.1 E-01		3.4 E-02		1.1 E-03
Residential – Drinking Water (compare to <4 mrem/yr target)						
Technetium-99	2082	4.4 E-01	2107	7.0 E-02	2324	2.3 E-02
Iodine-129	2082	1.6 E-01	2107	2.6 E-02	2324	8.5 E-03
Cumulative[a]		6.2 E-01		9.9 E-02		3.3 E-02

NA = not applicable. Risk metric does not apply to this constituent.
WMA = waste management area

[a] Cumulative includes all COPCs from *Inventory and Source Term Data Package* (DOE/ORP-2003-02) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).

Table 36. Hypothetical Retrieval Leaks Contribution to Incremental Lifetime Cancer Risk from Exposure to Groundwater for Selected Constituents.

Constituent	WMA Fenceline		Proposed Core Zone Boundary		Columbia River (Groundwater)	
	Time (yr AD)	Risk	Time (yr AD)	Risk	Time (yr AD)	Risk
HSRAM Industrial Scenario – Risk (compare to <1.0 E-05 target)						
Technetium-99	2082	5.7 E-06	2107	9.1 E-07	2324	3.0 E-07
Iodine-129	2082	6.1 E-07	2107	9.7 E-08	2324	3.2 E-08
RAD TOTAL[a]		6.5 E-06		1.0 E-06		3.4 E-07
Chromium^{+6}[b]	2082	1.7 E-07	2107	2.8 E-08	2324	9.2 E-09
Nitrate	NA		NA		NA	
Nitrite	NA		NA		NA	
Uranium	NA		NA		NA	
Non-RAD Total[a]		1.7 E-07		2.8 E-08		9.2 E-09
HSRAM Residential Scenario – Risk (compare to <1.0 E-05 target)						
Technetium-99	2082	1.4 E-04	2107	2.2 E-05	2324	7.4 E-06
Iodine-129	2082	3.2 E-06	2107	5.0 E-07	2324	1.7 E-07
RAD TOTAL[a]		1.4 E-04		2.3 E-05		7.6 E-06
Chromium^{+6}[b]	2082	3.8 E-07	2107	6.1 E-08	2324	2.0 E-08
Nitrate	NA		NA		NA	
Nitrite	NA		NA		NA	
Uranium	NA		NA		NA	
Non-RAD Total[a]		3.8 E-07		6.1 E-08		2.0 E-08

HSRAM = Hanford Site Risk Assessment Methodology (DOE/RL-91-45).
NA = not applicable. Risk metric does not apply to this constituent.
WMA = waste management area

[a] Cumulative includes all COPCs from *Inventory and Source Term Data Package* (DOE/ORP-2003-02) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).
[b] For conservative purposes, all chromium is assumed to be in the +6 valence state. Additionally, when calculating ILCR, only the slope factors for inhalation are available, hexavalent chromium is assumed to be inhaled through shower, sprinklers, and/or dust contaminated with it.

Table 37. Hypothetical Retrieval Leak Contribution to Hazard Index from Exposure to Groundwater for Selected Constituents for Selected Constituents.

Constituent	WMA Fenceline		Proposed Core Zone Boundary		Columbia River (Groundwater)	
	Time (yr AD)	Hazard Index	Time (yr AD)	Hazard Index	Time (yr AD)	Hazard Index
HSRAM Industrial Scenario – Hazard Index (compare to < 1.00 target)						
Chromium^{+6}	2082	2.8 E-02	2107	4.4 E-03	2324	1.5 E-03
Nitrate	2082	4.1 E-03	2107	6.5 E-04	2324	2.2 E-04
Nitrite	2082	2.6 E-02	2107	4.1 E-03	2324	1.4 E-03
Uranium	12000	1.9 E-03	12000	1.3 E-03	12000	1.0 E-04
Cumulative[a]		6.7 E-02		1.1 E-03		3.6 E-03
HSRAM Residential – Hazard Index (compare to < 1.00 target)						
Chromium^{+6}	2082	1.5 E-01	2107	2.4 E-02	2324	8.1 E-03
Nitrate	2082	2.6 E-02	2107	4.2 E-03	2324	1.4 E-03
Nitrite	2082	1.7 E-01	2107	2.7 E-02	2324	8.9 E-03
Uranium	12000	1.3 E-02	12000	9.0 E-03	12000	7.3 E-04
Cumulative[a]		4.2 E-01		6.7 E-02		2.2 E-03

HSRAM = Hanford Site Risk Assessment Methodology (DOE/RL-91-45).
NA = not applicable. Risk metric does not apply to this constituent.
WMA = waste management area

[a] Cumulative includes all COPCs from *Inventory and Source Term Data Package* (DOE/ORP-2003-02) that have unit dose factors (HNF-SD-WM-TI-707 Rev 3).

7.5.1 Residual Ancillary Equipment Waste Source Term Impacts

The potential impact of residual waste remaining in the waste transfer piping components was evaluated and is discussed in this section. The ancillary piping components were assigned a conservative residual waste volume of 250 ft^3 based on an arbitrary 25% blockage in 20,000 linear feet of 3-in.-diameter piping. The average BBI minus liquids inventory for the entire WMA C was used due to lack of any other basis for deriving an inventory.

The constituents in the residual waste are assumed to release from the pipelines through a diffusion-controlled process. Release from a grouted* mass is realistic based on the existence of the current preliminary plans to fill ancillary piping components with grout* as part of closure activities. Applying the results of a scaled simulation Case 13 simulates this process.

* See Preface in *SST System Closure Plan* (RPP-13774).

Peak groundwater concentration of the highly mobile constituents (e.g., technetium-99, iodine-129) attributed to ancillary piping components occurs approximately 4892 AD, preceding the peak impact from residual tank waste by roughly 700 years. Groundwater dose, ILCR, and Hazard Index values attributed to this source term are roughly an order of magnitude less than those for residual tank waste and nearly two orders of magnitude less than the past leaks source term. The residual waste in the pipeline represents approximately 12% of cumulative impacts at the peak arrival time for release from the pipeline, which occurs 700 years before the impacts due to tank residual waste.

7.6 CUMULATIVE EFFECTS OF ALL SOURCE TERMS

An analysis of cumulative effects of multiple source terms is presented in this section.

The analysis identifies the individual source term contributions to ILCR and Hazard Index for the industrial worker exposure scenario, and radiological dose (EDE) for the all-pathways exposure farmer scenario. The summary results are presented in graphs for each performance metric with each graph including individual contribution curves for the individual source terms and the cumulative curve representing the additive effects of the source terms. All of the results of this analysis are based on groundwater concentrations at the WMA C fenceline.

Figure 25 indicates the cumulative effects in terms of ILCR to the industrial worker scenario. This figure indicates that the ILCR Risk (1.3E-05) is greater than the performance objective of 1.0E-05. However, the source term that pushes the risk over the performance objective is the hypothetical retrieval leaks, in which it is assumed that all tanks leak 8,000 gal. However, that scenario is somewhat unrealistic because steps would be taken to mitigate retrieval leaks, especially if retrieval leaks occur in tanks that are retrieved early in the process. Figure 26 shows the cumulative effects in terms of Hazard Index to the industrial worker scenario. The cumulative total (0.095) for the Hazard Index is an order of magnitude below the performance objective of 1.0. Figure 25 shows the cumulative effects of radiological dose (EDE) to the all-pathways farmer exposure scenario. The cumulative total for this performance metric (2.8 mrem in a year) is also almost an order of magnitude below the performance objective of 25 mrem/yr. The all-pathways farmer is identified as a conservative exposure scenario for radiological dose and is selected for comparison to dose limits established by the DOE for closure of radiological waste facilities.

In all cases of cumulative effects of residual tank waste, past leaks and hypothetical retrieval leaks in WMA C, the highest peak concentration occurs early in the post-closure period and existing past leaks contribute almost the entire peak value. After approximately 4700 AD, the residual waste contribution becomes the primary contributor to risk.

The potential contribution of hypothetical retrieval leaks would occur in a time frame parallel with the existing past leaks, although the magnitude is all most the same as existing past leaks under the assumption that all C-100 series tanks in WMA C may exhibit retrieval leaks.

Figure 25. Impacts of Base Case Multiple Source Terms on Incremental Lifetime Cancer Risk – Tank Residuals after Retrieval, Past Leaks, and Hypothetical Retrieval Leaks. Waste Management Area C. DOE/RL-91-45 Industrial Receptor at Downgradient Fenceline.

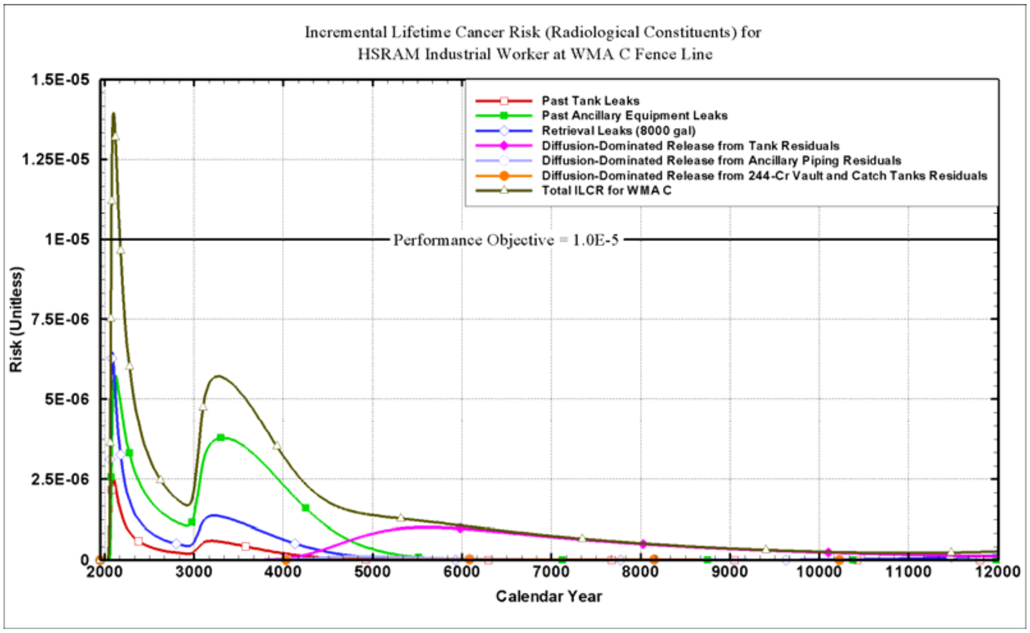


Figure 26. Impacts of Base Case Multiple Source Terms on Hazard Index – Tank Residuals after Retrieval, Past Leaks and Hypothetical Retrieval Leaks from Selected Tanks in Waste Management Area C. DOE/RL-91-45 Industrial Receptor at Downgradient Fenceline.

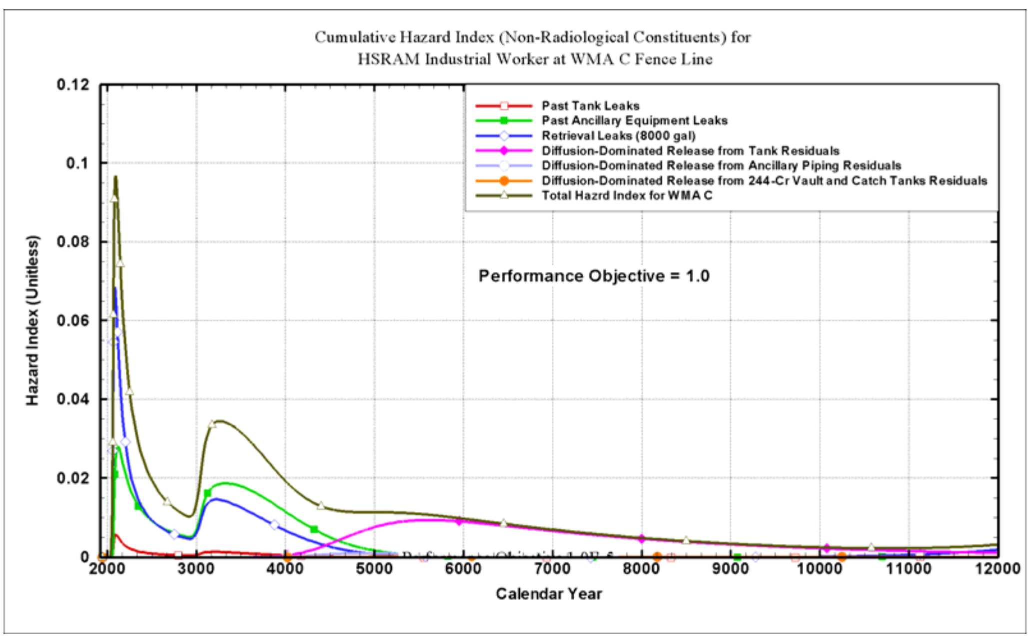
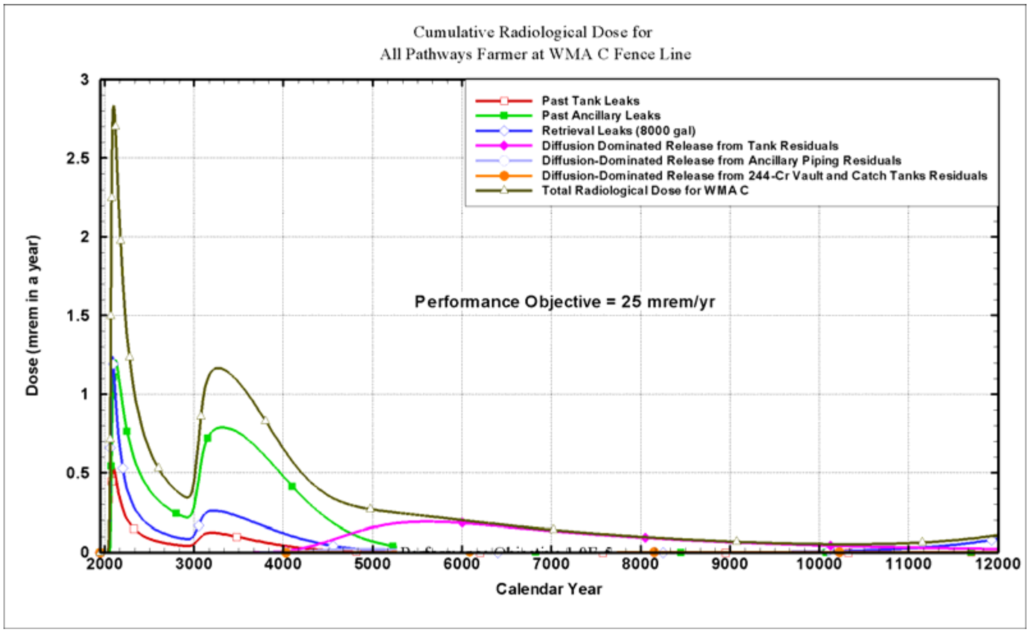


Figure 27. Impacts of Base Case Multiple Source Terms on Groundwater Dose – Tank Residuals after Retrieval, Past Leaks, and Hypothetical Retrieval Leaks from Selected Tanks in Waste Management Area C. All-Pathways Farmer Receptor at Downgradient Fenceline.



7.7 EVALUATION OF DRINKING WATER QUALITY IMPACTS

The primary drinking water standards were identified as tank closure performance objectives for protection of groundwater. The respective standards are the MCLs. The MCLs include both concentration-based standards (e.g., for metals and inorganic compounds/ions) and dose-based standards (e.g., for beta/photon-emitting radionuclides). The WMA C fenceline groundwater concentrations resulting from the individual source terms discussed above are presented in Table 38 and compared to concentration-based standards. The MCL for iodine-129 is exceeded in 2104 AD at the peak contribution from past leak and hypothetical retrieval leak source terms.

Table 38. Comparison of Resultant Groundwater Concentrations to Concentration-Based Drinking Water Standards

Constituent	Post-Retrieval Tank Residual Peak Contribution[a]	Past Leaks Peak Contribution	Hypothetical Retrieval Leaks Peak Contribution	Ancillary Equipment (Transfer lines) Peak Contribution	Baseline Closure Conditions – Concen-trations at Peak Impact	Drinking Water Standard (MCL)
Technetium-99	66 pCi/L	497 pCi/L	416 pCi/L	7.4 pCi/L	871 pCi/L	900 pCi/L[b]
Iodine-129	0.14 pCi/L	0.96 pCi/L	0.82 pCi/L	0.0153 pCi/L	1.7 pCi/L	1 pCi/L[b]
Nitrate	0.073 mg/L	0.27 mg/L	0.66 mg/L	0.00829 mg/L	0.794 mg/L	44 mg/L[c]
Nitrite	0.034 mg/L	0.14 mg/L	0.26 mg/L	0.0038 mg/L	0.359 mg/L	3.3 mg/L[c]
Chromium^{+6}	0.001 mg/L	0.004 mg/L	0.0064 mg/L	0.00012 mg/L	0.0094 mg/L	0.10 mg/L[d]
Total Uranium	2.9E-7 mg/L	8.5E-6 mg/L	0.00012 mg/L	4.2E-8 mg/L	0.00012 mg/L	0.030 mg/L

[a] Includes post-retrieval residual waste contribution from 301 catch tank and 244-CR vault.
[b] The radionuclide concentrations shown are the “C4” concentration which is the concentration of the nuclide in drinking water that would result in an annual dose of 4 mrem/yr using the target organ dose methodology specified by EPA.
[c] These concentrations are for nitrate and nitrite reported as the ions. The MCLs for nitrate and nitrite, reported as nitrogen, are 10 mg/L and 1 mg/L, respectively.
[d] The MCL for chromium is for total chromium, not just chromium(VI).
EPA = U.S. Environmental Protection Agency.
MCL = maximum contaminant level.

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8.0 SHORT-TERM HUMAN HEALTH RISK APPROACH

The worker and public exposure human health risk analysis estimated the potential health impacts from both accident and normal (non-accident) conditions resulting from various scenarios for C-106 and the C farm during closure activities. However, a safety analysis that identifies accident scenarios for closure activities is currently being developed under the document safety analysis effort and will be considered in future evaluation of short-term risk. The analysis provided below shows the methodology and calculations used in a worker and public exposure risk assessment. It uses the safety analysis completed for retrieval of wastes from tanks for its accident scenarios. Thus, these are expected to provide conservatively high risk estimates because much of the waste has been removed and less contact between waste and workers is expected during closure.

The hazards associated with these activities include potential occupational hazards resulting in physical trauma, radiological exposure resulting in latent cancer fatalities (LCFs) and chemical exposure resulting in a hazard index. Initiating events that could result in hazardous health effects may include natural phenomena, human error, component failure, and spontaneous reactions. Health risks during normal conditions include anticipated exposure to radiation and chemical fields and radiological and chemical releases to the atmosphere during normal closure activities. More specific information regarding approaches is presented in the following sections.

Tank filling will present potential exposures to workers and the general public. Worker and general public exposure scenarios were developed for tank (i.e., component) closure activities. The preliminary scenario presented in this document is Phase I grouting[*] (i.e., stabilizing grout[*]) and represents the type of exposure that is expected based on planned tank closure activities. Various options for tank filling following waste retrieval will be evaluated.

Because the short-term human health risks will be encountered in the near future while the site is under physical and administrative control of DOE, it can be reasonably anticipated that the tank closure activities will be conducted in a manner that maintains exposure to tank wastes as low as reasonably achievable through the use of engineering controls and protective equipment. It is assumed that after final closure of the tanks, short-term human worker health risk will be fully mitigated. Inadvertent intruder risk is mitigated by the Modified RCRA C Barrier (Section 3.2.1) .

Waste retrieval leak losses are assumed to occur at or near the base of a tank. It is not anticipated that the subsurface leaks at the base of a tank would result in an atmospheric release (in the short-term) nor would the ionizing radiation have an appreciable health risk to the workers. While it may be possible that retrieval leaks could result in atmospheric release of volatile compounds, such releases are not likely to contribute significant risk given the depth of the release and the low volatile content of the tank waste. For this reason the short-term human health risk from retrieval leak loss is not evaluated.

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[*] See Preface in *SST System Closure Plan* (RPP-13774).

8.1 OCCUPATIONAL INJURIES, ILLNESSES, AND FATALITIES APPROACH

The number of injuries, illnesses, and fatalities resulting from closure activities is calculated based on the most currently available incidence rates applicable to component closure activities. The number of injuries, illnesses, and fatalities from construction or operations is calculated by multiplying the total person-years required to support the activity by the incidence rates.

8.2 RADIOLOGICAL RISK FROM ACCIDENTS APPROACH

Radiological risk is expressed as the number of LCFs resulting from accidents in which people are exposed to radiation fields or radiological constituents released to the atmosphere. Radiological accidents are unplanned events or a sequence of events that result in undesirable consequences. The potential exists for radiological accidents to result from the tank closure operations. Radiological accidents could result in the unmitigated release of radiological constituents to the atmosphere, exposing the involved worker, the noninvolved worker, and general public, resulting in an LCF risk. The probability of the accident occurring also is evaluated. The methodology used to identify and quantify radiological risk from accidents is performed using the following steps.

- **Step 1. Accident Identification**. Potential hazards associated with closure activities are identified from existing preliminary hazard analyses and other safety documents. The hazards will be reported in a tabular format showing, for each accident, the barriers within the facility that prevent or mitigate the consequences of the accident, a rough estimate of the magnitude of consequences of the accident assuming that the listed preventive barriers fail, and the estimated likelihood of the accident occurring.

- **Step 2. Accident Strategy Selection**. The accident with the highest risk is screened for further analysis to determine, as accurately as possible, the consequences and probability of occurrence. The risk of a given accident is the product of the consequences of the accident and the estimated likelihood of the event occurring. Screening for the highest-risk accidents follows the same methodology as outlined in Section B.3.3.2.3.5 of *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (DOE-STD-3009-94). Accident frequencies are based on published safety hazard documents, for example *Tank Waste Remediation System Final Safety Analysis Report* (HNF-SD-WM-SAR-067).

- **Step 3. Accident Sequence Quantification**. The frequency of occurrence of the selected accidents is taken from referenced documents where available. Where accident frequencies are not available they are estimated.

- **Step 4. Source Term Development**. The source term is the respirable fraction of inventory from which the receptor dose is calculated. The source term is developed based on the inventory that could be released to the environment from an accident. The major reduction factors that control the source term are considered in the evaluation. The reduction factors include airborne release fractions, airborne release rates, and respirable fractions. Use of the reduction factors will be dependent upon the nature of the accident (i.e., energy of accident at impact, waste form, and effectiveness of mitigating

barriers). Exposure resulting from direct exposure to radiation under accident conditions also is evaluated. Direct exposure is the direct beta and gamma radiation dose rate to a receptor. Exposure due to ingestion would be negligible compared to inhalation and is not analyzed.

- **Step 5. Atmospheric Dispersion Coefficients**. The atmospheric dispersion coefficient (χ/Q) values are generated using the GXQ computer code in *GXQ 4.0 Program Users' Guide* (WHC-SD-GN-SWD-30002) following the methodology outlined in *Atmospheric Dispersion Models for Potential Accident Consequence Assessment at Nuclear Power Plants* (NUREG 1.145). The meteorological data used by the GXQ code are in the form of joint frequency tables. The joint frequency data are taken from data collected at the Hanford Site meteorology tower in the 200 Areas. The atmospheric dispersion coefficient values are used in equations to calculate the radiological dose experienced by the involved and noninvolved worker and general public receptors as a result of inhaling radioactive materials. Ingestion of radioactive materials is also included for the general public receptor dose.

- **Step 6. Receptor determination**. Potential health effects from radiological exposures are estimated for three subsets of populations and maximally exposed individuals (MEI) in those populations. The dose to a receptor depends on the location of the receptor relative to the point of release of the radioactive material. The involved workers are those involved in the proposed action and are performing work at the facility. Those workers are assumed to be in the center of a 10 m (33 ft) radius hemisphere where the airborne released material has spread instantaneously and uniformly. The noninvolved workers are those that would be on the Hanford Site but not involved in the action. Those workers are assumed to extend from 100 m (330 ft) out to the Hanford Site boundary. The general public is assumed to be located at the Site boundary to a distance of 80 km (50 mi) from the point of release. The Hanford Site boundary used in the analysis is the adjusted Site boundary that excludes areas designated as part of the Hanford Reach National Monument ("Establishment of the Hanford Reach National Monument" [65 FR 7319]). Those areas include the North Slope, the Hanford Reach of the Columbia River, and the Fitzner-Eberhardt Arid Lands Ecology Reserve. The Site boundaries are as follows:

  - **North**: Columbia River, 0.4 km (0.25 mi) south of the south river bank
  - **East**: Columbia River, 0.4 km (0.25 mi) west of the west river bank
  - **South**: A line running west from the Columbia River, just north of the Energy Northwest leased area, through the Wye Barricade to Highway 240
  - **West**: Highway 240 and Highway 24.

- **Step 7. Radiological dose assessment**. The inventory involved in each accident is evaluated to determine the activity concentrations. The activity concentrations are converted to unit liter dose factors. A single unit inhalation dose factor for each composite source term for a 50-year dose commitment period is taken from *Exposure Scenarios and Unit Dose Factors for Hanford Tank Waste Performance Assessments*

(HNF-SD-WM-TI-707 Rev. 3). The receptor doses are given in terms of committed effective dose equivalents. The unit inhalation dose factors are used with the appropriate atmospheric dispersion coefficient, breathing rates, and the source term to determine the radiological dose to the involved worker, noninvolved worker, and general public receptors.

- **Step 8. LCF risk development**. The likelihood that a dose of radiation would result in a fatal cancer at some future time is calculated by multiplying the receptor dose by a dose-to-risk conversion factor. Conversion factors are predictions of health effects from radiation exposure. The dose-to-risk conversion factors used for estimating LCFs from low doses of radiological exposure and from high doses are consistent with those taken from *Recommendations of the International Commission on Radiological Protection* (ICRP 1991). They are summarized as follows:
  - **Involved worker and noninvolved worker**: 4.0×10^{-4} LCF/rem for low doses less than 20 rem and 8.0×10^{-4} LCF/rem for doses greater than or equal to 20 rem.
  - **General public**: 5.0×10^{-4} LCF/rem for low doses less than 20 rem and 1.0×10^{-3} LCF/rem for doses greater than or equal to 20 rem. The dose-to-risk conversion factors for the general public accounts for the presence of children.

8.3 RADIOLOGICAL LATENT CANCER FATALITY RISK FROM ROUTINE EXPOSURE APPROACH

Closure activities require radiation workers to work in radiation zones during the construction and installation of closure equipment and during closure operations. Due to the nature of the work in a radiation zone, the workers will be exposed to and receive a radiological dose from ionizing radiation. The involved worker exposure is a combination of exposure from inhalation and direct radiation. Involved worker dose rates are estimated based on time, distance, and shielding considerations associated with the various tasks. Atmospheric emissions will also result from closure activities. Although the emissions are first filtered through high-efficiency particulate air filters, the abated emissions related to the atmosphere and carried downwind will be inhaled by onsite workers and the offsite population, resulting in an exposure and subsequent dose. Noninvolved worker and general public exposure are estimated by determining the expected routine radiological releases during closure. Exposure to the noninvolved worker is assumed to be from inhalation and external radiation from the plume continuously throughout the year, and from deposition of radionuclides on the ground. The offsite population will receive an additional dose from ingesting radiological contaminants attached to food substances such as fruits, vegetables, meat, and milk. Every effort is made to reduce the exposures to the radiation workers and the air emissions, but the exposures are still anticipated and are considered routine. The risk from these exposures is measured in terms of LCFs.

This analysis considers the risk from routine radiological exposures to three receptor groups of people and an MEI from each group:

- **Involved workers**: Radiation workers in radiation zones directly involved in the construction and closure operation activities.

- **Noninvolved workers**: Hanford Site workers distributed within the Hanford Site boundary but no closer than 100 m (328 ft) from the source of the emissions.

- **General public**: Offsite population distributed from the Hanford Site to a distance of 80 km (50 mi).

The LCF risk is calculated by multiplying the dose (in units of person-rem for the population and rem for the MEI) by an appropriate dose-to-risk conversion factor (in units of LCF/person-rem for the population and LCF/rem for the MEI). The involved worker population dose resulting from construction and operations is based on worker exposures to support closure of C-106 in *Engineering Report for Interim Closure of Tank 241-C-106 and the 241-C Farm 200-Series Tanks* (RPP-14590). The involved worker MEI dose is based on a current site administrative control of 0.5 rem/yr (*Tank Farms Radiological Control Manual (TFCRM)* [HNF-5183]).

Exposures to the noninvolved workers and general public are from abated air emissions of radionuclides. The radionuclides released in the abated air emissions are then used as input to the GENII computer code (*GENII – The Hanford Environmental Radiation Dosimetry Software System* [PNL-6584]). The GENII system has been designed for calculating radiation doses for acute and chronic releases. It evaluates direct exposure, inhalation and ingestion pathways and targeted populations identified by distance and direction for individuals and populations. Atmospheric dispersion coefficients used in the GENII code are calculated using the GXQ computer code (WHC-SD-GN-SWD-30002).

The GENII computer code (PNL-6584) is used to calculate the dose. The LCF risk is then calculated by multiplying the receptor dose by a dose-to-risk conversion factor from ICRP (1991).

8.4 CHEMICAL EXPOSURE FROM ACCIDENTS

The chemical inventory used for this assessment is made up of two components, the organic chemicals and the inorganic chemicals. The emission rates for organic chemicals are taken from *Organic Vapor Source Term for Tanks 241-C-201, 241-C-202, 241-C-203, and 241-C-204 During Waste Retrieval Operations*, RPP-14841. The emission rates for inorganic chemicals are taken from *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment*, HNF-SD-WM—TI-707. Potential acute hazards associated with exposure to concentrations of postulated accidental chemical releases were evaluated using a screening-level approach for the receptors. This involves directly comparing calculated exposure point concentrations of chemicals to a set of air concentration screening criteria, known as emergency response planning guidelines (ERPGs). The ERPGs, as developed by the American Industrial Hygiene Association, are specific levels of chemical contaminants in air designed to be protective of acute adverse health impacts for the general population. ERPGs are the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing the following effects:

- ERPG 1 - Mild transient adverse health effects or perceiving a clearly defined objectionable odor

- ERPG 2 - Irreversible or other serious health effects, or symptoms that could impair ability to take protective action

- ERPG 3 - Irreversible or life-threatening health effects could result from exposures exceeding one hour.

In the event that an ERPG value does not exist, DOE requires the use of Threshold Emergency Exposure Limit (TEEL) values. Like the ERPGs, there are multiple levels of TEELs as follows:

TEEL-0 The threshold concentration below which most people will experience no appreciable risk of health effects;

TEEL-1 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.

TEEL-2 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action;

TEEL-3 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

Cumulative hazards or the acute hazard index (HI) for toxic and corrosive/irritant chemical classes were evaluated using the following equation.

$$HI = \sum \frac{C_{chemical}}{ERPG_{chemical}}$$

where:

HI is the cumulative hazard index for acute exposure

$C_{chemical}$ is the concentration at the exposure point of each chemical (mg/m^3)

$ERPG_{chemical}$ is the ERPG (or TEEL if no ERPG available) for each chemical (mg/m^3).

A cumulative HI is calculated for each ERPG/TEEL level (1, 2, and 3). If the HI is greater than 1.0 indicates that the acute hazard guidelines for a mixture of chemicals has been exceeded and the chemical mixture may pose a potential acute health impact. The potential impact is described in the level definition shown above. To be consistent with previous tank farm worker risk assessments and DOE guidance TEELs and ERPGs were chosen as the hierarchy approach versus other hierarchy approaches used in the WTP risk assessment on-site.

Determining the accidents to be used in the strategies, the source term, atmospheric dispersion coefficients, and the receptor location followed the same methodology as that applied to radiological risk from accidents in Section 8.2.

8.5 CHEMICAL HAZARDS FROM ROUTINE EXPOSURE

The chemical inventory used for this assessment is made up of two components, the organic chemicals and the inorganic chemicals. The emission rates for organic chemicals are taken from RPP-14841. The emission rates for inorganic chemicals are taken from HNF-SD-WM—TI-707.

To estimate the potential noncarcinogenic effects from exposure to multiple chemicals, the HI approach was used consistent to EPA methodology that was used in DOE/EIS-0189 and DOE/RL-98-72. The HI is defined as the summation of the inhalation HQ (chemical concentration divided by the reference concentration [RfC] for that chemical). This HI was calculated as follows:

$$HI = \sum \frac{C_{chemical}}{RfC_{chemical}} \qquad (8\text{-}2)$$

where:

HI is the cumulative hazard index for acute exposure

$C_{chemical}$ is the concentration at the exposure point of each chemical (mg/m^3)

$RfC_{chemical}$ is the reference concentration of the chemical from the EPA IRIS database (mg/m^3).

A total HI less than or equal to 1.0 is indicative of acceptable levels of exposure.

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9.0 SHORT-TERM HUMAN HEALTH RISK CALCULATION

Short-term human health risk calculation will be based on RPP-14590. That report evaluates closure activities for C-106 with its current inventory and schedule. This section provides the calculation detail and results for the short-term human health risk analysis. The analysis focuses on two evaluation cases involving:

- Phase I grouting* of C-106
- Phase I grouting* of the worst-case 200-series tank in the C farm, except where otherwise noted.

9.1 OCCUPATIONAL ACCIDENT RISK CALCULATION

The potential exists for accidents (e.g., cuts, falls) to occur resulting from construction and operation activities associated with component closure (i.e., tank closure). The occupational injuries, illnesses, and fatalities resulting from potential accidents are calculated based on the following assumptions:

- C-106 labor requirements for Phase I grouting* of the tank

  Phase I grouting* of tank = 3,800 hours

  Phase I grouting* of all C farm tanks = 60,800 hours.

- Hanford-specific incidence rates for occupational accidents

  Total recordable cases = 1.93×10^{-5} total recordable cases/hour

  Lost workday cases = 8.04×10^{-6} lost workday cases/hour

  Fatalities = 1.35×10^{-8} fatalities/hour.

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* See Preface in *SST System Closure Plan* (RPP-13774).

The number of incidences (I) resulting from potential occupational accidents is calculated using Equation 9.1 and presented in Table 39.

$$I = L \times ir \qquad (9\text{-}1)$$

Where:

I = incident
L = labor requirement (hours)
ir = incidence rates (I/hour).

Table 39. Worker Risk From Occupational Accidents

Case	Incidence	Tank	
		C-106	**All**
Phase I grouting* of C-106	TRC	7.3 E-02	NA
	LWC	3.1 E-02	NA
	Fatalities	5.1 E-05	NA
Phase I grouting* of all C farm tanks	TRC	NA	1.2 E+00
	LWC	NA	4.9 E-01
	Fatalities	NA	8.2 E-04

LWC = lost workday case
NA = not applicable
TRC = total recordable case

9.2 RADIOLOGICAL ACCIDENT RISK

Past safety assessments were used for the radiological accident risk. A spectrum of potential accidents associated with from C-106 is reviewed in *Safety Assessment for Tank 241-C-106 Waste Retrieval Project W-320* (WHC-SD-WM-SAD-024). Several of the more bounding accidents identified in the safety assessment are summarized in Table 40. The WHC-SD-WM-SAD-024 safety assessment was used to provide the technical basis for a change to the authorization basis to allow the Project W-320 retrieval of high-heat waste from C-106 to tank AY-102 to proceed. An additional review in *Preliminary Hazard Identification and Evaluation for the Tank 241-C-106 Waste Heel Retrieval Demonstration* (10245-CD-006) identifies several more potential accidents that are not identified in WHC-SD-WM-SAD-024. These accidents are also summarized in Table 40. The ventilation failure accident with a high severity level (major onsite and offsite impacts on people) and an extremely unlikely probability (1.0×10^{-4} to 1.0×10^{-6}) was selected for evaluation in this analysis because it was determined to be a bounding accident.

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* See Preface in *SST System Closure Plan* (RPP-13774).

Table 40. Preliminary Hazard Analysis

Accident	Consequences	Mitigative/Preventive Barriers		Severity Level	Probability
		Administrative	Engineered		
Opening a riser[a]	Increases exposure to worker from direct radiation and release of radiological contaminants	Surveillance by radiation protection technician Radiological workers will wear personal protective gear while removing risers	Radiation detectors	Low	Likely
Flammable gas deflagration[b]	Energy from deflagration could compromise the tank dome or ventilation system resulting in release of radiological contaminants and exposure to the workers Potential trauma to workers from deflagration	Flammable gas control	Tank ventilation system	High	Extremely unlikely
Spray leak from transfer line[a]	Spray leak from transfer line resulting in release of radiological contaminants and exposure to the workers	Operator surveillance	Cover block over jumper pit Leak detection Radiation detectors	High	Unlikely
Ventilation failure[a]	Ventilation failure resulting in unfiltered release of radiological contaminants and exposure to the workers	Evacuation procedures	Differential pressure alarms	High	Extremely unlikely
Natural phenomena[a]	Seismic event comprises waste tank or transfers lines resulting in release of radiological contaminants and exposure to the workers	Evaluation procedures	Seismic switch on transfer pump	Medium	Extremely unlikely

[a]Accident taken from WHC-SD-WM-SAD-024.

[b]Accident taken from 10245-CD-06.

During the ventilation failure accident, a volume of waste with a concentration of radionuclides would be released to the atmosphere, dispersed in the atmosphere as it travels downwind from

the point of release, inhaled by the various receptors, and result in an LCF risk. The following assumptions were made in calculating the LCF risk:

- Volume of respirable waste released in the accident is as calculated in *Potential Accidents with Radiological and Toxicological Source Terms for Hanford Tank Waste Remediation System Environmental Impact Statement* (WHC-SD-WM-ANAL-041).
- Concentration of radionuclides is calculated from the inventory presented in DOE/ORP-2003-02 and provided in Table 8b.
- For the noninvolved workers and general public exposure scenarios, the atmospheric dispersion coefficients were calculated using the GXQ computer code (WHC-SD-GN-SWD-30002).
- For the involved workers it was assumed the respirable waste released in the accident would be released as a "puff" and spread instantaneously and uniformly around the exhaust port over a hemisphere 10 m (33 ft) in radius (WHC-SD-WM-ANAL-041).
- Breathing rates for the various receptors are provided in HNF-SD-WM-TI-707.
- Inhalation dose conversion factors for a 70-year dose commitment for each radionuclide are taken from HNF-SD-WM-TI-707.
- Dose-to-risk conversion factors for converting receptor doses to LCFs are referenced in "Preamble to Standard for Protection Against Radiation" (56 FR 23363) and ICRP (1991) and apply as follows:

  Involved worker and noninvolved worker = 4.0×10^{-4} LCF/rem for low doses under 20 rem, 8.0×10^{-4} LCF/rem for high doses over 20 rem

General public = 5.0×10^{-4} LCF/rem for low doses under 20 rem, 1.0×10^{-3} LCF/rem for doses equal to or over 20 rem.

The number of accidents is calculated by multiplying the annual frequency of the accident by the time required to perform the activity. The annual frequency of a ventilation failure accident is referenced in WHC-SD-WM-ANAL-041. The time required to close the tanks was based on RPP-14590.

It is estimated that the involved workers would receive a dose within 15 minutes from tanks C-106 and a worst-case 200-series C farm tank. The dose to the involved workers resulting from a postulated ventilation failure accident is calculated using Equation 9.2:

$$D = IQ\ (L) \times BR(m^3/s) \times t(s) \times (2/3 \times \pi r^3)^{-1} \times ULD(mrem/L) \qquad (9\text{-}2)$$

Where:

IQ = liters of respirable tank waste released, 5 L (1.3 gal)

BR = typical acute breathing rate, 3.0 E-04 m^3/s

t = duration of worker exposure, 15 minutes for C-106 and worst-case C farm 200-series tank

r = assumed radius for distribution of source activity, 10 m (33 ft)

ULD = committed EDE per unit liter inhaled of inhaled material (mrem/L) summed over the list of nuclides (i.e. $\sum$ ($IDF_{nuclide}$ x $Concentration_{nuclide}$) (IDF taken from Table A.22 from WHC-SD-WM-TI-707)

The LCF risk to the noninvolved workers and general public resulting from a postulated ventilation failure accident is calculated using Equation 0.3:

$$LCF = IQ\ (L) \times BR(m^3/s) \times \chi/Q\ (s/m^3) \times ULD\ (rem/L) \times cf\ (LCF/rem) \quad (9\text{-}3)$$

Where:

IQ = liters of respirable tank waste released, 5 L (3.7 gal)

BR = typical acute breathing rate, 3.0 E-04 m^3/s

χ/Q = atmospheric dispersion coefficient, (taken from RPP-12194)

1.13 E-02 s/m^3, noninvolved worker MEI

2.65 E-01 s/m^3, noninvolved worker population

1.34 E-05 s/m^3, general public MEI

4.86 E-02 s/m^3, general public population

ULD = committed EDE per unit liter inhaled of inhaled material (mrem/L) summed over the list of nuclides (i.e. $\sum$ ($IDF_{nuclide}$ x $Concentration_{nuclide}$) (IDF taken from Table A.22 from WHC-SD-WM-TI-707)

Cf = dose-to-risk conversion factor,

8.0 E-04 LCF/rem for the noninvolved worker receptors for doses over 20 rem

4.0 E-04 LCF/rem for the noninvolved worker receptors for doses under 20 rem,

5.0 E-04 LCF/rem for the general public receptors.

Applying Equation 9.2 for the involved worker and Equation 9.3 for the noninvolved worker and general public the LCF risk to the various receptors are calculated and summarized in Table 41.

Table 41. Latent Cancer Fatality Risk
From Ventilation Failure Accident

Receptor	**C-106**[a]	**C Farm**[b]
IW MEI	LD[c]	LD[c]
IW Pop	LD[c]	LD[c]
NIW MEI	0.17	2.7
NIW Pop	4.0	62.3
GP MEI	1.0 E-04	1.6 E-03
GP Pop	0.74	11.4

[a] LCF risk from ventilation failure accident during Phase I grouting.*
[b] LCF risk from ventilation failure accident from the worst-case tank.
[c]LD = lethal dose for involved worker within 15 minutes of exposure
GP MEI = general public maximum exposed individual.
GP Pop = general pubic population.
IW MEI = involved worker maximum exposed individual.
IW Pop = involved worker population.
LCF = latent cancer fatality.
NIW MEI = noninvolved worker maximum exposed individual.
NIW Pop = noninvolved worker population.

The values shown in Table 41 represent the statistical probability of cancer fatality resulting from exposure to radioactive material released from a ventilation failure accident. The values in Table 41 represent the most conservative case for exposure (i.e. resulting from ventilation failure accident with a extremely unlikely probability of occurring [Table 40]). In the event of an actual accident occurring, numerous safety protocols would be invoked to mitigate of the effects to the NIW MEI and population (*Tank Farms Documented Safety Analysis* [RPP-13033, Rev. 0]).

The frequency for a ventilation failure is estimated to range from 1.1×10^{-4} per year to 8.0×10^{-3} per year (WHC-SD-WM-ANAL-041). The time of Phase I grouting* is estimated to be approximately two years (RPP-14590). Therefore, the probability of the accident is calculated as follows:

$$\text{C-106 Phase I grouting}^{*} = (1.1\text{ E-04/yr}) \times (2\text{ yr}) = 2.2\text{ E-04}.$$

The point estimate risks are calculated by multiplying the receptor LCF risk by the probability of the accident occurring. The results are summarized in Table 42.

* See Preface in *SST System Closure Plan* (RPP-13774).

Table 42. Point Estimate Risk From Ventilation Failure Accident.

Case	Receptor	C-106	C Farm
Phase I Grouting*	IW MEI	2.2 E+01	1.4 E-00
	IW Pop	2.2 E+01	1.4 E-00
	NIW MEI	3.8 E-05	5.9 E-04
	NIW Pop	8.8 E-04	1.4 E-02
	GP MEI	2.3 E-08	3.5 E-07
	GP Pop	1.6 E-04	2.5 E-03

GP MEI = general public maximum exposed individual.
GP Pop = general pubic population.
IW MEI = involved worker maximum exposed individual.
IW Pop = involved worker population.
NIW MEI = noninvolved worker maximum exposed individual.
NIW Pop = noninvolved worker population.

The values shown in Table 42 represent the statistical probability of cancer fatality resulting from exposure to radioactive material released from a ventilation failure accident occurring during Phase I Grouting*. The values presented 42 represent the most conservative case for exposure (i.e. resulting from a ventilation failure accident with an extremely unlikely probability of occurring [Table 40]). In the event of an actual accident occurring, numerous safety protocols would be invoked to mitigate of the effects to the IW MEI and population and NIW MEI and population (*Tank Farms Documented Safety Analysis* (RPP-13033, Rev. 0)).

9.3 ROUTINE RADIOLOGICAL EXPOSURE RISK

The LCF risk is calculated by multiplying the dose (in units of person-rem for the population and rem for the MEI by an appropriate dose-to-risk conversion factor (in units of LCF/person-rem for the population and LCF/rem for the MEI). The involved worker population dose resulting from construction and operations is based on worker exposures to support closure of C-106 in RPP-14590. The involved worker MEI dose is based on a current site administrative control of 0.5 rem/yr (HNF-5183).

The LCF risk from routine radiological exposures to the various receptor populations and MEIs is calculated using Equation 9.4:

$$LCF = D \times cf \qquad (9\text{-}4)$$

Where:

D = Dose to the receptor (person-rem [population] or rem [MEI])

cf = Dose-to-risk conversion factor (LCF/person-rem [population] or LCF/rem [MEI]).

* See Preface in *SST System Closure Plan* (RPP-13774).

The dose to the involved worker population for the Phase I grouting* of C-106 is based on (RPP-14590). The dose from Phase I grouting* is estimated as follows:

Phase I grouting for C-106 – The dose is equal to the sum of the doses from the following activities (RPP-14590) and is typical for only C-106.

6.13 person-mrem; riser installation

+ 3.71 person-mrem; Phase I grouting*

= 9.84 person-mrem; total dose

Phase I grouting* of worst-case 200-series tank – The dose is equal to the sum of the doses from the following activities (RPP-14590) and is typical for only C-106.

6.13 person-mrem; riser installation

+ 3.71 person-mrem; Phase I grouting*

= 9.84 person-mrem; total dose

The dose to the non-involved workers and general public are based on air emissions that are scaled from the abated air emissions and presented in Table 43.

Table 43. Abated Air Emissions from Retrieval Activities.

Radionuclide	**Abated Air Emissions (Ci/yr)**	
	C-106	**Worst-Case Composite Tank**
C-14	6.4 E-12	5.2 E-09
Co-60	1.9 E-10	8.5 E-07
Sr-90	2.2 E-04	6.9 E-03
Technetium-99	8.0 E-10	9.1 E-08
Iodine-129	6.4 E-12	4.3 E-10
Cs-137	8.9 E-06	4.1 E-04
Pu-239	5.8 E-08	5.0 E-06
Pu-240	1.2 E-08	7.7 E-07
Am-241	1.8 E-07	5.5 E-06

Note: Tank inventory was based on DOE/ORP-2003-02.

* See Preface in *SST System Closure Plan* (RPP-13774).

The radionuclides released in the abated air emissions are then used as input to the GENII computer code (PNL-6584) to calculate the dose. The atmospheric dispersion coefficients for exposures used in the GENII code that are calculated using the GXQ computer code are summarized as follows:

- Noninvolved worker MEI = 4.0×10^{-4} s/m^3
- Noninvolved worker population = 1.8×10^{-2} s/m^3
- General public MEI = 1.0×10^{-7} s/m^3
- General public population = 2.9×10^{-3} s/m^3.

These values are chronic and calculated from extensive meteorological data. The doses generated from the GENII computer code for the Phase I grouting* are presented in Table 44.

Table 44. Dose From Routine Radiological Exposure

Receptor	C-106 (mrem/yr)	Worst-Case Composite Tank (mrem/yr)	Regulatory Limit (mrem/yr)
	Dose (person-mrem/yr for population or mrem/yr for MEI)		
NIW MEI	4.4 E-01	1.8 E+01	5,000
NIW Pop	1.0 E+01	4.3 E+02	NA
GP MEI	5.2 E-04	2.2 E-02	100
GP Pop	1.9 E+00	7.9 E+01	NA

GP MEI = general public maximum exposed individual.
GP Pop = general public population.
NIW MEI = noninvolved worker maximum exposed individual.
NIW Pop = noninvolved worker population.

Applying Equation 9.4 with the appropriate dose values estimated for the Phase I grouting* and using the appropriate dose-to-risk conversion factors, the LCF risk to the various receptor populations and MEIs are calculated and presented in Table 45.

* See Preface in *SST System Closure Plan* (RPP-13774).

Table 45. Latent Cancer Fatality Risk
From Routine Radiological Exposure

Receptor	C-106 (LCF/yr)	Worst-Case Composite Tank (LCF/yr)
IW MEI	2.0 E-04	2.0 E-04
IW Pop	4.0 E-06[2]	4.0 E-06
NIW MEI	1.8 E-07	7.2 E-06
NIW Pop	4.0 E-06	1.7 E-04
GP MEI	2.6 E-10	1.1 E-08
GP Pop	9.5 E-07	4.0 E-05

[1] Dose used for involved worker MEI was 500 mrem/yr
[2] Dose used for IW population was 9.84 person-mrem/yr.
GP MEI = general public maximum exposed individual.
GP Pop = general public population.
IW MEI = involved worker maximum exposed individual.
IW Pop = involved worker population.
NA = not applicable.
NIW MEI = noninvolved worker maximum exposed individual.
NIW Pop = noninvolved worker population.

9.4 CHEMICAL ACCIDENTS RISKS

The chemical inventory is presented in Table 46 and represents the same inventory as used in RPP-14841. The chemical inventory is from tank C-204. Organic pollutant release concentrations and ammonia release concentrations were calculated assuming that 900 m3/hr of air containing the pollutant concentrations observed in tank C-204 are exhausted year around. In addition the mean concentrations of the organic pollutant and ammonia release were increased by 2 times the standard deviation to reflect statistical variability in the results. Two times the standard deviation represents a 95 percent confidence that the actual concentration is bounded. Therefore, the results for the cumulative hazards or the acute hazard index is extremely conservative. The cumulative hazards or the acute hazard index (HI) for chemicals was evaluated using the following equation.

$$HI = \sum \frac{C_{chemical}}{ERPG_{chemical}}$$

Where:

HI is the cumulative hazard index for acute exposure

$C_{chemical}$ is the concentration at the exposure point of each chemical (mg/m3)

$ERPG_{chemical}$ is the ERPG (or TEEL if no ERPG available) for each chemical (mg/m3).

A cumulative HI is calculated for each ERPG/TEEL level (1, 2, and 3). If the HI is greater than 1.0 indicates that the acute hazard guidelines for a mixture of chemicals has been exceeded and the chemical mixture may pose a potential acute health impact. Table 46 shows the results of the accident hazard index.

Table 46. Chemical Risk from Accident – Hazard Index.

Activity	TEEL-0	TEEL-1	TEEL-2	TEEL-3
Involved Worker	1.86 E+01	7.09 E+00	1.02 E+00	6.63 E-02
Noninvolved Worker	5.25 E-02	2.00 E-02	2.98 E-03	1.94 E-04

For the involved worker, TEEL-2 is the corresponding potential health impact. For the noninvolved worker and general public, TEEL-0 is the corresponding health impact. The general public MEI would be exposed to concentrations less than the ERPG-1 threshold values, which translates to no expected health effects.

9.5 ROUTINE CHEMICAL EXPOSURE

Routine chemical exposure from noncarcinogenic chemicals were evaluated. Table 47 presents the noncarcinogenic health impacts as hazard index for all the chemicals with reference inhalation dose factors.

Table 47. Chemical Noncarcinogenic Hazard Index[(1)].

CAS	Name	Reference Concentration RfC (mg/m^3)	Hazard Quotient HQ
7440-47-3	Cromium(VI) [(2)]	1 E-04	4.6 E-05
7439-97-6	Mercury	3 E-04	3.3 E-06
7439-96-5	Manganese	5 E-05	3.3 E-03
100-41-4	Ethyl benzene	1 E+00	1.2 E-02
106-99-0	Butadiene,1,3-	2 E-03	5.1 E+02
108-10-1	Methyl isobutyl ketone; (Hexone)	3 E+00	8.5 E-03
108-88-3	Benzene, methyl (Toluene)	4 E-01	4.5 E-01
110-54-3	Hexane	2 E-01	2.5 E-01
110-82-7	Cyclohexane	6 E+00	1.0 E-02
71-43-2	Benzene	3 E-02	4.0 E-01
74-87-3	Methyl chloride	9 E-02	1.5 E-01
75-05-8	Acetonitrile	6 E-02	5.8 E+00
75-07-0	Acetaldehyde	2.2 E-03	1.2 E+02

Table 47. Chemical Noncarcinogenic Hazard Index[(1)].

CAS	Name	Reference Concentration RfC (mg/m^3)	Hazard Quotient HQ
75-68-3	Chloro-1,1-difluoroethane, 1-; (HCFC-142b)	5 E+01	1.8 E-02
7664-41-7	Ammonia	1 E-01	6.7 E-03
78-93-3	Butanone, 2-; (MEK)	5 E+00	1.3 E-01
Total Hazard Index (HI):			**6.4 E+02**

[(1)] For convenience only the substances with available RfC are listed.
[(2)] 33% of total Chromium assumed to be Cr(VI)

The hazard quotients (HQs) calculated here are based on conservative maximum emission concentrations from the C Farm tanks as listed in RPP-14841. These estimates were developed to describe a maximum anticipated emissions concentration for each chemical species for which there was data. This data represents the HI to the IW MEI without any mitigation. Current tank farm safety protocols require respiratory protection which would mitigate the exposure and risk to the IW MEI.

10.0 SUMMARY AND CONCLUSIONS

The scope of this initial closure risk assessment was to provide estimates of short- and long-term human health risks related to closure activities and the anticipated endstate conditions at WMA C. Additionally, this document is being prepared before any waste retrieval to support closure has been performed. Therefore, the focus of this document was not only to provide estimates of short- and long- term human health risks using existing data, but also to present the methods, procedures, existing data, and analysis approaches.

This report concludes that residual tank waste alone contributes to a concentration of 66 pCi/L for technetium-99 and 0.14 pCi/L for iodine-129 (Table 38). The calculated peak residential drinking water dose for all beta/photon emitters, is 0.097 mrem in a year (Table 29) at the WMA C fenceline with the peak occurring approximately 3,500 years after closure. Technetium-99 and iodine-129 make up approximately 90 % of the dose. This dose is below the DOE Order 5400.5 (II)(d) value of 4 mrem in a year. The simulated peak concentration at the WMA C fenceline attributed to unplanned releases and hypothetical retrieval leaks for technetium-99 is 497 pCi/L and 416 pCi/L (table 38), respectively, while the peak concentration for iodine-129 for those same sources is 0.96 pCi/L and 0.82, respectively (Table 38). The calculated peak residential drinking water dose for these sources is 0.8 mrem in a year (Table 32) and 0.62 mrem in a year (table 35), respectively.

As one moves downgradient from the WMA C fenceline to the 200 Area core zone boundary (2,900 m from the WMA C fenceline) and the Columbia River (14,300 m from the WMA C fenceline), the simulated peaks (concentration, dose, ILCR, and HI) drop by a factor of approximately 6 (Core Zone Boundary and 18 (Columbia River).

10.1 LONG-TERM HUMAN HEALTH RISK

This preliminary risk assessment highlights analyses and findings when data is sufficient and identifies gaps in existing data. Reasonable assumptions have been made, of necessity, when the data is insufficient or absent to enable the long-term human health risks to be estimated for C farm and tentative conclusions to be drawn. Implications of the conclusions on retrieval are included.

Where the data is insufficient or absent, additional data collection should be accomplished before preparation of the risk assessment after closure. Such additional data should improve the accuracy of analyses after closure, and strengthen the analyses and conclusions in the post-closure document.

10.1.1 C Waste Management Area Risk

Assumptions

Conclusions concerning risk are based on the simulation of COCs released from the entire closed WMA C incorporate the following major assumptions:

- A surface water infiltration barrier that lasts 500 years is present at the end of tank closure.
- Residual tank waste contents are based on selected phase retrieval to the HFFACO goal of 360 ft^3 for the 100-series tanks and 30 ft^3 for the 200-series tanks.
- Tanks are filled with a cement-based grout*.
- Long-term infiltration returns to desert conditions (3.5 mm/yr) (after 500 years).

Related Data Gaps

- BBI data has been used to represent the concentrations of contaminants that are expected to be present in the C farm tanks after interim closure. The representativeness of this data can only be confirmed by sampling and analysis performed after retrieval.
- Concentration of retrieval leaks is calculated based on hypothetical leak volumes divided by the estimated total volume of fluids used for retrieval and the multiplying by the total BBI for the tank.
- Data on contaminant concentrations in the vadose zone at C farm has been obtained from various existing sources. Detailed analysis of contamination in the vadose zone at C farm will be provided in a field investigation report for C farm. This report will incorporate new data obtained from future characterization drilling. The C farm field investigation report is scheduled for completion in fiscal year 2006.
- The hydraulic conductivity of the unconfined aquifer is based on both laboratory measurements and field-testing in other parts of the 200 East Area. Site-specific hydraulic conductivity of the unconfined aquifer in the vicinity of WMA C is not presently available. However, RCRA monitoring well, which penetrates to the base of the aquifer, will be placed just to the north of the WMA in the summer of 2003. During the development of this well, an estimate of the hydraulic conductivity of the unconfined aquifer will be made.

Conclusions

- The primary contributors to groundwater contamination are contaminants contained in past leaks from tanks and ancillary equipment and that have K_d = 0.0 mg/L.
- The placement of the surface barrier greatly reduces recharge through vadose contamination, which results in a decrease in the predicted groundwater concentration until the barrier degrades.

* See Preface in *SST System Closure Plan* (RPP-13774).

- Key parameters affecting the predicted groundwater contaminant concentrations resulting from tank residual waste releases are inventory, groundwater flow rate under the WMA, recharge, release rate, and contaminant mobility (i.e., K_d).

- Past leaks potentially have the largest impact (depending upon inventory).

- Retrieval of tank residuals to levels at or near the HFFACO goal of 360 ft^3(100-series tanks) and 30 ft^3 (200-series tanks) can reduce fenceline concentrations to below the MCL or MCL derived constituent concentration.

- The foundation for the risk assessment calculations presented in this document is the inventory established by the BBI, which is based on both process knowledge and sampling data. Over time as more knowledge about a tank becomes available, the inventory estimates for a tank are updated. In some cases, this has led to significant changes in inventory values. Post-retrieval sampling and analysis of residuals must be made to further assess the risk associated with the residuals. The risk assessment presented here could easily over/under estimate the risk without this information.

10.1.2 Tank Waste Release Mechanism

The retrieval approach determines the contaminant release mechanism of the remaining waste in each tank at C farm. Thus, the retrieval approach selected directly affects the long-term human health risk assessment.

Assumptions

- The impacts of three tank waste release mechanisms were simulated because the stabilized waste form for each tank in C farm has not been determined. Simulations chosen were:

  A diffusion-dominated release mechanism corresponding to a stabilized waste form covered with grout or cementitious grout*.

  An advection-dominated release mechanism corresponding to an unstabilized waste form covered with sand and gravel backfill.

  A solubility-dominated mechanism corresponding to a material that releases risk driving contaminants congruently with the dissolution of the waste form, such as saltcake releases.

- The diffusion-dominated release mechanism is assumed to be the release mechanism.

* See Preface in *SST System Closure Plan* (RPP-13774).

Related Data Gaps

- The waste form that will remain in each of the C farm tanks is continuing to be evaluated through engineering and regulatory reviews.
- There is minimal laboratory data for the C farm tanks that is available to support the choice of the three release models included in this risk document.

Conclusions

- The residual waste inventory has a dominant influence on the second peak concentration at the fenceline. If the inventory is contained within the aqueous phase of the waste form, and the release from the waste form is advection-dominated, the peak concentration based on the BBI is 9,640 pCi/L (Figure 11a) for technetium-99, With retrieval to HFFACO limits, the resulting peak concentration is 210 pCi/L (Figure 11b) for the advection dominated model. The MCL Derived Constituent Concentration for technetium-99 is 900 pCi/L
- If the release mechanism is diffusion-dominated, retrieving waste to HFFACO goals reduces the technetium-99 concentration from 3030 pCi/L (Figure 11a) to 65 pCi/L (Figure 11b).

Implications to Retrieval and Closure

Determining the type of release form of waste from each C farm tank is important in direct proportion to the amount of waste that remains in the tank after waste retrieval. The more waste left behind, the more important the release model becomes.

10.1.3 Quantitative Dose and Risk Estimates

Comparison of the dose and risk estimates with the performance objectives show that the performance objectives are satisfied in all, but a few cases. Larger values occur for wastes containing the largest inventories of mobile constituents (past leaks) and for groundwater collected closest to the WMA C fenceline. DOE/RL-91-45 industrial and residential exposure scenarios were used for this analysis.

Conclusions

- Following retrieval of tank waste to meet the maximum residual specified in the HFFACO, known past leaks are responsible for the largest peak values for dose and cancer risk (Figures 25 and 27).
- Radiological dose does not exceed the performance objected for any of the sources at the WMA C fenceline (Figure 27).
- ILCR exceeded the target value of 1.00×10^{-5} for tank residuals at the WMA C fenceline, but not at downgradient Core Zone Boundary or at the Columbia River for DOE/RL-91-45 residential receptor with technetium-99 responsible for the majority of

the estimated risk. For unplanned releases ILCR was below the target value of 1.00×10^{-5} for the industrial scenario, but not the residential scenario, which was above the target value at the fenceline, core zone boundary, and Columbia River. For hypothetical retrieval leaks, ILCR was below the target value of 1.00×10^{-5} for the industrial scenario, but not the residential scenario, which was above the target value at the fenceline, and core zone boundary, but not the Columbia River (Tables 30, 33, and 36)

- Hazard Index did not exceed the target value for residual waste, past unplanned releases or hypothetical retrieval leaks for any of the scenarios presented (Tables (31, 34, and 37)

10.2 SHORT-TERM HUMAN HEALTH RISK

The short-term human health risk analysis estimated the potential health impacts from both accident and normal (nonaccident) conditions resulting from various scenarios for C-106 and the C farm during closure activities. However, at this point in time, a safety analysis that identifies accident scenarios for closure activities has not been prepared. The analysis provided in this paper was to show the methodology and calculations, which will be used in a short-term human health risk assessment. It uses the safety analysis completed for retrieval of wastes from tanks for its accident scenarios.

Assumptions

For occupational injuries, illnesses, and fatalities resulting from potential accidents are calculated based on the following assumptions:

- C-106 labor requirements for Phase I grouting* of the tank
  - Phase I grouting* of tank = 3,800 hours
  - Phase I grouting* of all C farm tanks = 60,800 hours.
- Hanford-specific incidence rates for occupational accidents
  - Total recordable cases = 1.93×10^{-5} total recordable cases/hour
  - Lost workday cases = 8.04×10^{-6} lost workday cases/hour

  Fatalities = 1.35×10^{-8} fatalities/hour.

In calculating the radiological LCF risk from routine exposure approach risk, the following assumptions were made:

- Volume of respirable waste released in the accident is as calculated in WHC-SD-WM-ANAL-041.

* See Preface in *SST System Closure Plan* (RPP-13774).

- Concentration of radionuclides is calculated from the inventory presented in DOE/ORP-2003-02 and provided in Table 8.

- For the noninvolved workers and general public exposure scenarios, the atmospheric dispersion coefficients were calculated using the GXQ computer code (WHC-SD-GN-SWD-30002).

- For the involved workers it was assumed the respirable waste released in the accident would be released as a "puff" and spread instantaneously and uniformly around the exhaust port over a hemisphere 10 m (30 ft) in radius (WHC-SD-WM-ANAL-041).

- Breathing rates for the various receptors are provided in HNF-SD-WM-TI-707.

- Inhalation dose conversion factors for a 50-year dose commitment for each radionuclide are taken from HNF-SD-WM-TI-707.

- Dose-to-risk conversion factors for converting receptor doses to LCFs are referenced in 56 FR 23363 and ICRP (1991) and apply as follows:

  Involved worker and noninvolved worker = 4.0×10^{-4} LCF/rem for low doses under 20 rem, 8.0×10^{-4} LCF/rem for high doses over 20 rem

  General public = 5.0×10^{-4} LCF/rem for low doses under 20 rem, 1.0×10^{-3} LCF/rem for doses equal to or over 20 rem.

The number of accidents is calculated by multiplying the annual frequency of the accident by the time required to perform the activity. The annual frequency of a ventilation failure accident is referenced in WHC-SD-WM-ANAL-041. The time required to close the tanks was based on RPP-14590.

In calculating the chemical hazard index from accident and routine exposure approach, the following assumptions were made:

- The chemical inventory used for these assessments were made up of two components, the organic chemicals and the inorganic chemicals. The emission rates for organic chemicals are taken from *Organic Vapor Source Term for Tanks 241-C-201, 241-C-202, 241-C-203, and 241-C-204 During Waste Retrieval Operations*, RPP-14841.

- Organic pollutant release concentrations and ammonia release concentrations were calculated assuming that 900 m3/hr of air containing the pollutant concentrations observed in tank C-204 are exhausted year around.

- The mean concentrations of the organic pollutant and ammonia release were increased by 2 times the standard deviation to reflect statistical variability in the results. Two times the standard deviation represents a 95 percent confidence that the actual concentration is bounded.

- Only 33% of total chromium was assumed to be chromium(VI).

Related Data Gaps

- A safety analysis of tank closure activities at C farm has not been performed. Consequently, safety data from other tank farm construction and operation activities for past component retrieval are used to approximate short-term risk at C farm.

Conclusions

- In no case is the administrative control level of 0.5 rem/yr for a worker exceeded under routine conditions.

- In no case are the standards for routine exposure of the public of 0.1 rem/yr exceeded.

- In all cases the acute exposure limit of 5.0 rem to an involved worker (located at 10 m [33 ft] from the point of release) from a radiological accident with an extremely unlikely probability of occurrence ($>10^{-6}$ to $\leq 10^{-4}$) would be exceeded. Mitigative measures are currently employed to reduce this accident. However, the assumptions used in calculating this probability are extremely conservative.

- In no case would there be a fatality from occupational accidents.

- In all cases, there would be at least one total recordable case for closing all C farm tanks.

- Short-term radiation risk to the public for closure activities, expressed as LCFs, is very small, and the order of 1.0×10^{-10} LCF.

- Conservative chemical accident impacts do not exceed the TEEL/ERPG-3 threshold for the involved worker, however small refinements to the methodology may allow the impacts to meet the TEEL/ERPG-2 threshold as the current estimate exceeds the threshold values by only 2 percent. The impacts to the non-involved worker and the general public would not exceed the TEEL-0 threshold, of no impact.

- Total Hazard Index exceeded 1.0 for routine chemical exposure.

Implications to Closure

- A safety analysis of potential tank closure activities at C farm should be prepared.

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ADDENDUM C-2

SIMULATED GROUNDWATER CONCENTRATIONS AND RESULTANT ESTIMATED RISK AND HAZARD INDEX FOR SELECTED CONSTITUENTS IN WMA C

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1.0 URANIUM

Table 1-1. Simulated Peak Concentrations and Arrival Times for Uranium at Various Boundaries.

Uranium Concentration (mg /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.2E-04	12000	7.8E-05	12000	6.3E-06
Past Tank Leaks	12000	3.2E-06	12000	2.3E-06	12000	2.8E-07
Past Ancillary Equipment Leaks	12000	5.2E-06	12000	3.4E-06	12000	2.1E-07
Residual Tank Unlimited Advection Release	12000	2.6E-04	12000	1.6E-04	12000	4.1E-06
Residual Tank Release Limited to Diffusion	12000	1.5E-05	12000	8.7E-06	12000	1.8E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	5.8E-09	12000	3.4E-09	12000	6.9E-11
Residual Ancillary Pipeline Release Limited to Diffusion	12000	4.2E-08	12000	2.4E-08	12000	3.2E-10
Post-Retrieval						
Residual Tank Unlimited Advection Release	12000	5.1E-06	12000	3.1E-06	12000	7.9E-08
Residual Tank Release Limited to Diffusion	12000	2.9E-07	12000	1.7E-07	12000	3.4E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	5.8E-09	12000	3.4E-09	12000	6.9E-11
Residual Ancillary Pipeline Release Limited to Diffusion	12000	4.2E-08	12000	2.4E-08	12000	3.2E-10

Table 1-2. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries All Pathways Farmer -- Groundwater Only.

Uranium (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	6.3E-03	12000	4.3E-03	12000	3.5E-04
Past Tank Leaks	12000	1.8E-04	12000	1.3E-04	12000	1.5E-05
Past Ancillary Equipment Leaks	12000	2.9E-04	12000	1.9E-04	12000	1.1E-05
Unlimited Advection Release	12000	1.4E-02	12000	8.6E-03	12000	2.2E-04
Release Limited to Diffusion	12000	8.1E-04	12000	4.8E-04	12000	9.6E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	3.2E-07	12000	1.9E-07	12000	3.8E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	2.3E-06	12000	1.3E-06	12000	1.8E-08
Post-Retrieval						
Unlimited Advection Release	12000	2.8E-04	12000	1.7E-04	12000	4.3E-06
Release Limited to Diffusion	12000	1.6E-05	12000	9.3E-06	12000	1.9E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	3.2E-07	12000	1.9E-07	12000	3.8E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	2.3E-06	12000	1.3E-06	12000	1.8E-08

Table 1-3. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries Native American -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.6E-02	12000	1.1E-02	12000	8.5E-04
Past Tank Leaks	12000	4.4E-04	12000	3.1E-04	12000	3.8E-05
Past Ancillary Equipment Leaks	12000	7.1E-04	12000	4.7E-04	12000	2.8E-05
Unlimited Advection Release	12000	3.5E-02	12000	2.1E-02	12000	5.5E-04
Release Limited to Diffusion	12000	2.0E-03	12000	1.2E-03	12000	2.4E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	7.9E-07	12000	4.6E-07	12000	9.3E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	5.7E-06	12000	3.2E-06	12000	4.3E-08
Post-Retrieval						
Unlimited Advection Release	12000	6.8E-04	12000	4.1E-04	12000	1.1E-05
Release Limited to Diffusion	12000	3.9E-05	12000	2.3E-05	12000	4.6E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	7.9E-07	12000	4.6E-07	12000	9.3E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	5.7E-06	12000	3.2E-06	12000	4.3E-08

Table 1-4. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries HSRAM Industrial.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.9E-03	12000	1.3E-03	12000	1.0E-04
Past Tank Leaks	12000	5.3E-05	12000	3.8E-05	12000	4.6E-06
Past Ancillary Equipment Leaks	12000	8.6E-05	12000	5.7E-05	12000	3.4E-06
Unlimited Advection Release	12000	4.3E-03	12000	2.6E-03	12000	6.7E-05
Release Limited to Diffusion	12000	2.5E-04	12000	1.4E-04	12000	2.9E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	9.6E-08	12000	5.7E-08	12000	1.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	7.0E-07	12000	3.9E-07	12000	5.3E-09
Post-Retrieval						
Unlimited Advection Release	12000	8.4E-05	12000	5.1E-05	12000	1.3E-06
Release Limited to Diffusion	12000	4.8E-06	12000	2.8E-06	12000	5.6E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	9.6E-08	12000	5.7E-08	12000	1.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	7.0E-07	12000	3.9E-07	12000	5.3E-09

Table 1-5. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries HSRAM Recreational -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	2.4E-04	12000	1.6E-04	12000	1.3E-05
Past Tank Leaks	12000	6.6E-06	12000	4.7E-06	12000	5.7E-07
Past Ancillary Equipment Leaks	12000	1.1E-05	12000	7.1E-06	12000	4.2E-07
Unlimited Advection Release	12000	5.3E-04	12000	3.2E-04	12000	8.3E-06
Release Limited to Diffusion	12000	3.0E-05	12000	1.8E-05	12000	3.6E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	1.2E-08	12000	7.0E-09	12000	1.4E-10
Residual Ancillary Pipeline Release Limited to Diffusion	12000	8.6E-08	12000	4.8E-08	12000	6.5E-10
Post-Retrieval						
Unlimited Advection Release	12000	1.0E-05	12000	6.2E-06	12000	1.6E-07
Release Limited to Diffusion	12000	5.9E-07	12000	3.5E-07	12000	7.0E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	1.2E-08	12000	7.0E-09	12000	1.4E-10
Residual Ancillary Pipeline Release Limited to Diffusion	12000	8.6E-08	12000	4.8E-08	12000	6.5E-10

Table 1-6. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries HSRAM Residential -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.3E-02	12000	9.0E-03	12000	7.3E-04
Past Tank Leaks	12000	3.7E-04	12000	2.7E-04	12000	3.2E-05
Past Ancillary Equipment Leaks	12000	6.0E-04	12000	4.0E-04	12000	2.4E-05
Unlimited Advection Release	12000	3.0E-02	12000	1.8E-02	12000	4.7E-04
Release Limited to Diffusion	12000	1.7E-03	12000	1.0E-03	12000	2.0E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	6.7E-07	12000	4.0E-07	12000	8.0E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	4.9E-06	12000	2.7E-06	12000	3.7E-08
Post-Retrieval						
Unlimited Advection Release	12000	5.8E-04	12000	3.5E-04	12000	9.1E-06
Release Limited to Diffusion	12000	3.3E-05	12000	2.0E-05	12000	3.9E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	6.7E-07	12000	4.0E-07	12000	8.0E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	4.9E-06	12000	2.7E-06	12000	3.7E-08

Table 1-7. Simulated Peak Hazard Index and Arrival Times for Uranium at Various Boundaries HSRAM Agricultural -- Groundwater Only.

Uranium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	12000	1.4E-02	12000	9.2E-03	12000	7.4E-04
Past Tank Leaks	12000	3.8E-04	12000	2.7E-04	12000	3.3E-05
Past Ancillary Equipment Leaks	12000	6.1E-04	12000	4.1E-04	12000	2.4E-05
Unlimited Advection Release	12000	3.1E-02	12000	1.9E-02	12000	4.8E-04
Release Limited to Diffusion	12000	1.7E-03	12000	1.0E-03	12000	2.1E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	6.8E-07	12000	4.0E-07	12000	8.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	5.0E-06	12000	2.8E-06	12000	3.8E-08
Post-Retrieval						
Unlimited Advection Release	12000	5.9E-04	12000	3.6E-04	12000	9.3E-06
Release Limited to Diffusion	12000	3.4E-05	12000	2.0E-05	12000	4.0E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	12000	6.8E-07	12000	4.0E-07	12000	8.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	12000	5.0E-06	12000	2.8E-06	12000	3.8E-08

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2.0 TECHNETIUM-99

Table 2-1. Simulated Peak Concentrations and Arrival Times for Technetium 99 at Various Boundaries.

Technetium-99 Concentration (pCi /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.2E+02	2107	6.6E+01	2324	2.2E+01
Past Tank Leaks	2092	1.6E+02	2117	2.5E+01	2333	8.5E+00
Past Ancillary Equipment Leaks	2117	3.5E+02	2141	5.6E+01	2355	2.0E+01
Residual Tank Unlimited Advection Release	4653	9.6E+03	4676	1.5E+03	4883	5.6E+02
Residual Tank Release Limited to Diffusion	5614	3.0E+03	5637	4.7E+02	5839	1.8E+02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E+00	5637	2.1E-01	5839	7.7E-02
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.4E+00	4925	1.1E+00	5130	4.2E-01
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	2.1E+02	4676	3.3E+01	4883	1.2E+01
Residual Tank Release Limited to Diffusion	5614	6.6E+01	5637	1.0E+01	5839	3.8E+00
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E+00	5637	2.1E-01	5839	7.7E-02
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.4E+00	4925	1.1E+00	5130	4.2E-01

Table 2-2. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries All Pathways Farmer -- Groundwater Only.

Technetium-99 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.9E-04	2107	4.6E-05	2324	1.5E-05
Past Tank Leaks	2092	1.1E-04	2117	1.7E-05	2333	5.9E-06
Past Ancillary Equipment Leaks	2117	2.5E-04	2141	3.9E-05	2355	1.4E-05
Unlimited Advection Release	4653	6.7E-03	4676	1.1E-03	4883	3.9E-04
Release Limited to Diffusion	5614	2.1E-03	5637	3.3E-04	5839	1.2E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.3E-07	5637	1.4E-07	5839	5.4E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.2E-06	4925	8.0E-07	5130	3.0E-07
Post-Retrieval						
Unlimited Advection Release	4653	1.5E-04	4676	2.3E-05	4883	8.3E-06
Release Limited to Diffusion	5614	4.6E-05	5637	7.1E-06	5839	2.6E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.3E-07	5637	1.4E-07	5839	5.4E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.2E-06	4925	8.0E-07	5130	3.0E-07

Table 2-3. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries Native American -- Groundwater Only.

Technetium-99 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.0E-03	2107	3.2E-04	2324	1.1E-04
Past Tank Leaks	2092	7.6E-04	2117	1.2E-04	2333	4.1E-05
Past Ancillary Equipment Leaks	2117	1.7E-03	2141	2.7E-04	2355	9.8E-05
Unlimited Advection Release	4653	4.7E-02	4676	7.3E-03	4883	2.7E-03
Release Limited to Diffusion	5614	1.5E-02	5637	2.3E-03	5839	8.6E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.5E-06	5637	1.0E-06	5839	3.7E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.6E-05	4925	5.6E-06	5130	2.1E-06
Post-Retrieval						
Unlimited Advection Release	4653	1.0E-03	4676	1.6E-04	4883	5.8E-05
Release Limited to Diffusion	5614	3.2E-04	5637	5.0E-05	5839	1.8E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.5E-06	5637	1.0E-06	5839	3.7E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.6E-05	4925	5.6E-06	5130	2.1E-06

Table 2-4. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries HSRAM Industrial.

Technetium-99 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.7E-06	2107	9.1E-07	2324	3.0E-07
Past Tank Leaks	2092	2.1E-06	2117	3.4E-07	2333	1.2E-07
Past Ancillary Equipment Leaks	2117	4.9E-06	2141	7.7E-07	2355	2.8E-07
Unlimited Advection Release	4653	1.3E-04	4676	2.1E-05	4883	7.7E-06
Release Limited to Diffusion	5614	4.2E-05	5637	6.5E-06	5839	2.4E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.8E-08	5637	2.9E-09	5839	1.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.0E-07	4925	1.6E-08	5130	5.8E-09
Post-Retrieval						
Unlimited Advection Release	4653	2.9E-06	4676	4.5E-07	4883	1.7E-07
Release Limited to Diffusion	5614	9.0E-07	5637	1.4E-07	5839	5.2E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.8E-08	5637	2.9E-09	5839	1.1E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.0E-07	4925	1.6E-08	5130	5.8E-09

Table 2-5. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries HSRAM Recreational Groundwater Only.

Technetium-99 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.8E-07	2107	7.7E-08	2324	2.6E-08
Past Tank Leaks	2092	1.8E-07	2117	2.9E-08	2333	9.9E-09
Past Ancillary Equipment Leaks	2117	4.1E-07	2141	6.5E-08	2355	2.3E-08
Unlimited Advection Release	4653	1.1E-05	4676	1.8E-06	4883	6.4E-07
Release Limited to Diffusion	5614	3.5E-06	5637	5.5E-07	5839	2.0E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-09	5637	2.4E-10	5839	8.9E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.6E-09	4925	1.3E-09	5130	4.9E-10
Post-Retrieval						
Unlimited Advection Release	4653	2.4E-07	4676	3.8E-08	4883	1.4E-08
Release Limited to Diffusion	5614	7.6E-08	5637	1.2E-08	5839	4.4E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-09	5637	2.4E-10	5839	8.9E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.6E-09	4925	1.3E-09	5130	4.9E-10

Table 2-6. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries HSRAM Residential Groundwater Only.

Technetium-99 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.4E-04	2107	2.2E-05	2324	7.4E-06
Past Tank Leaks	2092	5.2E-05	2117	8.3E-06	2333	2.9E-06
Past Ancillary Equipment Leaks	2117	1.2E-04	2141	1.9E-05	2355	6.7E-06
Unlimited Advection Release	4653	3.2E-03	4676	5.1E-04	4883	1.9E-04
Release Limited to Diffusion	5614	1.0E-03	5637	1.6E-04	5839	5.9E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.5E-07	5637	7.0E-08	5839	2.6E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.5E-06	4925	3.8E-07	5130	1.4E-07
Post-Retrieval						
Unlimited Advection Release	4653	7.0E-05	4676	1.1E-05	4883	4.0E-06
Release Limited to Diffusion	5614	2.2E-05	5637	3.4E-06	5839	1.3E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.5E-07	5637	7.0E-08	5839	2.6E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.5E-06	4925	3.8E-07	5130	1.4E-07

Table 2-7. Simulated Peak Risk and Arrival Times for Technetium-99 at Various Boundaries HSRAM Agricultural Groundwater Only.

Technetium-99 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.0E-04	2107	3.1E-05	2324	1.0E-05
Past Tank Leaks	2092	7.3E-05	2117	1.2E-05	2333	4.0E-06
Past Ancillary Equipment Leaks	2117	1.7E-04	2141	2.6E-05	2355	9.5E-06
Unlimited Advection Release	4653	4.6E-03	4676	7.1E-04	4883	2.6E-04
Release Limited to Diffusion	5614	1.4E-03	5637	2.2E-04	5839	8.3E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.3E-07	5637	9.8E-08	5839	3.6E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.5E-06	4925	5.4E-07	5130	2.0E-07
Post-Retrieval						
Unlimited Advection Release	4653	9.8E-05	4676	1.5E-05	4883	5.7E-06
Release Limited to Diffusion	5614	3.1E-05	5637	4.8E-06	5839	1.8E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.3E-07	5637	9.8E-08	5839	3.6E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.5E-06	4925	5.4E-07	5130	2.0E-07

Table 2-8. Simulated Peak Dose and Arrival Times for Technetium-99 at Various Boundaries All Pathways Farmer -- Groundwater Only.

Technetium-99 (Dose)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)	Time	Dose (mrem/yr)
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	7.3E-01	2107	1.2E-01	2324	3.9E-02
Past Tank Leaks	2092	2.7E-01	2117	4.3E-02	2333	1.5E-02
Past Ancillary Equipment Leaks	2117	6.2E-01	2141	9.8E-02	2355	3.5E-02
Unlimited Advection Release	4653	1.7E+01	4676	2.6E+00	4883	9.7E-01
Release Limited to Diffusion	5614	5.3E+00	5637	8.3E-01	5839	3.1E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-03	5637	3.6E-04	5839	1.3E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-02	4925	2.0E-03	5130	7.4E-04
Post-Retrieval						
Unlimited Advection Release	4653	3.7E-01	4676	5.7E-02	4883	2.1E-02
Release Limited to Diffusion	5614	1.2E-01	5637	1.8E-02	5839	6.7E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-03	5637	3.6E-04	5839	1.3E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-02	4925	2.0E-03	5130	7.4E-04

Table 2-9. Simulated Peak Dose and Arrival Times for Technetium-99 at Various Boundaries Native American -- Groundwater Only.

Technetium-99 (Dose)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Dose (mrem/yr)**	**Time**	**Dose (mrem/yr)**	**Time**	**Dose (mrem/yr)**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.8E+00	2107	2.8E-01	2324	9.3E-02
Past Tank Leaks	2092	6.6E-01	2117	1.0E-01	2333	3.6E-02
Past Ancillary Equipment Leaks	2117	1.5E+00	2141	2.4E-01	2355	8.5E-02
Unlimited Advection Release	4653	4.1E+01	4676	6.4E+00	4883	2.3E+00
Release Limited to Diffusion	5614	1.3E+01	5637	2.0E+00	5839	7.4E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.6E-03	5637	8.8E-04	5839	3.3E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.2E-02	4925	4.9E-03	5130	1.8E-03
Post-Retrieval						
Unlimited Advection Release	4653	8.8E-01	4676	1.4E-01	4883	5.1E-02
Release Limited to Diffusion	5614	2.8E-01	5637	4.3E-02	5839	1.6E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.6E-03	5637	8.8E-04	5839	3.3E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.2E-02	4925	4.9E-03	5130	1.8E-03

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3.0 CHROMIUM

Table 3-1. Simulated Peak Concentrations and Arrival Times for Chromium at Various Boundaries.

Chromium Concentration (mg /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	6.4E-03	2107	1.0E-03	2324	3.4E-04
Past Tank Leaks	2092	7.9E-04	2117	1.3E-04	2333	4.3E-05
Past Ancillary Equipment Leaks	2117	3.3E-03	2141	5.2E-04	2355	1.9E-04
Residual Tank Unlimited Advection Release	4653	1.6E-01	4676	2.4E-02	4883	8.9E-03
Residual Tank Release Limited to Diffusion	5614	4.9E-02	5637	7.6E-03	5839	2.8E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.1E-05	5637	3.3E-06	5839	1.2E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.2E-04	4925	1.8E-05	5130	6.7E-06
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	3.3E-03	4676	5.2E-04	4883	1.9E-04
Residual Tank Release Limited to Diffusion	5614	1.0E-03	5637	1.6E-04	5839	6.0E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.1E-05	5637	3.3E-06	5839	1.2E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.2E-04	4925	1.8E-05	5130	6.7E-06

Table 3-2. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries All Pathways Farmer -- Groundwater Only.

Chromium (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.7E-07	2107	9.0E-08	2324	3.0E-08
Past Tank Leaks	2092	7.0E-08	2117	1.1E-08	2333	3.9E-09
Past Ancillary Equipment Leaks	2117	2.9E-07	2141	4.7E-08	2355	1.7E-08
Unlimited Advection Release	4653	1.4E-05	4676	2.2E-06	4883	7.9E-07
Release Limited to Diffusion	5614	4.4E-06	5637	6.8E-07	5839	2.5E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.9E-09	5637	2.9E-10	5839	1.1E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-08	4925	1.6E-09	5130	6.0E-10
Post-Retrieval						
Unlimited Advection Release	4653	2.9E-07	4676	4.6E-08	4883	1.7E-08
Release Limited to Diffusion	5614	9.3E-08	5637	1.4E-08	5839	5.4E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.9E-09	5637	2.9E-10	5839	1.1E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-08	4925	1.6E-09	5130	6.0E-10

Table 3-3. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

All Pathways Farmer -- Groundwater Only.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	7.1E-02	2107	1.1E-02	2324	3.8E-03
Past Tank Leaks	2092	8.8E-03	2117	1.4E-03	2333	4.8E-04
Past Ancillary Equipment Leaks	2117	3.7E-02	2141	5.8E-03	2355	2.1E-03
Unlimited Advection Release	4653	1.7E+00	4676	2.7E-01	4883	9.9E-02
Release Limited to Diffusion	5614	5.4E-01	5637	8.5E-02	5839	3.1E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-04	5637	3.7E-05	5839	1.4E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-03	4925	2.0E-04	5130	7.5E-05
Post-Retrieval						
Unlimited Advection Release	4653	3.7E-02	4676	5.7E-03	4883	2.1E-03
Release Limited to Diffusion	5614	1.2E-02	5637	1.8E-03	5839	6.7E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-04	5637	3.7E-05	5839	1.4E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-03	4925	2.0E-04	5130	7.5E-05

Table 3-3. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries Native American -- Groundwater Only.

Chromium (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.8E-04	2107	7.7E-05	2324	2.6E-05
Past Tank Leaks	2092	6.0E-05	2117	9.4E-06	2333	3.3E-06
Past Ancillary Equipment Leaks	2117	2.5E-04	2141	3.9E-05	2355	1.4E-05
Unlimited Advection Release	4653	1.2E-02	4676	1.8E-03	4883	6.7E-04
Release Limited to Diffusion	5614	3.7E-03	5637	5.8E-04	5839	2.1E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.6E-06	5637	2.5E-07	5839	9.2E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.9E-06	4925	1.4E-06	5130	5.1E-07
Post-Retrieval						
Unlimited Advection Release	4653	2.5E-04	4676	3.9E-05	4883	1.4E-05
Release Limited to Diffusion	5614	7.9E-05	5637	1.2E-05	5839	4.5E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.6E-06	5637	2.5E-07	5839	9.2E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.9E-06	4925	1.4E-06	5130	5.1E-07

Table 3-5. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

Native American -- Groundwater Only.

Chromium (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.2E+00	2107	8.2E-01	2324	2.7E-01
Past Tank Leaks	2092	6.4E-01	2117	1.0E-01	2333	3.5E-02
Past Ancillary Equipment Leaks	2117	2.7E+00	2141	4.2E-01	2355	1.5E-01
Unlimited Advection Release	4653	1.3E+02	4676	2.0E+01	4883	7.2E+00
Release Limited to Diffusion	5614	3.9E+01	5637	6.2E+00	5839	2.3E+00
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.7E-02	5637	2.7E-03	5839	9.8E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	9.5E-02	4925	1.5E-02	5130	5.4E-03
Post-Retrieval						
Unlimited Advection Release	4653	2.7E+00	4676	4.2E-01	4883	1.5E-01
Release Limited to Diffusion	5614	8.4E-01	5637	1.3E-01	5839	4.9E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.7E-02	5637	2.7E-03	5839	9.8E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	9.5E-02	4925	1.5E-02	5130	5.4E-03

Table 3-4. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries HSRAM Industrial.

Chromium (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.7E-07	2107	2.8E-08	2324	9.2E-09
Past Tank Leaks	2092	2.1E-08	2117	3.4E-09	2333	1.2E-09
Past Ancillary Equipment Leaks	2117	8.9E-08	2141	1.4E-08	2355	5.1E-09
Unlimited Advection Release	4653	4.2E-06	4676	6.6E-07	4883	2.4E-07
Release Limited to Diffusion	5614	1.3E-06	5637	2.1E-07	5839	7.6E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.7E-10	5637	8.9E-11	5839	3.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.2E-09	4925	4.9E-10	5130	1.8E-10
Post-Retrieval						
Unlimited Advection Release	4653	8.9E-08	4676	1.4E-08	4883	5.1E-09
Release Limited to Diffusion	5614	2.8E-08	5637	4.4E-09	5839	1.6E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.7E-10	5637	8.9E-11	5839	3.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.2E-09	4925	4.9E-10	5130	1.8E-10

Table 3-7. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

HSRAM Industrial.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.8E-02	2107	4.4E-03	2324	1.5E-03
Past Tank Leaks	2092	3.4E-03	2117	5.4E-04	2333	1.9E-04
Past Ancillary Equipment Leaks	2117	1.4E-02	2141	2.3E-03	2355	8.1E-04
Unlimited Advection Release	4653	6.7E-01	4676	1.0E-01	4883	3.9E-02
Release Limited to Diffusion	5614	2.1E-01	5637	3.3E-02	5839	1.2E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.1E-05	5637	1.4E-05	5839	5.3E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.1E-04	4925	7.9E-05	5130	2.9E-05
Post-Retrieval						
Unlimited Advection Release	4653	1.4E-02	4676	2.2E-03	4883	8.2E-04
Release Limited to Diffusion	5614	4.5E-03	5637	7.0E-04	5839	2.6E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.1E-05	5637	1.4E-05	5839	5.3E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.1E-04	4925	7.9E-05	5130	2.9E-05

Table 3-8. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries HSRAM Recreational -- Groundwater Only.

Chromium (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	6.8E-09	2107	1.1E-09	2324	3.6E-10
Past Tank Leaks	2092	8.5E-10	2117	1.3E-10	2333	4.6E-11
Past Ancillary Equipment Leaks	2117	3.5E-09	2141	5.6E-10	2355	2.0E-10
Unlimited Advection Release	4653	1.7E-07	4676	2.6E-08	4883	9.6E-09
Release Limited to Diffusion	5614	5.2E-08	5637	8.2E-09	5839	3.0E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-11	5637	3.5E-12	5839	1.3E-12
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-10	4925	1.9E-11	5130	7.2E-12
Post-Retrieval						
Unlimited Advection Release	4653	3.5E-09	4676	5.5E-10	4883	2.0E-10
Release Limited to Diffusion	5614	1.1E-09	5637	1.8E-10	5839	6.5E-11
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.3E-11	5637	3.5E-12	5839	1.3E-12
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.3E-10	4925	1.9E-11	5130	7.2E-12

Table 3-9. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

HSRAM Recreational -- Groundwater Only.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.8E-03	2107	4.5E-04	2324	1.5E-04
Past Tank Leaks	2092	3.5E-04	2117	5.6E-05	2333	1.9E-05
Past Ancillary Equipment Leaks	2117	1.5E-03	2141	2.3E-04	2355	8.3E-05
Unlimited Advection Release	4653	6.9E-02	4676	1.1E-02	4883	4.0E-03
Release Limited to Diffusion	5614	2.2E-02	5637	3.4E-03	5839	1.3E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.4E-06	5637	1.5E-06	5839	5.4E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.3E-05	4925	8.1E-06	5130	3.0E-06
Post-Retrieval						
Unlimited Advection Release	4653	1.5E-03	4676	2.3E-04	4883	8.5E-05
Release Limited to Diffusion	5614	4.6E-04	5637	7.3E-05	5839	2.7E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.4E-06	5637	1.5E-06	5839	5.4E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.3E-05	4925	8.1E-06	5130	3.0E-06

Table 3-10. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries HSRAM Residential -- Groundwater Only.

Chromium (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	3.8E-07	2107	6.1E-08	2324	2.0E-08
Past Tank Leaks	2092	4.8E-08	2117	7.5E-09	2333	2.6E-09
Past Ancillary Equipment Leaks	2117	2.0E-07	2141	3.1E-08	2355	1.1E-08
Unlimited Advection Release	4653	9.3E-06	4676	1.5E-06	4883	5.4E-07
Release Limited to Diffusion	5614	2.9E-06	5637	4.6E-07	5839	1.7E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E-09	5637	2.0E-10	5839	7.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.1E-09	4925	1.1E-09	5130	4.0E-10
Post-Retrieval						
Unlimited Advection Release	4653	2.0E-07	4676	3.1E-08	4883	1.1E-08
Release Limited to Diffusion	5614	6.3E-08	5637	9.8E-09	5839	3.6E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E-09	5637	2.0E-10	5839	7.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.1E-09	4925	1.1E-09	5130	4.0E-10

Table 3-11. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

HSRAM Residential -- Groundwater Only.

Chromium (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.5E-01	2107	2.4E-02	2324	8.1E-03
Past Tank Leaks	2092	1.9E-02	2117	3.0E-03	2333	1.0E-03
Past Ancillary Equipment Leaks	2117	7.9E-02	2141	1.3E-02	2355	4.5E-03
Unlimited Advection Release	4653	3.7E+00	4676	5.8E-01	4883	2.1E-01
Release Limited to Diffusion	5614	1.2E+00	5637	1.8E-01	5839	6.8E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.1E-04	5637	7.9E-05	5839	2.9E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.8E-03	4925	4.4E-04	5130	1.6E-04
Post-Retrieval						
Unlimited Advection Release	4653	7.9E-02	4676	1.2E-02	4883	4.6E-03
Release Limited to Diffusion	5614	2.5E-02	5637	3.9E-03	5839	1.4E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.1E-04	5637	7.9E-05	5839	2.9E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.8E-03	4925	4.4E-04	5130	1.6E-04

Table 3-12. Simulated Peak Risk and Arrival Times for Chromium at Various Boundaries HSRAM Agricultural -- Groundwater Only.

Chromium (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	3.8E-07	2107	6.1E-08	2324	2.0E-08
Past Tank Leaks	2092	4.8E-08	2117	7.5E-09	2333	2.6E-09
Past Ancillary Equipment Leaks	2117	2.0E-07	2141	3.1E-08	2355	1.1E-08
Unlimited Advection Release	4653	9.3E-06	4676	1.5E-06	4883	5.4E-07
Release Limited to Diffusion	5614	2.9E-06	5637	4.6E-07	5839	1.7E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E-09	5637	2.0E-10	5839	7.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.1E-09	4925	1.1E-09	5130	4.0E-10
Post-Retrieval						
Unlimited Advection Release	4653	2.0E-07	4676	3.1E-08	4883	1.1E-08
Release Limited to Diffusion	5614	6.3E-08	5637	9.8E-09	5839	3.6E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.3E-09	5637	2.0E-10	5839	7.3E-11
Residual Ancillary Pipeline Release Limited to Diffusion	4891	7.1E-09	4925	1.1E-09	5130	4.0E-10

Table 3-13. Simulated Peak Hazard Index and Arrival Times for Chromium at Various Boundaries

HSRAM Agricultural -- Groundwater Only.

Chromium (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.6E-01	2107	2.5E-02	2324	8.4E-03
Past Tank Leaks	2092	2.0E-02	2117	3.1E-03	2333	1.1E-03
Past Ancillary Equipment Leaks	2117	8.2E-02	2141	1.3E-02	2355	4.6E-03
Unlimited Advection Release	4653	3.8E+00	4676	6.0E-01	4883	2.2E-01
Release Limited to Diffusion	5614	1.2E+00	5637	1.9E-01	5839	7.0E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.2E-04	5637	8.2E-05	5839	3.0E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.9E-03	4925	4.5E-04	5130	1.7E-04
Post-Retrieval						
Unlimited Advection Release	4653	8.2E-02	4676	1.3E-02	4883	4.7E-03
Release Limited to Diffusion	5614	2.6E-02	5637	4.0E-03	5839	1.5E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.2E-04	5637	8.2E-05	5839	3.0E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.9E-03	4925	4.5E-04	5130	1.7E-04

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4.0 IODINE-129

Table 4-1. Simulated Peak Concentrations and Arrival Times for Iodine-129 at Various Boundaries.

Iodine-129 Concentration (pCi /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	8.2E-01	2107	1.3E-01	2324	4.4E-02
Past Tank Leaks	2092	3.0E-01	2117	4.8E-02	2333	1.6E-02
Past Ancillary Equipment Leaks	2117	6.8E-01	2141	1.1E-01	2355	3.9E-02
Residual Tank Unlimited Advection Release	4653	2.8E+01	4676	4.3E+00	4883	1.6E+00
Residual Tank Release Limited to Diffusion	5614	8.7E+00	5637	1.4E+00	5839	5.0E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.8E-03	5637	4.3E-04	5839	1.6E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.5E-02	4925	2.4E-03	5130	8.7E-04
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	4.3E-01	4676	6.7E-02	4883	2.5E-02
Residual Tank Release Limited to Diffusion	5614	1.4E-01	5637	2.1E-02	5839	7.9E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.8E-03	5637	4.3E-04	5839	1.6E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.5E-02	4925	2.4E-03	5130	8.7E-04

Table 4-2. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries All Pathways Farmer -- Groundwater Only.

Iodine-129 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.3E-05	2107	2.0E-06	2324	6.7E-07
Past Tank Leaks	2092	4.6E-06	2117	7.3E-07	2333	2.5E-07
Past Ancillary Equipment Leaks	2117	1.0E-05	2141	1.6E-06	2355	5.9E-07
Unlimited Advection Release	4653	4.2E-04	4676	6.6E-05	4883	2.4E-05
Release Limited to Diffusion	5614	1.3E-04	5637	2.1E-05	5839	7.7E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.2E-08	5637	6.6E-09	5839	2.4E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-07	4925	3.6E-08	5130	1.3E-08
Post-Retrieval						
Unlimited Advection Release	4653	6.6E-06	4676	1.0E-06	4883	3.8E-07
Release Limited to Diffusion	5614	2.1E-06	5637	3.2E-07	5839	1.2E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.2E-08	5637	6.6E-09	5839	2.4E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-07	4925	3.6E-08	5130	1.3E-08

Table 4-3. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries Native American -- Groundwater Only.

Iodine-129 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	9.0E-05	2107	1.4E-05	2324	4.8E-06
Past Tank Leaks	2092	3.3E-05	2117	5.2E-06	2333	1.8E-06
Past Ancillary Equipment Leaks	2117	7.4E-05	2141	1.2E-05	2355	4.2E-06
Unlimited Advection Release	4653	3.0E-03	4676	4.7E-04	4883	1.7E-04
Release Limited to Diffusion	5614	9.5E-04	5637	1.5E-04	5839	5.5E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.0E-07	5637	4.7E-08	5839	1.7E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.7E-06	4925	2.6E-07	5130	9.5E-08
Post-Retrieval						
Unlimited Advection Release	4653	4.7E-05	4676	7.3E-06	4883	2.7E-06
Release Limited to Diffusion	5614	1.5E-05	5637	2.3E-06	5839	8.6E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.0E-07	5637	4.7E-08	5839	1.7E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.7E-06	4925	2.6E-07	5130	9.5E-08

Table 4-4. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries HSRAM Industrial.

Iodine-129 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	6.1E-07	2107	9.7E-08	2324	3.2E-08
Past Tank Leaks	2092	2.2E-07	2117	3.5E-08	2333	1.2E-08
Past Ancillary Equipment Leaks	2117	5.1E-07	2141	8.0E-08	2355	2.9E-08
Unlimited Advection Release	4653	2.0E-05	4676	3.2E-06	4883	1.2E-06
Release Limited to Diffusion	5614	6.4E-06	5637	1.0E-06	5839	3.7E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.0E-09	5637	3.2E-10	5839	1.2E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-08	4925	1.8E-09	5130	6.5E-10
Post-Retrieval						
Unlimited Advection Release	4653	3.2E-07	4676	5.0E-08	4883	1.8E-08
Release Limited to Diffusion	5614	1.0E-07	5637	1.6E-08	5839	5.8E-09
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.0E-09	5637	3.2E-10	5839	1.2E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-08	4925	1.8E-09	5130	6.5E-10

Table 4-5. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries HSRAM Recreational Groundwater Only.

Iodine-129 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.2E-08	2107	8.2E-09	2324	2.7E-09
Past Tank Leaks	2092	1.9E-08	2117	3.0E-09	2333	1.0E-09
Past Ancillary Equipment Leaks	2117	4.3E-08	2141	6.7E-09	2355	2.4E-09
Unlimited Advection Release	4653	1.7E-06	4676	2.7E-07	4883	9.9E-08
Release Limited to Diffusion	5614	5.4E-07	5637	8.5E-08	5839	3.1E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.7E-10	5637	2.7E-11	5839	9.9E-12
Residual Ancillary Pipeline Release Limited to Diffusion	4891	9.6E-10	4925	1.5E-10	5130	5.5E-11
Post-Retrieval						
Unlimited Advection Release	4653	2.7E-08	4676	4.2E-09	4883	1.5E-09
Release Limited to Diffusion	5614	8.5E-09	5637	1.3E-09	5839	4.9E-10
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.7E-10	5637	2.7E-11	5839	9.9E-12
Residual Ancillary Pipeline Release Limited to Diffusion	4891	9.6E-10	4925	1.5E-10	5130	5.5E-11

Table 4-6. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries HSRAM Residential Groundwater Only.

Iodine-129 (Risk)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Risk	Time	Risk	Time	Risk
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	3.2E-06	2107	5.0E-07	2324	1.7E-07
Past Tank Leaks	2092	1.2E-06	2117	1.8E-07	2333	6.4E-08
Past Ancillary Equipment Leaks	2117	2.6E-06	2141	4.2E-07	2355	1.5E-07
Unlimited Advection Release	4653	1.1E-04	4676	1.7E-05	4883	6.1E-06
Release Limited to Diffusion	5614	3.3E-05	5637	5.2E-06	5839	1.9E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.1E-08	5637	1.7E-09	5839	6.1E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.9E-08	4925	9.1E-09	5130	3.4E-09
Post-Retrieval						
Unlimited Advection Release	4653	1.7E-06	4676	2.6E-07	4883	9.5E-08
Release Limited to Diffusion	5614	5.2E-07	5637	8.2E-08	5839	3.0E-08
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.1E-08	5637	1.7E-09	5839	6.1E-10
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.9E-08	4925	9.1E-09	5130	3.4E-09

Table 4-7. Simulated Peak Risk and Arrival Times for Iodine-129 at Various Boundaries HSRAM Agricultural Groundwater Only.

Iodine-129 (Risk)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Risk**	**Time**	**Risk**	**Time**	**Risk**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.9E-05	2107	3.1E-06	2324	1.0E-06
Past Tank Leaks	2092	7.0E-06	2117	1.1E-06	2333	3.8E-07
Past Ancillary Equipment Leaks	2117	1.6E-05	2141	2.5E-06	2355	9.0E-07
Unlimited Advection Release	4653	6.4E-04	4676	1.0E-04	4883	3.7E-05
Release Limited to Diffusion	5614	2.0E-04	5637	3.2E-05	5839	1.2E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.4E-08	5637	1.0E-08	5839	3.7E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.6E-07	4925	5.5E-08	5130	2.0E-08
Post-Retrieval						
Unlimited Advection Release	4653	1.0E-05	4676	1.6E-06	4883	5.8E-07
Release Limited to Diffusion	5614	3.2E-06	5637	4.9E-07	5839	1.8E-07
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.4E-08	5637	1.0E-08	5839	3.7E-09
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.6E-07	4925	5.5E-08	5130	2.0E-08

Table 4-8. Simulated Peak Dose and Arrival Times for Iodine-129 at Various Boundaries All Pathways Farmer -- Groundwater Only.

Iodine-129 (Dose)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Dose (mrem/yr)**	**Time**	**Dose (mrem/yr)**	**Time**	**Dose (mrem/yr)**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.3E-01	2107	6.9E-02	2324	2.3E-02
Past Tank Leaks	2092	1.6E-01	2117	2.5E-02	2333	8.7E-03
Past Ancillary Equipment Leaks	2117	3.6E-01	2141	5.7E-02	2355	2.0E-02
Unlimited Advection Release	4653	1.5E+01	4676	2.3E+00	4883	8.3E-01
Release Limited to Diffusion	5614	4.6E+00	5637	7.1E-01	5839	2.6E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-03	5637	2.3E-04	5839	8.4E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.1E-03	4925	1.2E-03	5130	4.6E-04
Post-Retrieval						
Unlimited Advection Release	4653	2.3E-01	4676	3.5E-02	4883	1.3E-02
Release Limited to Diffusion	5614	7.1E-02	5637	1.1E-02	5839	4.1E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-03	5637	2.3E-04	5839	8.4E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.1E-03	4925	1.2E-03	5130	4.6E-04

Table 4-9. Simulated Peak Dose and Arrival Times for Iodine-129 at Various Boundaries Native American -- Groundwater Only.

Iodine-129 (Dose)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Dose (mrem/yr)**	**Time**	**Dose (mrem/yr)**	**Time**	**Dose (mrem/yr)**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.0E+00	2107	1.6E-01	2324	5.4E-02
Past Tank Leaks	2092	3.7E-01	2117	5.8E-02	2333	2.0E-02
Past Ancillary Equipment Leaks	2117	8.4E-01	2141	1.3E-01	2355	4.7E-02
Unlimited Advection Release	4653	3.4E+01	4676	5.3E+00	4883	1.9E+00
Release Limited to Diffusion	5614	1.1E+01	5637	1.7E+00	5839	6.2E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.4E-03	5637	5.3E-04	5839	2.0E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.9E-02	4925	2.9E-03	5130	1.1E-03
Post-Retrieval						
Unlimited Advection Release	4653	5.3E-01	4676	8.3E-02	4883	3.0E-02
Release Limited to Diffusion	5614	1.7E-01	5637	2.6E-02	5839	9.6E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.4E-03	5637	5.3E-04	5839	2.0E-04
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.9E-02	4925	2.9E-03	5130	1.1E-03

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5.0 NITRATE

Table 5-1. Simulated Peak Concentrations and Arrival Times for Nitrate at Various Boundaries.

Nitrate Concentration (mg /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	6.6E-01	2107	1.1E-01	2324	3.5E-02
Past Tank Leaks	2092	2.5E-02	2117	4.0E-03	2333	1.4E-03
Past Ancillary Equipment Leaks	2117	2.4E-01	2141	3.9E-02	2355	1.4E-02
Residual Tank Unlimited Advection Release	4653	1.1E+01	4676	1.7E+00	4883	6.4E-01
Residual Tank Release Limited to Diffusion	5614	3.5E+00	5637	5.5E-01	5839	2.0E-01
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-03	5637	2.3E-04	5839	8.6E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.3E-03	4925	1.3E-03	5130	4.7E-04
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	2.3E-01	4676	3.6E-02	4883	1.3E-02
Residual Tank Release Limited to Diffusion	5614	7.3E-02	5637	1.1E-02	5839	4.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-03	5637	2.3E-04	5839	8.6E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.3E-03	4925	1.3E-03	5130	4.7E-04

Table 5-2. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries All Pathways Farmer -- Groundwater Only.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	8.9E-03	2107	1.4E-03	2324	4.7E-04
Past Tank Leaks	2092	3.4E-04	2117	5.4E-05	2333	1.9E-05
Past Ancillary Equipment Leaks	2117	3.3E-03	2141	5.2E-04	2355	1.9E-04
Unlimited Advection Release	4653	1.5E-01	4676	2.3E-02	4883	8.6E-03
Release Limited to Diffusion	5614	4.7E-02	5637	7.4E-03	5839	2.7E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.0E-05	5637	3.1E-06	5839	1.2E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-04	4925	1.7E-05	5130	6.4E-06
Post-Retrieval						
Unlimited Advection Release	4653	3.1E-03	4676	4.9E-04	4883	1.8E-04
Release Limited to Diffusion	5614	9.9E-04	5637	1.5E-04	5839	5.7E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	2.0E-05	5637	3.1E-06	5839	1.2E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.1E-04	4925	1.7E-05	5130	6.4E-06

Table 5-3. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries Native American -- Groundwater Only.

Nitrate (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.8E-02	2107	2.9E-03	2324	9.7E-04
Past Tank Leaks	2092	7.0E-04	2117	1.1E-04	2333	3.8E-05
Past Ancillary Equipment Leaks	2117	6.7E-03	2141	1.1E-03	2355	3.8E-04
Unlimited Advection Release	4653	3.1E-01	4676	4.8E-02	4883	1.8E-02
Release Limited to Diffusion	5614	9.6E-02	5637	1.5E-02	5839	5.6E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.1E-05	5637	6.4E-06	5839	2.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.3E-04	4925	3.5E-05	5130	1.3E-05
Post-Retrieval						
Unlimited Advection Release	4653	6.4E-03	4676	1.0E-03	4883	3.7E-04
Release Limited to Diffusion	5614	2.0E-03	5637	3.2E-04	5839	1.2E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.1E-05	5637	6.4E-06	5839	2.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.3E-04	4925	3.5E-05	5130	1.3E-05

Table 5-4. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries HSRAM Industrial.

Nitrate (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	4.1E-03	2107	6.5E-04	2324	2.2E-04
Past Tank Leaks	2092	1.6E-04	2117	2.5E-05	2333	8.6E-06
Past Ancillary Equipment Leaks	2117	1.5E-03	2141	2.4E-04	2355	8.6E-05
Unlimited Advection Release	4653	6.9E-02	4676	1.1E-02	4883	4.0E-03
Release Limited to Diffusion	5614	2.2E-02	5637	3.4E-03	5839	1.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.2E-06	5637	1.4E-06	5839	5.3E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.1E-05	4925	7.9E-06	5130	2.9E-06
Post-Retrieval						
Unlimited Advection Release	4653	1.4E-03	4676	2.3E-04	4883	8.3E-05
Release Limited to Diffusion	5614	4.5E-04	5637	7.1E-05	5839	2.6E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	9.2E-06	5637	1.4E-06	5839	5.3E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	5.1E-05	4925	7.9E-06	5130	2.9E-06

Table 5-5. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries HSRAM Recreational -- Groundwater Only.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.0E-04	2107	8.0E-05	2324	2.7E-05
Past Tank Leaks	2092	1.9E-05	2117	3.1E-06	2333	1.1E-06
Past Ancillary Equipment Leaks	2117	1.9E-04	2141	2.9E-05	2355	1.1E-05
Unlimited Advection Release	4653	8.5E-03	4676	1.3E-03	4883	4.9E-04
Release Limited to Diffusion	5614	2.7E-03	5637	4.2E-04	5839	1.5E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.1E-06	5637	1.8E-07	5839	6.5E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	6.3E-06	4925	9.8E-07	5130	3.6E-07
Post-Retrieval						
Unlimited Advection Release	4653	1.8E-04	4676	2.8E-05	4883	1.0E-05
Release Limited to Diffusion	5614	5.6E-05	5637	8.7E-06	5839	3.2E-06
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.1E-06	5637	1.8E-07	5839	6.5E-08
Residual Ancillary Pipeline Release Limited to Diffusion	4891	6.3E-06	4925	9.8E-07	5130	3.6E-07

Table 5-6. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries HSRAM Residential -- Groundwater Only.

Nitrate (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.6E-02	2107	4.2E-03	2324	1.4E-03
Past Tank Leaks	2092	1.0E-03	2117	1.6E-04	2333	5.5E-05
Past Ancillary Equipment Leaks	2117	9.7E-03	2141	1.5E-03	2355	5.5E-04
Unlimited Advection Release	4653	4.4E-01	4676	6.9E-02	4883	2.5E-02
Release Limited to Diffusion	5614	1.4E-01	5637	2.2E-02	5839	8.0E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.9E-05	5637	9.2E-06	5839	3.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.3E-04	4925	5.1E-05	5130	1.9E-05
Post-Retrieval						
Unlimited Advection Release	4653	9.3E-03	4676	1.4E-03	4883	5.3E-04
Release Limited to Diffusion	5614	2.9E-03	5637	4.6E-04	5839	1.7E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.9E-05	5637	9.2E-06	5839	3.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.3E-04	4925	5.1E-05	5130	1.9E-05

Table 5-7. Simulated Peak Hazard Index and Arrival Times for Nitrate at Various Boundaries HSRAM Agricultural -- Groundwater Only.

Nitrate (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.6E-02	2107	4.2E-03	2324	1.4E-03
Past Tank Leaks	2092	1.0E-03	2117	1.6E-04	2333	5.5E-05
Past Ancillary Equipment Leaks	2117	9.7E-03	2141	1.5E-03	2355	5.5E-04
Unlimited Advection Release	4653	4.4E-01	4676	6.9E-02	4883	2.5E-02
Release Limited to Diffusion	5614	1.4E-01	5637	2.2E-02	5839	8.0E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.9E-05	5637	9.2E-06	5839	3.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.3E-04	4925	5.1E-05	5130	1.9E-05
Post-Retrieval						
Unlimited Advection Release	4653	9.3E-03	4676	1.4E-03	4883	5.3E-04
Release Limited to Diffusion	5614	2.9E-03	5637	4.6E-04	5839	1.7E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	5.9E-05	5637	9.2E-06	5839	3.4E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.3E-04	4925	5.1E-05	5130	1.9E-05

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6.0 NITRITE

Table 6-1. Simulated Peak Concentrations and Arrival Times for Nitrite at Various Boundaries.

Nitrite Concentration (mg /L)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Concentration	Time	Concentration	Time	Concentration
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.6E-01	2107	4.2E-02	2324	1.4E-02
Past Tank Leaks	2092	2.2E-02	2117	3.4E-03	2333	1.2E-03
Past Ancillary Equipment Leaks	2117	1.2E-01	2141	2.0E-02	2355	7.0E-03
Residual Tank Unlimited Advection Release	4653	5.3E+00	4676	8.2E-01	4883	3.0E-01
Residual Tank Release Limited to Diffusion	5614	1.7E+00	5637	2.6E-01	5839	9.6E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.9E-04	5637	1.1E-04	5839	4.0E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.8E-03	4925	5.9E-04	5130	2.2E-04
Post-Retrieval						
Residual Tank Unlimited Advection Release	4653	1.1E-01	4676	1.7E-02	4883	6.2E-03
Residual Tank Release Limited to Diffusion	5614	3.4E-02	5637	5.3E-03	5839	2.0E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.9E-04	5637	1.1E-04	5839	4.0E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.8E-03	4925	5.9E-04	5130	2.2E-04

Table 6-2. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries All Pathways Farmer -- Groundwater Only.

Nitrite (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	5.7E-02	2107	9.0E-03	2324	3.0E-03
Past Tank Leaks	2092	4.7E-03	2117	7.4E-04	2333	2.6E-04
Past Ancillary Equipment Leaks	2117	2.7E-02	2141	4.2E-03	2355	1.5E-03
Unlimited Advection Release	4653	1.1E+00	4676	1.8E-01	4883	6.6E-02
Release Limited to Diffusion	5614	3.6E-01	5637	5.6E-02	5839	2.1E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-04	5637	2.3E-05	5839	8.6E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.3E-04	4925	1.3E-04	5130	4.7E-05
Post-Retrieval						
Unlimited Advection Release	4653	2.3E-02	4676	3.6E-03	4883	1.3E-03
Release Limited to Diffusion	5614	7.3E-03	5637	1.1E-03	5839	4.2E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	1.5E-04	5637	2.3E-05	5839	8.6E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	8.3E-04	4925	1.3E-04	5130	4.7E-05

Table 6-3. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries Native American -- Groundwater Only.

Nitrite (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.2E-01	2107	1.8E-02	2324	6.1E-03
Past Tank Leaks	2092	9.5E-03	2117	1.5E-03	2333	5.2E-04
Past Ancillary Equipment Leaks	2117	5.4E-02	2141	8.6E-03	2355	3.1E-03
Unlimited Advection Release	4653	2.3E+00	4676	3.6E-01	4883	1.3E-01
Release Limited to Diffusion	5614	7.3E-01	5637	1.1E-01	5839	4.2E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.0E-04	5637	4.7E-05	5839	1.7E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.7E-03	4925	2.6E-04	5130	9.6E-05
Post-Retrieval						
Unlimited Advection Release	4653	4.7E-02	4676	7.4E-03	4883	2.7E-03
Release Limited to Diffusion	5614	1.5E-02	5637	2.3E-03	5839	8.6E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	3.0E-04	5637	4.7E-05	5839	1.7E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	1.7E-03	4925	2.6E-04	5130	9.6E-05

Table 6-4. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries HSRAM Industrial.

Nitrite (Hazard Index)	WMA C Fenceline Boundary		Proposed Exclusion Boundary		Columbia River	
	Time	Hazard Index	Time	Hazard Index	Time	Hazard Index
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	2.6E-02	2107	4.1E-03	2324	1.4E-03
Past Tank Leaks	2092	2.1E-03	2117	3.4E-04	2333	1.2E-04
Past Ancillary Equipment Leaks	2117	1.2E-02	2141	1.9E-03	2355	6.9E-04
Unlimited Advection Release	4653	5.2E-01	4676	8.1E-02	4883	3.0E-02
Release Limited to Diffusion	5614	1.6E-01	5637	2.6E-02	5839	9.5E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.8E-05	5637	1.1E-05	5839	3.9E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.8E-04	4925	5.9E-05	5130	2.2E-05
Post-Retrieval						
Unlimited Advection Release	4653	1.1E-02	4676	1.7E-03	4883	6.1E-04
Release Limited to Diffusion	5614	3.4E-03	5637	5.2E-04	5839	1.9E-04
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	6.8E-05	5637	1.1E-05	5839	3.9E-06
Residual Ancillary Pipeline Release Limited to Diffusion	4891	3.8E-04	4925	5.9E-05	5130	2.2E-05

Table 6-5. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries HSRAM Recreational -- Groundwater Only.

Nitrite (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	3.2E-03	2107	5.1E-04	2324	1.7E-04
Past Tank Leaks	2092	2.6E-04	2117	4.2E-05	2333	1.4E-05
Past Ancillary Equipment Leaks	2117	1.5E-03	2141	2.4E-04	2355	8.6E-05
Unlimited Advection Release	4653	6.4E-02	4676	1.0E-02	4883	3.7E-03
Release Limited to Diffusion	5614	2.0E-02	5637	3.2E-03	5839	1.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	8.4E-06	5637	1.3E-06	5839	4.8E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	4.7E-05	4925	7.2E-06	5130	2.7E-06
Post-Retrieval						
Unlimited Advection Release	4653	1.3E-03	4676	2.0E-04	4883	7.5E-05
Release Limited to Diffusion	5614	4.1E-04	5637	6.5E-05	5839	2.4E-05
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	8.4E-06	5637	1.3E-06	5839	4.8E-07
Residual Ancillary Pipeline Release Limited to Diffusion	4891	4.7E-05	4925	7.2E-06	5130	2.7E-06

Table 6-6. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries HSRAM Residential -- Groundwater Only.

Nitrite (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.7E-01	2107	2.7E-02	2324	8.9E-03
Past Tank Leaks	2092	1.4E-02	2117	2.2E-03	2333	7.6E-04
Past Ancillary Equipment Leaks	2117	7.9E-02	2141	1.2E-02	2355	4.5E-03
Unlimited Advection Release	4653	3.3E+00	4676	5.2E-01	4883	1.9E-01
Release Limited to Diffusion	5614	1.1E+00	5637	1.6E-01	5839	6.1E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.4E-04	5637	6.8E-05	5839	2.5E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-03	4925	3.8E-04	5130	1.4E-04
Post-Retrieval						
Unlimited Advection Release	4653	6.8E-02	4676	1.1E-02	4883	3.9E-03
Release Limited to Diffusion	5614	2.2E-02	5637	3.4E-03	5839	1.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.4E-04	5637	6.8E-05	5839	2.5E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-03	4925	3.8E-04	5130	1.4E-04

Table 6-7. Simulated Peak Hazard Index and Arrival Times for Nitrite at Various Boundaries HSRAM Agricultural -- Groundwater Only.

Nitrite (Hazard Index)	**WMA C Fenceline Boundary**		**Proposed Exclusion Boundary**		**Columbia River**	
	Time	**Hazard Index**	**Time**	**Hazard Index**	**Time**	**Hazard Index**
Pre-Retrieval						
Retrieval Leak (8000 gallons)	2082	1.7E-01	2107	2.7E-02	2324	8.9E-03
Past Tank Leaks	2092	1.4E-02	2117	2.2E-03	2333	7.6E-04
Past Ancillary Equipment Leaks	2117	7.9E-02	2141	1.2E-02	2355	4.5E-03
Unlimited Advection Release	4653	3.3E+00	4676	5.2E-01	4883	1.9E-01
Release Limited to Diffusion	5614	1.1E+00	5637	1.6E-01	5839	6.1E-02
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.4E-04	5637	6.8E-05	5839	2.5E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-03	4925	3.8E-04	5130	1.4E-04
Post-Retrieval						
Unlimited Advection Release	4653	6.8E-02	4676	1.1E-02	4883	3.9E-03
Release Limited to Diffusion	5614	2.2E-02	5637	3.4E-03	5839	1.2E-03
Residual CR Vault and Catch-Tank Release Limited to Diffusion	5614	4.4E-04	5637	6.8E-05	5839	2.5E-05
Residual Ancillary Pipeline Release Limited to Diffusion	4891	2.4E-03	4925	3.8E-04	5130	1.4E-04

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ATTACHMENT C-1

SINGLE-SHELL TANK 241-C-106
COMPONENT CLOSURE ACTIVITY PLAN

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CONTENTS

SUPPLEMENTS

FIGURES

TABLES

LIST OF TERMS

BBI	best basis inventory
bgs	below ground surface
C-106	single-shell tank 241-C-106
CFR	*Code of Federal Regulations*
COPC	constituents of potential concern
DQA	data quality assessment
DQO	data quality objectives
DOE	U.S. Department of Energy
DST	double-shell tank
DWTP	Dangerous Waste Training Plan
ECN	Engineering Change Notice
EIS	Environmental Impact Statement
Ecology	Washington State Department of Ecology
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
ILCR	Incremental Lifetime Cancer Risk
LDMM	Leak Detection, Monitoring, and Mitigation
LDR	land disposal restrictions
MCL	maximum contaminant level
PUREX	plutonium-uranium extraction
QA	quality assurance
QAPjP	Quality Assurance Project Plan
RCRA	*Resource Conservation and Recovery Act of 1976*
SEPA	State Environmental Policy Act
SST	single-shell tank
SVOC	semi-volatile organic compound
TSD	treatment, storage, and disposal
TVMS	tank volume measurement system
TWINS	Tank Waste Information Network System
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WMA	waste management area
WMA C	Waste Management Area C

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1.0 INTRODUCTION

This document describes component closure activities for single-shell tank (SST) 241-C-106 (hereinafter referred to as C-106). C-106 is a tank containing high-level mixed waste located in waste management area C (WMA C) of the Hanford Site. An operating history and description of C-106 is provided in Section 2.0. C-106 is the first tank to undergo component closure activities in accordance with *Hanford Federal Facility Agreement and Consent Order* (HFFACO, Ecology et al. 1989) Milestone M-45-00. This component closure activity plan (identified as the C-106 Waste Retrieval and Closure Demonstration Plan in Milestone M-45-06-A) will comply with regulatory requirements including, but not limited to, the HFFACO Milestones and *Washington Administrative Code* (WAC) 173-303. The component closure activities are in accordance with WAC 173-303-610, HFFACO, and the *Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste,* Rev. 7 (Ecology 2001, hereafter referred to as the Site-Wide Permit).

C-106 component closure action will demonstrate closure activities, regulatory processes, and provide lessons learned to accelerate future SST component and WMA closure actions. As additional components within WMA C undergo closure activities, corresponding component closure activity plans will be developed for inclusion as attachments to the WMA C Closure Action Plan, which is Appendix C to the *Framework Plan for Single-Shell Tank System Closure* (Framework Plan). Together these plans and plans for other WMAs and components form the *SST System Closure Plan*. Each component closure activity plan will constitute a modification of the *SST System Closure Plan* and require a modification to the Site-Wide Permit. Closure decisions made under corrective actions for past practices (Part IV of the Site-Wide Permit) or a *Comprehensive Environmental Response, Compensation, and Liability Act* record of decision will be approved through incorporation into the Site-Wide Permit.

1.1 PURPOSE

This plan identifies activities that will accomplish the retrieval and component closure demonstration of C-106 conforming to the applicable requirements of WAC 173-303 and the HFFACO Milestones M-45-06A, M-45-05N-T01, and M-45-05H, as well as Section 6 of the HFFACO action plan.

1.1.1 Scope of Plan Submission

The scope of this component closure activity plan is C-106, including risers. This plan does not include closure activities for any equipment or ancillary piping external to the tank, and does not include any corrective measures that may be needed for soil or groundwater contamination. A description of isolation activities for adjacent/interconnected components, including evaluations to determine impacts on future closure actions, is included in Section 5.3. Subsequent component closure activity plans and the WMA C Closure Action Plan will address the remaining components in WMA C. The C-106 component closure activities will not preclude future closure activities for other components.

Retrieval of SST waste constitutes a key SST System closure action. The C-106 retrieval actions will be approved through the HFFACO and scheduled, in advance, through HFFACO M-45 Milestones. Since retrieval actions are significant closure actions, detailed summaries of those actions are included in Section 2.5.3.

Retrieval actions will have occurred for C-106 (HFFACO Milestone M-45-05L-T01) prior to modification of the Site-Wide Permit to include this closure activity plan (HFFACO Milestone M-45-05H). Therefore, retrieval actions described in this closure activity plan are being provided to more fully address the extent of closure activities that have been and will be implemented at C-106. Pursuant to M-45-05H, the project data report will describe C-106 retrieval and characterization results.

C-106 component closure activities identified will occur in phases pursuant to approval by Ecology of the Site-Wide Permit. These phases are:

- Retrieval of remaining waste to the extent technically possible in accordance with HFFACO Milestone M-45-00

- Isolation of the tank

- Phase I fill – grout* base layer to cover remaining residuals and debris to approximately 12 to 36 inches in depth

- Phase II fill – structural layer to be placed on top of the Phase I fill to provide long-term structural stability to the tank

- Phase III fill – intruder layer consisting of a high-strength grout* fill on top of the Phase II fill that extends to the top of the tank dome. Risers will be filled to the dome elevation level.

HFFACO Milestone M-45-06A required U.S. Department of Energy (DOE) to submit to Washington State Department of Ecology (Ecology) "a certified (Framework) SST System Closure Plan and C-106 waste retrieval and closure demonstration plan" by December 19, 2002, "as a Hanford site-wide hazardous waste facility permit modification..." The milestone also required DOE to include a characterization approach for residual wastes and a risk assessment methodology in the plan. The approach for characterizing C-106 residual wastes is outlined in Section 2.5.5 with supporting details provided in Section 5.0. The results of C-106 characterization will be used to support the risk assessment methodology described in Section C5.0 of the WMA C Closure Action Plan.

HFFACO Milestone M-45-05H states criteria for interim completion of the C-106 SST waste retrieval and closure demonstration project that must be met by April 30, 2004. One criterion is "The C-106 demonstration SST closure plan has been submitted by DOE and approved by

* See Preface in *SST System Closure Plan* (RPP-13774).

Ecology." Incorporation of this component closure activity plan into the Site-Wide Permit through the permit modification process will meet this criterion. The other criteria are "Full scale waste retrieval has been completed in accordance with applicable regulatory requirements including Washington Hazardous Waste Management Act and requirements set by this agreement [HFFACO] (DOE will document project data and results in a waste retrieval and closure demonstration report)."; "Remaining wastes have been adequately characterized, and a risk assessment, approved by Ecology, has been completed for residuals remaining in the tank; and "If appropriate, DOE has requested and Ecology has approved, an exception to waste retrieval criteria pursuant to Agreement Appendix H."

HFFACO Milestone M-45-05N-T01, *Final Completion of Tank C-106 SST Retrieval and Closure Demonstration Projec*t, states "Completion of the tank C-106 retrieval and closure demonstration project is defined as the completion of necessary field project actions required by the approved SST closure plan for C-106." This milestone will be fulfilled when all actions described in this component closure activity plan and required by the Site-Wide Permit are completed. The date for completion of all project activities is December 31, 2004. Table 5-4 lists the milestones for C-106 retrieval and component closure. Figure 5-4 shows the major C-106 component closure activities.

1.1.2 Component Closure Activity Process

The dangerous waste portion of the Site-Wide Permit for the treatment, storage, and disposal of dangerous waste (dangerous waste permit) issued in conjunction with the U.S. Environmental Protection Agency (EPA) hazardous and solid waste amendments permit, constitutes the Site-Wide Permit for the Hanford Site. This component closure activity plan will be incorporated into the WMA C Closure Action Plan portion of the *SST System Closure Plan*. Approval of the C-106 Component Closure Activity Plan is accomplished by incorporation into the Site-Wide Permit through the permit modification process.

In addition, a State Environmental Policy Act (SEPA) Environmental Checklist is being submitted concurrently with the application for modification of the Site-Wide Permit to support the C-106 component closure activities.

1.2 REGULATIONS AND STANDARDS APPLICABLE TO C-106 COMPONENT CLOSURE ACTIVITY

The C-106 retrieval and component closure activities are regulated by many requirements. Drivers include a state-federal agreement, federal and state statutes and regulations, and DOE directives and orders. A discussion of these requirements is contained in the Framework Plan.

Ecology regulates the SSTs as dangerous waste storage and treatment units under WAC 173-303, which implements the *Resource Conservation and Recovery Act of 1976* (RCRA). C-106 contains mixed waste and is included in the RCRA dangerous waste permit application, Part A, Form 3, submitted for the SST system.

1.2.1 SST Closure Performance Standards

The HFFACO requires that all treatment, storage and disposal (TSD) units, regardless of permit status, be closed under WAC 173-303-610. DOE will close the SST system in compliance with the performance standards set out in WAC 173-303-610 (2)(a) and -640(8). The actions described in this component closure activity plan are consistent with closure of the SST system in compliance with these performance standards. However, the C-106 component closure activities described in this plan are just the initial steps required to meet the closure performance standards for the WMA C and SST system (see Section 3.0 of the Framework Plan). Retrieval actions, isolation activities, and subsequent placement of fill layers into C-106 (described in Section 5.0 of this closure activity plan) will initiate the process of complying with the closure performance standards for the SST system.

According to HFFACO Milestone M-45-05L-T01, "Waste shall be retrieved to the DST system to the limits of the technology (or technologies) selected. Retrieval shall retrieve as much waste as technically possible, with a remaining residual of no more than 360 cubic feet (cu. ft.)." If the retrieval goal of 360 ft^3 is not met, DOE will request an exception to the criteria as specified in Appendix H of the HFFACO. This HFFACO requirement is one of the most significant tank-related performance standards. Retrieval of waste in accordance with these requirements, along with the other closure activities described in this plan, will make significant progress toward meeting closure performance standards at the WMA C and the SST system.

The three general closure performance standards defined in WAC 173-303-610(2)(a) are described in Sections 1.2.1.1 through 1.2.1.3. Removal or decontamination standards defined in WAC 173-303-610(2)(b) and WAC 173-303-640(8) are described in Section 1.2.1.4. Compliance with requirements will be documented in waste retrieval and closure demonstration project reports, and will be incorporated into the Site-Wide Permit as needed.

1.2.1.1 Minimize Need for Further Maintenance. Component closure activities planned for C-106 are designed to minimize the maintenance required after the actions are complete. Waste will be retrieved from C-106 to meet HFFACO retrieval goals and the tank will be isolated from the system. If the tank is filled as part of closure demonstration field activities, DOE will conduct annual visual inspections of the tank farm surface in the tank vicinity. If the tank is not filled as part of closure demonstration field activities, DOE will conduct annual visual inspections of the tank farm surface in the tank vicinity and will continue to operate any existing liquid detection or monitoring device, i.e., Enraf™. Other actions, such as capping lines and risers, covering the tank, and providing run-on controls also will serve to minimize the need for further maintenance.

1.2.1.2 Control the Postclosure Escape of Tank Waste to Protect Human Health and the Environment. C-106 will be retrieved to the extent technically possible in accordance with criteria set forth in Milestone M-45 and Appendix H of the HFFACO. Component closure activities, as described in Section 5.0, will include stabilizing any remaining wastes, complete filling of the tank for structural integrity and intrusion prevention, and isolating C-106 from the SST system and the environment. Tank isolation activities will include administrative actions and physical actions sealing off all pipes or other pathways between C-106 and the balance of the SST system. All of these activities will serve to control the postclosure escape of remaining

dangerous waste constituents. At a later point in the overall closure of the SST system, DOE will undertake final closure of WMA C. Individual actions will be assessed for their impact on long-term cumulative risk (i.e., WMA C together with other adjacent or nearby non-tank risk sources).

1.2.1.3 Return Land to Appearance of Surrounding Land Areas. This closure performance standard will be met as part of closure of WMA C and is not a part of this C-106 component closure activity plan.

1.2.1.4 Removal or Decontamination Standards. C-106 closure activities will comply with WAC 173-303-610 (closure and postclosure) and WAC 173-303-640(8) (tank system closure and postclosure care) requirements. WAC 173-303-640(8)(a) requires DOE to demonstrate removal or decontamination of tank waste residuals and structures to the extent practicable. Per WAC 173-303-610(2)(b)(ii), such removal or decontamination must assure on a case-by-case basis that levels of dangerous waste or dangerous waste constituents or residues do not exceed those established by Ecology and are in accordance with the closure performance standards of WAC 173-303-610(2)(a)(ii) for controlling, minimizing, or eliminating postclosure escape of dangerous waste constituents to the environment. These levels are identified as clean closure standards. Ecology clean closure guidance (Ecology F-HTWR-94-144) states that clean closure decontamination levels for metal tanks are generally considered to be met upon meeting the performance treatment standards contained in 40 *Code of Federal Regulations* (CFR) 268.45, Table 1 (debris rule treatment standards).

WAC 173-303-640(8)(b) requires that, if removal and decontamination of all contaminated soils is not practicable, postclosure care must be performed. The owner or operator must close the tank system and perform postclosure care in accordance with the closure and postclosure care requirements that apply to landfills (WAC 173-303-665(6)).

WAC 173-303-640(8)(c) requires that the closure plan for any tank system that does not have secondary containment include a contingent closure and postclosure plan. Because C-106 closure activities described in this plan do not constitute full closure of the entire tank system (WMA C), a contingent postclosure plan is not included as part of this C-106 closure activity plan. Instead, the contingent postclosure plan will be submitted as part of the WMA C closure action plan (Section C8.1) to which this plan is attached.

Retrieval and closure activities described in this plan will attempt to remove or decontaminate C-106 to the extent technically possible in accordance with HFFACO Milestone M-45-00 and to meet clean closure standards. Also, as part of this milestone, a data report will be submitted to Ecology to demonstrate completion of retrieval in accordance with M-45-00. The Tank Closure Environmental Impact Statement (EIS) under development will evaluate removal of a tank as a closure alternative.

Land use options available for tank system closure (including landfill and clean closure options) and the evaluation of environmental impacts for closure end-state alternatives will be addressed in the Tank Closure EIS during fiscal years 2003 and 2004. Ecology, as a cooperating agency, will play a key role in this process.

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2.0 C-106 UNIT DESCRIPTION

C-106 is one of twelve 100-series SSTs located in WMA C. The general WMA C site conditions are described in Section C2.0 of the WMA C Closure Action Plan (Appendix C of the *SST System Closure Plan*). Figures 2-1 and 2-2 show the location of WMA C and C-106, respectively.

2.1 C-106 COMPONENT CONSTRUCTION

Construction of C-106 was completed in 1944. The concrete foundation for the tanks was reinforced with steel reinforcing bar and formed into a dish shape. A three-ply membrane of asphalt waterproofing fabric was applied over the reinforced concrete foundation. The carbon steel tank was constructed of 0.25-inch steel using three pass welds. Waterproofing asphalt fabric was applied on the outside of the steel tank, and joined with the fabric covering the foundation. The tanks were then filled with water to test for leaks prior to pouring the concrete walls. The tank dome was poured and covered with three applications of lapidolith (zinc fluorosilicate wash), a strong concrete hardener (RPP-7155). Lead flashing was used around the top of the steel liner to protect the joint between the steel liner and the concrete wall.

2.1.1 C-106 Specifications

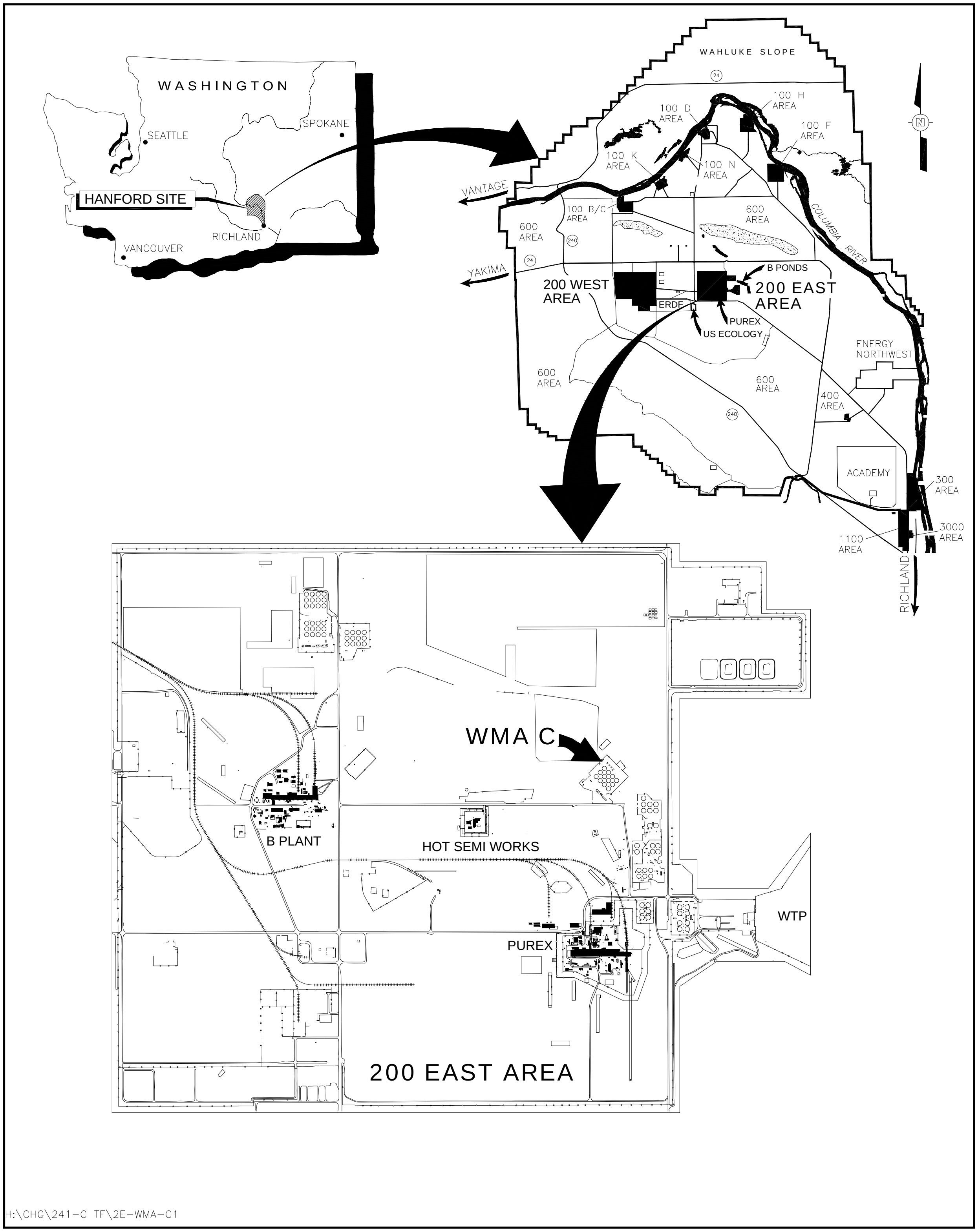
C-106 has a slight concave bottom and a curving intersection of the sides and bottom. This curvature decreases the buildup of stress in the bottom corners of the tank, reducing corrosive effects; thus reducing the chance of a leak developing in the tank bottom. C-106 is 23 m (75 ft) in diameter and approximately 9.75 m (32 ft) tall from the base to the dome. The dome of the tank is covered by a 1.83-m- (6 ft) thick layer of sand and gravel backfill. C-106 was constructed for a capacity of 2,000,000 L (530,000 gal) (Figure 2-3)[1].

2.1.2 Ancillary Equipment and Supporting Infrastructure

C-106 has nine associated pipelines. These include the cascade line between C-105 and C-106 and the two encased lines used for Project W-320, the waste retrieval project completed in October 1999 (RPP-6696). Four of the pipelines connect directly to the 241-CR-153 cascade diversion box. In addition, there are three at-tank pit drain lines connected to risers, three at-tank pits, an active ventilation system connected to a portable exhauster, and electrical and service connections (most of which have been disconnected, but the conduits remain in the ground) (RPP-10950).

[1] The SST system RCRA permit application, Part A, Form 3 (see Addendum 1 to Framework Plan) states that C-106's operating capacity is 1,892,700 L (500,000 gal).

Figure 2-1. Location Map of WMA C and Surrounding Facilities in the 200 East Area.



1 Figure 2-2. Location Map of C-106 within WMA C.

2

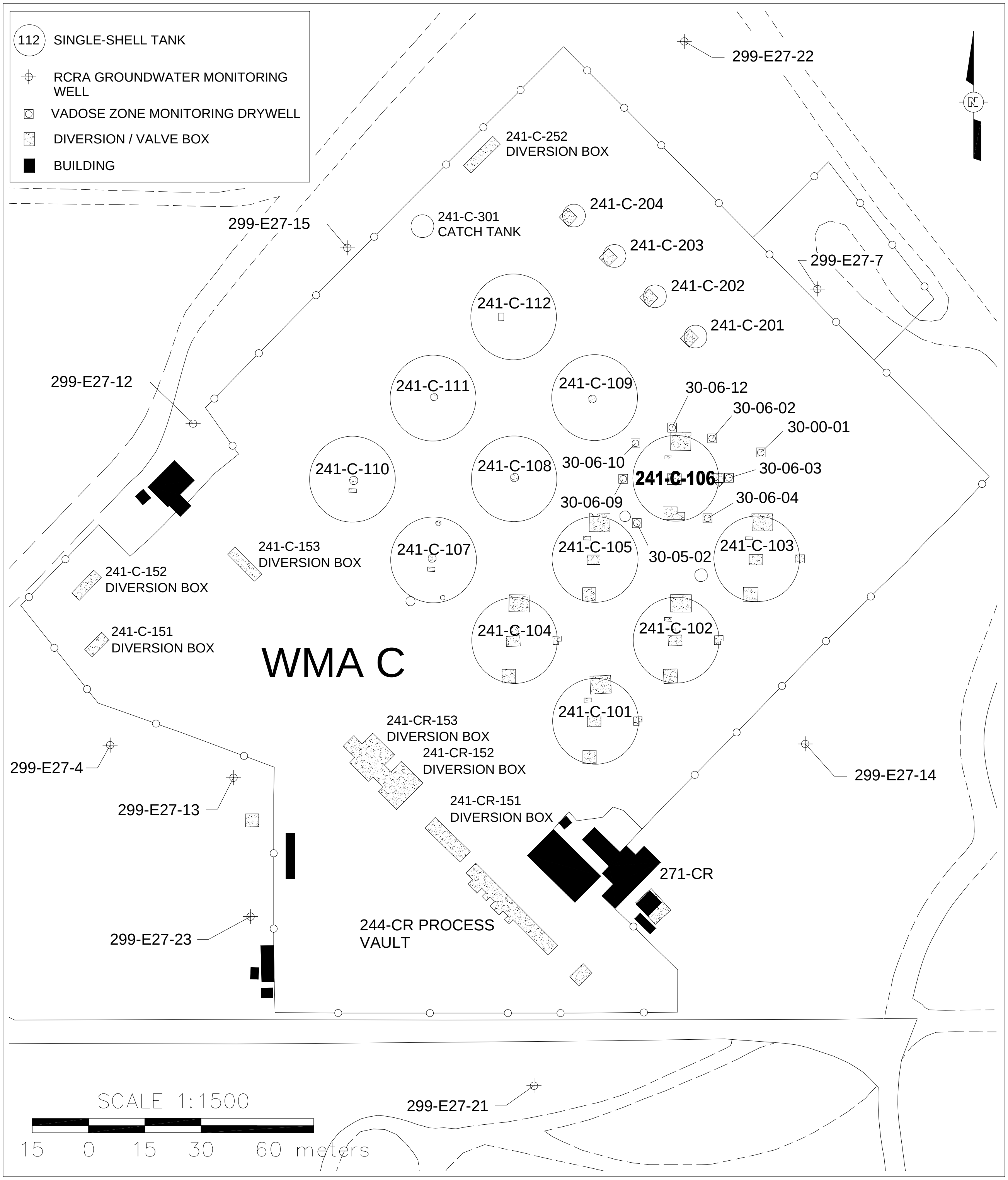


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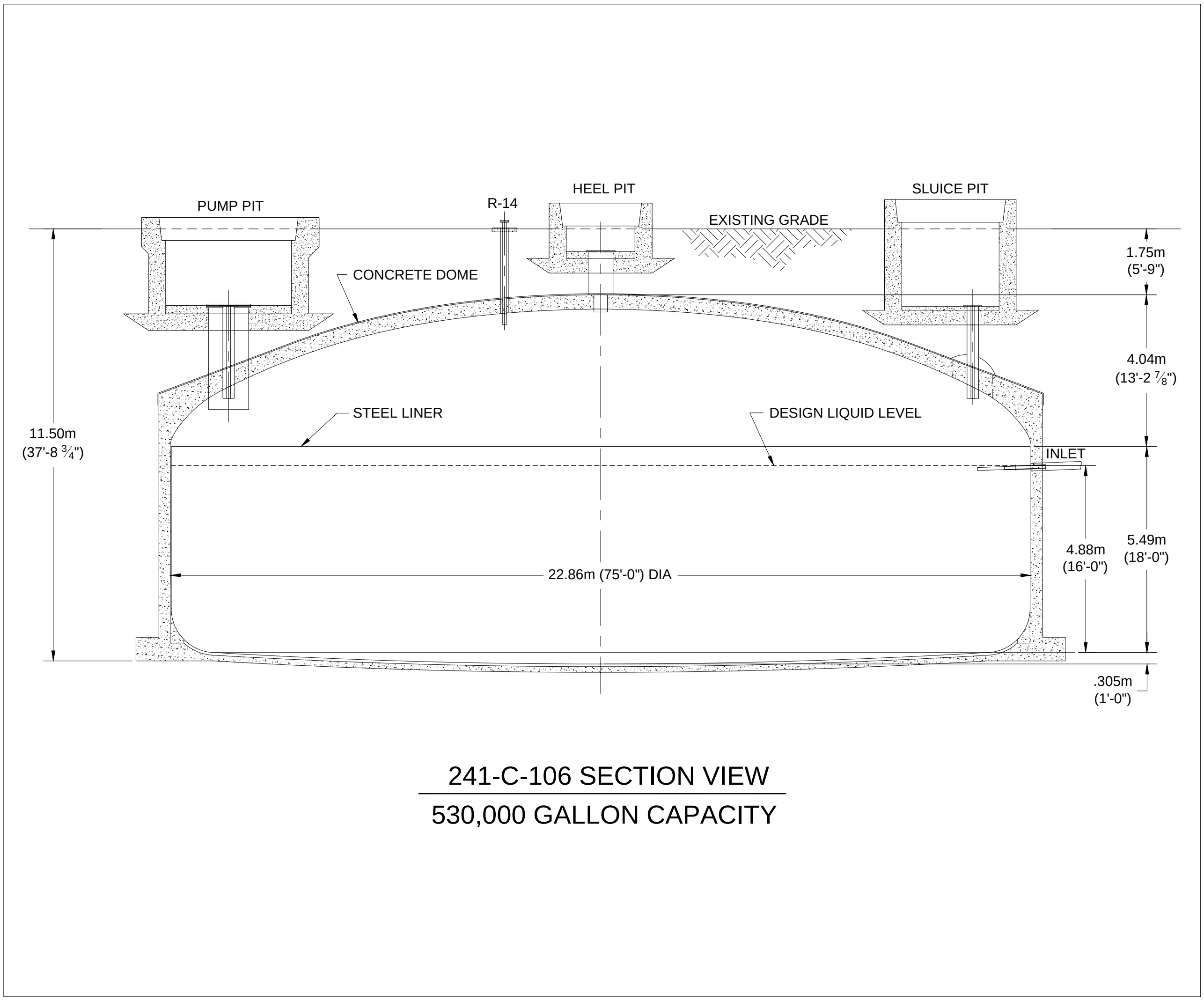
Figure 2-3. Configuration of C-106.



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C-106 also has 12 risers of varying diameters and lengths of protrusion into the tank. Each of the 12 risers is connected to various in-tank equipment, or serves a specific purpose listed as follows, as numbered on the tank:

Riser 1: Level indicating transmitter (Enraf™)

Riser 2: HVAC duct connected to portable exhauster

Riser 3: Sluicer jumper assembly

Riser 4: Recirculating dip leg (old)

Riser 5: Shield plug

Riser 6: Transfer pump PTX141 (failed)

Riser 7: Mixing eductor assembly

Riser 8: Thermocouple tree (temperature probe)

Riser 9: Slurry pump

Riser 13: Modified centrifugal Flygt pumps

Riser 14: Spare

Riser 15: High capacity breather filter

See Section 5.3 and Figure 5-2 for additional information on ancillary equipment adjacent to C-106.

2.2 C-106 OPERATIONS HISTORY

C-106 is the last tank in a three-tank cascade beginning with C-104 and C-105. C-106 was placed into service in 1947 when it received metal waste from the cascade overflow from C-105. In 1953, metal waste was sluiced for uranium recovery, then the tank became the metal waste supernatant blend tank, receiving metal waste from BY-102, C-104, C-105, C-202, C-203, and C-204 (LA-UR-96-3860). In 1953 and 1954, metal waste slurry was sent to U Plant for uranium recovery, and in 1954, uranium recovery waste was received into C-106.

In 1957, liquid waste from C-106 was sent to C-112 and C-109 for ferrocyanide scavenging and again during that same year C-106 received flush water, high-level plutonium-uranium extraction (PUREX) waste from A-101 and A-102, and organic wash water from A-102. Between 1958 and 1960, PUREX cladding waste was sent to C-106, and supernatant was sent from C-106 to BY-110. In 1963, supernatant was sent to B-101 and B-107. In 1963 and 1964, waste was received from and sent to A-102. In 1965, C-106 received decontamination waste from the CR vault.

In 1968, most of the waste in C-106 was sent to C-105. Between 1968 and 1971, C-106 received washed PUREX waste from the 244-AR vault. During this time, C-106 also received waste from A-102, A-104, A-106, and C-103, and sent waste to A-102, C-103, and C-105. In 1972, C-106 received waste from A-106.

Between 1974 and 1976, low-level waste from B Plant and flush water was sent to C-106. During this time, waste was sent from C-106 to AX-103, C-103, and C-104. Between 1976 and 1979, strontium recovery waste from B Plant and complexed and evaporator waste were sent to and received from A-102. In 1978, waste was sent from C-106 to AZ-101. In 1979, C-106 was declared inactive.

In August 1983, C-106 was partially interim isolated (WHC-SD-WM-ER-349). Partially interim isolated is an administrative designation reflecting the completion of the physical effort required to minimize the addition of liquids to an inactive storage tank, except for isolation of risers and piping that is required for jet pumping or for other methods of stabilization.

A maximum volume of approximately 2,080 kL (550 kgal) of waste in C-106 was reached twice—once in 1952 and again in 1966.

2.3 TANK INTEGRITY SUMMARY

The *Waste Tank Summary Report* (HNF-EP-0182), which documents the inventory for radioactive waste stored in the underground storage tanks, classifies C-106 as a "sound" tank. The "sound" tank classification is assigned to a tank when surveillance and historical data indicate no loss of liquid attributed to breach of integrity.

The "sound" tank classification is supported by results from vadose zone monitoring conducted in the eight vadose zone monitoring wells (drywells) associated with C-106. DOE employs various borehole geophysical logging methods in the drywells to evaluate the presence of man-made radionuclides in the vadose zone. The presence of man-made radionuclides in the vadose zone may be an indicator of contamination from the tank or ancillary equipment (e.g., pipelines) leaks, surface spills, or sources outside the WMA boundary.

Vadose zone monitoring conducted to date in drywells around C-106 have detected the presence of cesium-137, europium-154, uranium-235, and cobalt-60 at depths ranging from ground surface to below 38 m (125 ft). Analyses of the concentrations and distribution of these man-made radionuclides indicates that the presence of cesium-137, europium-154, and uranium-235 near the surface and at depths less than 15 m (50 ft) is attributed to surface spills and/or leaking pipelines. The presence of cesium-137 and cobalt-60 at depths greater than 15 m (50 ft) bgs is attributed to leaking transfer lines and/or tank leakage from sources other than C-106. Section 3.3 provides a more detailed discussion of the C-106 drywell-monitoring network and results from the borehole geophysical logging program.

Tanks listed in the Waste Tank Summary Report were categorized as leakers or assumed leakers to determine their status for continued use specifically for the receipt and storage of radioactive waste. Many of these tanks were evaluated at the initiation of the tank categorization process in 1989. With the exception of those tanks that demonstrated significant losses of tank liquids, this categorization required the interpretation and consolidation of many sources of information. Reproducibility was facilitated by procedure development. Tank status is not updated as new data and information are obtained.

Recently, in support of developing estimates of curies leaked to the vadose zone (which are not contained in the Waste Tank Summary Report), a preliminary evaluation of the available data to support these historic decisions was conducted in conjunction with the more recent geophysical data and other information. This later information was not available at the time the initial "sound tank" decisions were made. Based on that evaluation, areas of contamination were, on occasion, not found around some tanks declared leakers or assumed leakers and vice versa. Estimates of

curies leaked to the vadose zone were based on an evaluation of all the data available at the time and documented for review. The process will be updated as new information is uncovered.

For the purpose of selecting retrieval methods, no changes to the designation provided by the Waste Tank Summary Report are suggested. When other information is available that provides insight into the historical integrity of a tank, it will be evaluated and provided as part of the permitting process in light of its intended purpose in retrieval. Information provided in Section 3.3 summarizes those areas where information was noted that may warrant additional evaluation based on the proposed use of the respective tank. Current tank integrity and historical tank integrity are dissimilar concepts on occasion. Since classic field tank integrity testing is considered unwise, Leak Detection, Monitoring, and Mitigation (LDMM) will be employed as the means to confirming tank integrity and to trigger alternative courses of action, as necessary.

As mentioned above, evaluations of in-tank level records and drywell logging information provides no indication that tank C-106 has contributed contamination to the soils surrounding the tank. However, prior to and during the C-106 retrieval operations initiated in November 1998 (see Section 2.4), groundwater monitoring data indicated fluctuations in technetium-99 and nitrate concentrations in well 299-E27-14. In addition, groundwater monitoring results have shown low levels of cyanide with a maximum observation occurring in June 2000, approximately six months after the previous C-106 retrieval operations. Fluctuations of concentration/activity of nitrate and technetium-99 during the waste retrieval operation may suggest dilution by an unknown water source. To date, an exact cause for the technetium-99, nitrate, and/or cyanide occurrences in groundwater beneath WMA C has not been established. Detailed WMA C groundwater monitoring information is provided in Section C3.0 of the WMA C Closure Action Plan. External geophysical logging during the latest retrieval effort provided no confirmation to indicate that a change in the current status of C-106 was warranted. Due to the apparent relationship between the occurrence of retrieval activities and fluctuations in selected groundwater constituents, Ecology requested (letter correspondence from Washington Dept. of Ecology to Mr. K. Michael Thompson, U.S. DOE, Oct 11, 2000), that "a minimum of quarterly monitoring..." be performed. DOE agreed and instituted quarterly groundwater monitoring around WMA C.

2.4 PRIOR C-106 WASTE RETRIEVAL ACTIONS

Retrieval actions include past-practice sluicing done in the late 1990s. In November 1998, Project W-320, a waste retrieval effort, was initiated in C-106 and was completed in October 1999 (RPP-6696). The purpose of Project W-320 was to resolve the C-106 high-heat safety issue and demonstrate a sluicing retrieval technology. The retrieval effort was completed in accordance with the requirements of HFFACO Milestone M-45-03B, in effect at that time. Retrieval was performed using the Project W-320 sluicing system. Measurements at that time indicated approximately 97% of the sludge, 707 kL (187 kgal) of the estimated 727 kL (192 kgal), in C-106 was sluiced to double-shell tank (DST) AY-102. Sluicing operations were conducted using AY-102 supernatant as the sluicing medium. A description of closure related retrieval activities is in Section 2.5.3.

Approximately 75% of the sludge was removed from C-106 in the first 10 batches. In the last 10 batches, sludge recovery progressively decreased, approaching zero recovery in the final batch. This occurred for the following reasons:

- Sizes of sludge pieces (up to 8 cm [3 in.]) in sludge piles exceeded the mesh size (0.63 cm [0.25 in.]) on the submersible slurry pump screen.
- The sludge pile and debris under the submersible slurry pump prevented further lowering of the pump.
- The sludge pile and debris under the submersible slurry pump could not be moved by the sluicing jet from the opposite side of the tank.
- A severed thermocouple pipe and flexible hose/float interfered with lowering of the submersible slurry pump.

Although the Project W-320 sluicing effort successfully resolved the C-106 high-heat safety issue and met the sluicing waste retrieval requirements defined in the HFFACO at that time, this effort did not meet the waste retrieval requirements currently defined in Milestone M-45-00 for tank closure. Milestone M-45-00 states, "Closure will follow retrieval of as much waste as technically possible, with tank residues not to exceed 360 cubic feet (cu. ft.) in each of the 100 series tanks, 30 cu. ft. in each of the 200 series tanks, or the limit of waste retrieval technology capability, whichever is less."

2.5 C-106 WASTE CHARACTERISTICS

The estimated volume and nature of the waste remaining in C-106 are discussed in the following subsections.

2.5.1 Waste Volume

The volume of the sludge in C-106 was estimated based on videos taken on July 13, 2000 and August 1, 2002. The surface of the sludge was uneven. The sludge surface contours were mapped and sludge volume was calculated to be 34,000 L (9,000 gal). The supernatant volume on August 1, 2002 was estimated to be 70,000 L (19,000 gal). On April 1, 2003, much of the supernatant in the tank was pumped to tank AY-102. Dilution water was used to facilitate the transfer. It was estimated that approximately 19,000 L (5,000 gal) of diluted supernatant remained in the tank after pumping. The total waste volume in C-106, as of April 2, 2003, was calculated to be 53,000 L (14,000 gal) by summing the sludge and supernatant volumes.

2.5.2 Best Basis Inventory

The best basis inventory (BBI) effort involves developing and maintaining waste tank inventories comprising 24 chemical and 46 radionuclide components in the 177 Hanford Site underground storage tanks. The BBI provides waste composition data necessary as part of the

River Protection Project process flow-sheet modeling work, safety analyses, risk assessments, and system design for waste retrieval, treatment, and disposal operations.

The inventory of C-106 is estimated in the BBI, with the effective date of April 2, 2003. In fiscal year 1999, most of the sludge in C-106 was sluiced to DST AY-102. On April 1, 2003, most of the remaining supernatant in C-106 was pumped to AY-102. Current C-106 inventories are based on samples obtained from AY-102 after sluicing in 1999, and were supplemented with model-based data when sample data were not available. The volume of the residual sludge was estimated based on in-tank videos taken on July 13, 2000 and August 1, 2002. The volume of the remaining supernatant was estimated based on liquid pumping records.

Because the BBI was not developed to address tank closure activities, it does not provide all of the necessary data to satisfy closure requirements. However, it was used in preparing the initial component closure planning documentation. A data quality objectives (DQO) process was conducted that will provide the basis for sampling plan preparation. For further details on the sampling plan and the DQO process, see Section 5.1. Completion of the planned sampling and analyses will result in the data needed for this component closure activity.

2.5.3 Waste Retrieval and Compliance with HFFACO Milestone M-45-00

According to HFFACO Milestone M-45-05L-T01, “Waste shall be retrieved to the DST system to the limits of the technology (or technologies) selected. Retrieval shall retrieve as much waste as technically possible, with a remaining residual of no more than 360 cubic feet (cu. ft.).” Following retrieval activities, DOE may use in-tank survey methods to determine whether retrieval criteria are met.

If the waste residuals in C-106 meet the retrieval criteria, DOE will proceed with implementing the approved component closure activity plan. If residuals in C-106 do not meet the retrieval criteria, DOE will request an exception to the retrieval criteria. This request would be prepared pursuant to the procedure in HFFACO, Appendix H, Attachment 2: “The request shall include, at a minimum, the following information:

1. The reason DOE does not believe the retrieval criteria can be met.

2. The schedule, using existing technology, to complete retrieval to the criteria – if possible.

3. The potential for future retrieval technology developments that could achieve the criteria, including estimated schedules and costs for development and deployment.

4. The volume of waste proposed to be left in place, and it’s [sic] chemical and radiological characteristics.

5. Expected impacts to human health and the environment if the residual waste is left in place.

6. Additional information as required by EPA and/or Ecology."

The request for exception to the retrieval criteria must be approved by EPA and Ecology.

Retrieval of the remaining waste in C-106 will likely have occurred prior to the effective date of modification of the Site-Wide Permit to include this C-106 closure activity plan. This timing is consistent with Milestones M-45-05L-T01 (completion of retrieval by November 2003) and M-45-05H (includes completion of approved C-106 retrieval and closure demonstration plan, i.e., this closure activity plan, by April 2004). Also, as part of this milestone, a data report will be submitted to Ecology to demonstrate completion of retrieval in accordance with M-45-00.

The majority of the waste in C-106 was removed in previous sluicing/retrieval efforts. The estimated volume of the solid waste remaining is approximately 34,000 L (approximately 9,000 gal). Because of the difficulty in removing this waste with available equipment, retrieval of the waste by dissolving it in oxalic acid will be demonstrated in C-106. The oxalic acid dissolution process has been tested on samples of C-106 residuals and more than 70% of the residual solids sample was dissolved. Laboratory testing indicates a 1-week reaction time for each of six 114,000-L (30,000-gal) batches of acid will be adequate to complete the reaction. Corrosion rates between 50 and 200 mils/yr are expected for the carbon steel walls of C-106 (RPP-16537 and RPP-16256). Because of the short duration of the oxalic acid contact with the tank and the low temperature (between 70 and 90 degrees Fahrenheit), significant corrosion is not expected. The waste retrieved from C-106 will be pumped to DST AN-106.

Oxalic acid will be added to C-106 and recirculated with a mixing eductor. The solution will be removed by a pump located in the central heel pit and transferred to AN-106 at a controlled rate using an underground, double-encased, waste-retrieval sluicing system transfer line. Enough sodium hydroxide has been added to AN-106 to neutralize the entire amount of acid to be used for C-106 acid retrieval. The pH in AN-106 will be maintained at > 8.0 at all times. After acid dissolution, the tank walls will be washed with the sluicing system and the wash water will be transferred to AN-106. A maximum of 250,000 gallons of water may be used for waste retrieval to AN-106. In the last step, liquid remaining in C-106 will be neutralized with approximately 10,000 gallons of caustic solution. This neutralized acid will also be pumped to AN-106.

The chemical wash with oxalic acid will involve the following steps:

- Adding acid to the tank to react with the residual sludge. The acid will be added into the tank in a series of batch loadings.
- Stir and allow each acid batch a 1-week reaction time or less based on pH monitoring.
- Add caustic solution to AN-106 to neutralize the oxalic acid when pumped from C-106.
- Pump each batch containing dissolved waste to AN-106.

A series arrangement of two transfer pumps exists within C-106. These pumps were installed to remove the remaining pumpable supernatant from the tank. These pumps will be used during

acid dissolution and waste transfer. A backup transfer pump arrangement has been designed and is being procured to replace the current pumps if they fail during acid dissolution operations.

An eductor was chosen as the acid mixing method because the eductor nozzle, intake, and liquid jet could be located below the surface of the acid/waste pool, resulting in little or no generation of aerosols within the tank dome space. The eductor assembly prevents the oxalic acid solution from sitting stagnant.

The sludge in C-106 contains carbonate that will neutralize the oxalic acid as it dissolves. Once the carbonate is gone, the pH will stabilize. There is still some uncertainty on how the actual waste in the tank will behave, so the rate of change in pH will be used for process control rather than the actual pH measurement.

Up to 795,000 L (210,000 gal) of acid may be used. Transfers will be through a dedicated, fully encased line, thus minimizing the possibilities of misrouting or cross-connections. The liquid waste will then be pumped to AN-106 where the acid will be neutralized by excess caustic solution.

The sluicing system in C-106 will be used after acid dissolution to rinse off the tank walls. This rinse water will be pumped to AN-106. The sluicing system includes a steerable nozzle system used to direct raw water within the interior of the tank.

2.5.4 Leak Detection, Monitoring, and Mitigation Strategy and Approach

The HFFACO identifies programmatic expectations for the advancement of retrieval and leak detection technologies. The approach is based on preventing leakage, using available data for indication of possible leakage, and minimizing leak volumes if a leak should occur. Leak Detection, Monitoring, and Mitigation methods are undergoing development and evaluation and may vary according to tank-specific conditions and waste retrieval technologies deployed. Retrieval activities are anticipated to be complete prior to the effective date of modifications of the Site-Wide Permit to include C-106 component closure activities.

The primary goal is leak mitigation. C-106 is believed to be a structurally sound tank. Oxalic acid has a very low corrosion rate for the steel used to construct the tank. The time at risk will be low as the retrieval time is projected to be less than 6 weeks. Leak mitigation strategy for C-106 heel retrieval begins by quickly removing each batch of acid/waste from the tank and keeping the liquid levels low. The operations strategy is designed to mitigate any undiscovered leaks during retrieval operations as well as to respond properly to any detected leaks. The use of common sense, operational plans, and process observations supplement the baseline leak detection methods. Transfer line leak detection will consist of transfer line and pit leak detection alarm systems.

The available leak detection methods are 1) monitoring liquid level, 2) monitoring mass balances on liquids added and removed, and 3) monitoring the eight vadose zone monitoring wells

(drywells) associated with C-106. Process control data will be used to compare liquid added to liquid removed from the tank to reveal a gross deficit resulting from possible leakage.

Leak detection in quiescent SSTs has historically been based on level monitoring. Static liquid level monitoring works well if the tank being retrieved and the receiver tank both have a free liquid surface that can be accurately measured and used to estimate waste inventory in both tanks. Static level monitoring will be used for leak detection during the acid dissolution step and to provide mass balance data.

Static liquid level measurements using a direct Enraf™ level detector will provide mass balance data to indicate leakage. This instrumentation has a high degree of resolution and repeatability and is well suited for the volumetric method in tanks with a measurable air-liquid interface.

A leak from AN-106 can also be detected by either a conductivity probe leak detection system installed in the annulus or a continuous air monitor that detects airborne radionuclides entrained in the annulus ventilation exhaust stream. Detection of a leak into the annulus of the tank by either system activates an audible alarm and an annunciator panel light.

Leakage from the primary over-ground transfer hose (inner hose) will be contained by the secondary confinement system (outer hose) and detected by one of the leak detectors. The secondary confinement system has been designed to drain any fluid released from the primary hose to a common point for collection, detection, and removal. The hydraulics of the C-106 to AN-106 transfer pipeline cause any leakage to the secondary containment to drain towards C-106.

2.5.4.1 Dry Well Monitoring. Available ex-tank leak detection methods involve indirect measurement of subsurface conditions in the drywells surrounding the tank. Drywell monitoring has been used extensively in the past for leak detection and monitoring.

The eight vadose zone monitoring wells (drywells) associated with C-106, 30-00-01, 30-06-02, 30-06-03, 30-06-04, 30-06-09, 30-06-10, 30-06-12, and 30-05-02, will be used for monitoring fluid losses that may occur during retrieval operations. These wells are open-bottom, mild steel cased, 15.2 or 20.3 cm (6 or 8 inches) in diameter, and extend to depths of 23 to 30.5 m (75 to 100 ft (7.6 to 15.2 m [25 to 50 ft] below the tank bottom). A leakage plume that migrates within the detection range of 0.3 to 0.6 m (1 to 2 ft) of the dry wells will be detected by this method. The monitoring uses gamma radiation probes and neutron moisture instruments to detect a change in the radiation and moisture profiles over the length of the dry well. A baseline profile will be taken prior to retrieval operations. Subsequent monitoring results will then be compared with that baseline profile.

Because of the low percentage of soil interrogated and the timeframe required for leaks to migrate within range of the dry wells, detection of small leakage volumes (less than 15,000 to 45,000 L [4,000 to 12,000 gal]) is beyond the capabilities of the dry well system. However, the system will provide confirming information for the occurrence of a larger leak caused by either a continuous small leak or a shorter-term leak with a fast leak rate.

Additional surveys may be done using hand-held neutron moisture monitors. These surveys would be "quick looks" taken near the elevation of the tank bottom and near the cold joint between the tank's concrete base and walls. This elevation is where a leak is most likely to occur and is also where a plume is most likely to spread out to the dry wells because of the compacted soil in the construction elevation. Hand-held monitor surveys can also be used as needed to verify conditions if other methods indicate a possible leak or if a surface event, such as a snow melt, releases moisture into the soil. These additional surveys would increase the chance that a transitory plume may be detected.

Additional drywells within the farm may be monitored to investigate whether observed changes at C-106 are localized or more widespread as would be expected from seasonal changes in precipitation.

2.5.4.2 Liquid Level Monitoring. Another leak detection method available is to monitor the liquid level using the Enraf™ level gauge or visually, if the Enraf™ is not available. At appropriate times, the Enraf™ level gauge will be lowered into C-106 and placed in the liquid level-monitoring mode. The liquid level will be monitored for a period of time ranging from overnight to several days to detect a trend in the surface level that may indicate a potential leak.

Since the mitigation strategy requires that the liquid level be minimized between or at the end of retrieval operations, it is likely that there will be no liquid level under the Enraf™ level gauge, and it will not be possible to directly measure liquid level. During the acid retrieval batches, there will be sufficient liquid in the tank to use the Enraf™. However, there will be recirculation currents. The effect of the recirculation currents on the accuracy of the Enraf™ is not known. Recirculation may have to be stopped during readings.

Solids may be present under the Enraf™ that will cause the Enraf™ to display erroneous readings. This is highly likely to occur during the acid dissolution phase as it has occurred routinely during liquid removal, sluicing, and waste redistribution operations.

In the very likely event that the Enraf™ level gage cannot access the liquid pool, visual surveys will be done based on the diameter of the pool. Video recording of the exposed area of the tank will be required at the completion of each campaign as input to the leak detection material balance.

2.5.4.3 Material Balance Monitoring. The data requirements for performing the material balance include the AN-106 tank waste level from Enraf™ measurements (or a suitable replacement method if unavailable), waste flow from C-106, and raw water flow totalizer readings or water addition log sheets as applicable. There are no transfer routes into or out of C-106 other than the waste transfer line. During retrieval of C-106, all other transfers into tank AN-106 must be curtailed. Any waste leaks inside the pit would cause the pit leak detector to alarm and lead to shutdown of the transfer pump.

The Enraf™ in C-106 is on the edge of the dished bottom. Therefore, the Enraf™ will not respond to the liquid removal during the last portions of the transfers.

The material balance will be kept to assist in understanding what is happening with the process. However, the material balance will be of limited usefulness for LDMM purposes because of the dynamics of the process, as discussed below.

When oxalic acid is added to the tank waste, approximately 25% of the waste will effervesce as gas. This amount of gas cannot be measured, which means that the material balance will be inaccurate by at least 25%. The tank waste solids will change volume as they are dissolved in the acid. The 1,000 scfm air flow through the tank will evaporate some of the rather dilute acid. Eventually, some of the oxalate has the potential of forming insoluble oxalate solids in C-106 that will have an unknown density. When the acid is neutralized in AN-106, the dissolved solids will re-precipate, but they will not necessarily be the same species as were present in C-106. The oxalic acid will neutralize into insoluble sodium oxalate, so additional solids that were not present in C-106 will be created. The solids formed in AN-106 will need time to coalesce, settle and compact. Initially these solids will form a fluffy layer that will settle into a solid bed and eventually compact to a smaller volume.

An assessment of the C-106 ventilation system for compatibility with the anticipated oxalic acid vapors concluded that there would be negligible oxalic acid vapor that will enter the ventilation system. The predicted molar concentration of oxalic acid in the vapor space is $2.1X10^{-9}$. It was also concluded that due to the design of the in-tank acid mixing system, few aerosols would be created during retrieval operations (RPP-16256). A demister upstream of the filters will remove approximately 99% of any oxalic acid aerosols. In addition, a heater upstream of the filters will raise the temperature of the gas by 10 degrees Fahrenheit to minimize any condensation on the filter media.

The majority of the components of the ventilation system are stainless steel with a few items being carbon steel. Stainless steels and carbon steels are generally rated unsatisfactory for oxalic acid for long-term use. However, due to the short life of the project and low temperatures, the stainless steel and carbon steel components of the ventilation system are not expected to suffer significant corrosion.

Calculations of the heat of reaction caused by neutralizing the acid in AN-106 predict a maximum increase in temperature of 13 degrees Fahrenheit, assuming a worst-case scenario where all the acid was neutralized at once. The actual temperature rise will be less than this and well within the operating temperature for the tank (RPP-16462). The neutralization reaction will not produce gases.

The measured flow out of C-106 will be compared with the measured volume in AN-106. This will provide an understanding of the change in volume resulting from solids. However, this volume may be too small on any given batch to make a clear determination.

2.5.5 Characterization of Residual Wastes

Residual waste is any waste left in the tank at the end of the waste retrieval process. A DQO has been completed to develop a sampling plan for the C-106 residual waste (RPP-13889). Residual

waste in the tank will be sampled and analyzed after completion of the waste retrieval activities (see Section 5.1 for details).

The current method available for determining the residual waste volume remaining in C-106 is a video camera and modeling system. This system, used for the initial baseline measurements of C-106 (RPP-12547), can be deployed without additional development. A second method, the tank volume measurement system (TVMS), consists of a television camera and a laser range finder. The TVMS is inserted into a tank riser and the camera and laser range finder are used to map the surface of the residual waste in the tank. The TVMS will be used in C-106 if it is developed in time and determined to be a more effective and accurate method for waste volume measurements.

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3.0 HYDROGEOLOGY AND EXTENT OF VADOSE ZONE CONTAMINATION AT C-106

This section describes the hydrogeology, depth to the unconfined aquifer, and known extent of vadose zone contamination in the vicinity of C-106. Vadose zone monitoring activities are summarized and plans for future vadose zone characterization are identified. No tank-specific groundwater quality data exist, because groundwater monitoring is conducted for the entire WMA C. Further discussion of groundwater quality is provided in the annual RCRA groundwater monitoring reports (PNNL-13788). A description of groundwater monitoring activities is available in the WMA C groundwater monitoring plan (PNNL-13024 -ICN-1) and summarized in the WMA C Closure Action Plan (Appendix C of the *SST System Closure Plan*).

3.1 HYDROGEOLOGIC DESCRIPTION

The uppermost aquifer beneath C-106 occurs at approximately 75.9 m (249 ft) below ground surface (bgs) or 64.6 m (212 ft) below the bottom of the tank (PNNL HydroDat Database 2002). Details on the nature of the unconfined, uppermost aquifer are provided in PNNL-13024 and PNNL-13024-ICN-1.

In general, aquifer materials beneath C-106 are composed of sandy gravel or silty sandy gravel. Although there is some consolidation of sediments within the unconfined aquifer, there is little evidence of compaction or cementing. Consequently, permeability is high and relatively homogeneous within the aquifer. The hydraulic gradient beneath C-106 is relatively flat and groundwater currently flows toward the southwest (PNNL-13024, PNNL-13024-ICN-1). Historically, groundwater flow direction and gradient in the vicinity of WMA C has been influenced by the substantial groundwater mound beneath 216-B-3 ponds (B pond), located east of WMA C. The B pond mound, when at its peak, caused groundwater to assume a west to northwest flow direction. Following discontinuation of discharges to B pond, the mound has dissipated. As a result, the groundwater flow direction beneath WMA C has begun to return to what is expected to be its natural flow direction (generally southeast toward the Columbia River). The gradient beneath WMA C is currently very small and the flow direction (where it can be reliably measured) is variable, but is generally toward the southwest. The flow direction is expected to continue to change until it ultimately assumes a southeast direction. The actual time required for return to a normal flow pattern beneath WMA C will be driven by the decay of the B pond mound and potentially by continuing discharges to the Treated Effluent Discharge Facility located to the east of the 200 East Area.

The base of the uppermost unconfined aquifer is defined by the top of the basalt, which is estimated at 92 m (303 ft) bgs or 81 m (266 ft) below the bottom of C-106. Based on this estimate, the unconfined aquifer below C-106 is approximately 17 m (54 ft) thick.

3.2 VADOSE ZONE DESCRIPTION

The vadose zone is contained within the following strata (listed oldest to youngest). A brief description of each of these strata is found in Section C3.2.1 of the WMA C Closure Action Plan.

- Hanford formation lower-gravel sequence
- Hanford formation sand sequence
- Hanford formation upper-gravel sequence
- Backfill material.

Texturally, the vadose zone is largely comprised of coarse sands with some gravels and silts. Clastic dikes were observed during construction of WMA C but were not mapped (ARH-LD-132).

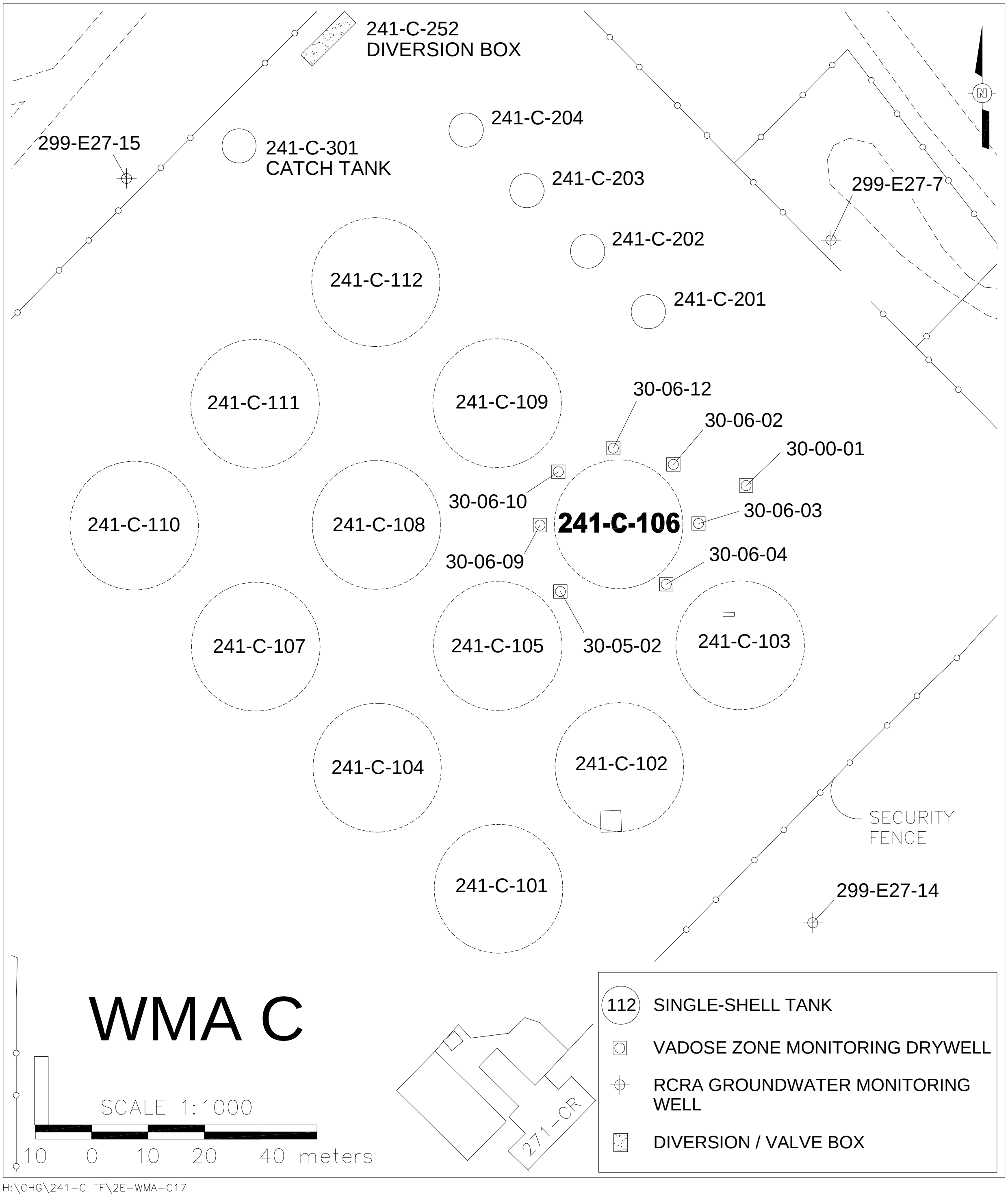
3.3 EXTENT OF VADOSE ZONE CONTAMINATION

This section describes the known extent of vadose zone contamination in the vicinity of C-106 to supplement groundwater data. As noted in Section 2.3, C-106 is believed to be a sound tank. There is no evidence of any waste leakage from C-106. There have been releases that have contaminated the environment from other tanks and ancillary equipment within the WMA C. Vadose monitoring efforts described in the following section provide data from drywells located around C-106.

3.3.1 Vadose Zone Monitoring – C-106 Drywells

Figure 3-1 shows the eight vadose zone monitoring wells (drywells) associated with C-106. These wells are identified as 30-00-01, 30-06-02, 30-06-03, 30-06-04, 30-06-09, 30-06-10, 30-06-12, and 30-05-02. In 1997, under DOE *Atomic Energy Act of 1954* authority, these eight wells were logged using a high-resolution spectral-gamma logging system. This effort was part of the baseline characterization for WMA C (GJO-HAN-18). Follow-up logging was conducted on selected drywells based on findings from the baseline characterization. Results from the follow-up logging have been documented (GJO-HAN-18). The purpose of the baseline characterization was to acquire a technically defensible baseline of the distribution and concentrations of individual gamma-emitting radioisotopes within the vadose zone. Results of the baseline characterization for C-106 are documented in GJ-HAN-84.

1 Figure 3-1. C-106 Vadose Zone Monitoring Network.



2

The current vadose zone monitoring program implemented at WMA C as well as other tank farms on the Hanford Site is described in GJO-HGLP-1.7.1. Under this plan, drywells are monitored (logged) on a quarterly, annual, or a 5-year frequency. The order and frequency of monitoring is based on a priority score that is calculated using tank and plume-related factors developed from the baseline characterization. Table 3-1 lists the frequency of routine monitoring currently established for the eight wells associated with C-106 (MAC-HGLP 1.8.1, Appendix A).

GJO-HGLP-1.7.1 describes the tasks and organizational requirements associated with routine vadose zone monitoring operations in the SST system farms. Included are the methods and procedures associated with data evaluation, selection, and prioritization of individual borehole intervals to be logged, scheduling, data acquisition procedures, and reporting.

Table 3-1. Frequency of Monitoring for C-106 Drywells.

Well Identification	Monitoring Frequency (yrs)
30-06-02	5.0
30-06-03	5.0
30-06-04	1.0
30-06-09	1.0
30-06-10	0.5
30-06-12	1.0
30-00-01	1.0
30-05-02	1.0

3.3.2 Vadose Zone Monitoring Results

The tank summary data report for C-106 documents the results of the 1997 spectral-gamma logging performed in the eight drywells around the tank (GJ-HAN-84). In general, manmade radionuclides detected in the subsurface around C-106 were cesium-137, cobalt-60, europium-154, and uranium-235.

Table 3-2 provides a summary of the detected gamma-emitting radionuclides from the 1997 spectral-gamma logging and previous radionuclide logging activities. A detailed analysis of these data and explanation of possible sources is provided in GJ-HAN-84.

The major conclusions from the 1997 logging effort at C-106 are as follows (GJ-HAN-84):

- Surface spills and subsurface leaks may have previously occurred in the vicinity of the tank and may be related to activities associated with C-106 or other nearby tanks.
- Cesium-137 is stable (not moving), based on a comparison of the 1997 spectral-gamma logging system data with the 1993 radionuclide logging system radionuclide logging system data.

Table 3-2. Summary of 1997 Baseline Spectral-Gamma Logging Around Tank C-106.

Radionuclide	Detected Location		Suspected Source	Suspected Migration Route
	Boreholes	Depth (datum-ground surface)		
Cesium-137	All	Near surface and shallow subsurface	Surface spills, airborne, or both (WHC-SD-EN-TI-185)	Soils, pipelines
Cesium-137, Europium-154, Uranium-235	All	Ground surface	Direct gamma radiation from contaminated equipment or localized surface spill	Soils
Cesium-137	30-06-02 30-06-03 30-06-04 30-05-02	2-3 m (5-10 ft)	Surface spills	Soil and/or tank dome
Cesium-137	All	10-20 m (40-50 ft)	Near surface spills	Tank dome runoff
Cesium-137	30-06-03 30-06-04 30-05-02 30-06-09	8.2 m (27 ft)	Separate source, surface spill or transfer line leak (WHC-SD-EN-TI-185)	Soil
Cesium-137, Cobalt-60 (intermittent)	30-00-01	15.4-20.6 m (50.5-67.5 ft)	Nearby tank or ancillary equipment	Soil
Cesium-137	30-06-04	16 m (52 ft)	Tank C-103 leak or ancillary equipment	Soil
Cobalt-60	30-05-02	23-24.5 m (75-80.5 ft)	Tank C-103 leak or ancillary equipment (WHC-SD-EN-TI-185)	Soil
Cobalt-60	30-06-04	26-27.6 m (85-90.5 ft)	Tank C-103 leak or ancillary equipment (WHC-SD-EN-TI-185)	Soil
Cobalt-60	30-06-10	26-35.51 m (86-116.5 ft)	Tank C-109 leak or ancillary equipment (WHC-SD-EN-TI-185)	Soil
Cobalt-60	30-06-12	5.94-6.86 (19.5-22.5 ft)	Transfer line or pipeline	Soil
Cobalt-60	30-06-12	30-40 m (90-130 ft)	Tank C-109 leak or ancillary equipment (WHC-SD-EN-TI-185)	Soil

Source: GJ-HAN-84

- Cobalt-60 has migrated, based on a comparison of the 1997 spectral-gamma logging system data with the 1993 radionuclide logging system data from borehole 30-06-10.

In 1999, geophysical logging using the spectral-gamma logging system was repeated in well 30-06-10. The primary purpose for this logging effort was to further evaluate the cobalt-60 plume below 26 m (86 ft). Data from the 1999 logging were compared to the baseline

characterization data from 1997 as well as previous spectral logging and gross-gamma logging dating back to 1985.

The primary observations from this study were that cobalt-60 appears to be relatively stable over time from 26 m (86 ft) to about 33 m (108 ft) and cobalt-60 below 33 m (108 ft) is increasing over time.

A detailed discussion of the 1999 spectral-gamma logging results for well 30-06-10 as well as the analysis of the cobalt-60 plume are documented in GJO-HAN-18. Movement of cobalt-60 also was noted in a letter to DOE dated March 10, 1999 (Bertsch 1999).

During the third quarter of fiscal year 2002, well 30-06-10 was logged as part of the routine vadose-zone monitoring program discussed in Section 4.3.1. Spectral-gamma logging system data collected from this event continued to exhibit evidence of downward migration of cobalt-60 below approximately 38 m (125 ft) (DOE-GJO 2002).

The cobalt-60 plume identified in well 30-06-10 appears to correlate with cobalt-60 detected between tanks C-108 and C-109, and at a similar depth in well 30-06-12 (GJO-HAN-18) and was previously attributed to source(s) associated with C-109 (WHC-SD-EN-TI-185).

After the 1997 spectral-gamma logging was performed around C-106, additional data were obtained from spectral-gamma logging around C-103 (GJ-HAN-82) and C-109 (GJ-HAN-91). These data, and additional vadose characterization data have been analyzed and reported in “Subsurface Conditions Description of the C and A-AX Waste Management Area” (RPP-14430). The primary conclusions presented in this report are (1) most of the vadose zone contamination in C Farm originated from surface or near surface sources, (2) tanks listed as known or suspected leakers did not exhibit an expected soil leak signature, and 3) contamination around C-106 may indicate the need for additional investigation prior to the implementation of a modified sluicing or similar retrieval technology.

3.3.3 Planned Vadose Zone Characterization

There are no contaminant characterization data for the vadose zone from the bottom of the drywell monitoring network to the groundwater in the vicinity of C-106. The deepest drywell around C-106 is 46 m (150 ft) bgs (well 30-00-01), and the maximum logged depth is 39.47 m (129.5 ft) bgs (well 30-06-04). A vadose zone investigation is planned for WMA C in fiscal year 2004 or 2005 (RPP-16608).

Additional vadose zone characterization outside the WMA C fenceline also will be conducted during the drilling and installation of the new groundwater monitoring wells discussed in Section C3.5.5 of the WMA C Closure Action Plan.

4.0 CLOSURE RISK ASSESSMENT RESULTS

The first approximation of the comprehensive closure risk assessment for WMA C has been prepared. The comprehensive risk assessment is presented and described in detail in the WMA C Closure Action Plan, Section 5.0 and Addendum C1. The purpose of this section is to describe the estimated risk impacts related to tank waste retrieval efficacy and proposed closure conditions for C-106. The analysis presented in this section is intended to focus the results of the WMA-level risk assessment to the single component (i.e., C-106). Using this approach, the component risk assessment can be appropriately placed in the perspective of the WMA as a whole. This approach also provides a basis for evaluation of potential waste retrieval effects on long-term risk metrics.

Included in this section are the long-term impacts to groundwater and the future use of this groundwater. Multiple exposure pathways (ingestion, inhalation, food chain, etc.) were considered for groundwater use. These exposure pathways are given in Table 26 of Addendum C1. Intruder scenarios were not considered in this document. However, in the future, DOE O 435.1 based intruder calculations will be provided to Ecology as part of a performance assessment. Based on preliminary discussions on implementing the recently proposed TPA Closure Process, performance assessments will replace risk assessments. The performance assessments will be designed to meet DOE, Ecology, and EPA's needs in this area. The performance assessment will become a central document in the effective integration of each agencies regulations and guidelines. The performance assessment document's contents will generally follow the DOE O 435.1 with modifications based on discussions among Ecology and EPA, and DOE. Short-term risk for C-106 is given in Section 9.0 of Addendum C1.

The WMA C risk assessment provides the mechanism for cumulative evaluation of risk contributions from multiple source terms as well as multiple constituents within individual source terms. At the individual WMA component level for C-106, the following source terms have been identified as applicable:

- Residual post-retrieval tank waste
- Residual waste in ancillary equipment adjacent to the tank (no inventory has been specified for ancillary equipment specifically associated with C-106 at this time, although ancillary equipment is addressed at the WMA C level)
- Hypothetical leaks from the tank occurring during waste retrieval
- Past leaks from the tank and/or adjacent ancillary equipment (no inventory is applicable to C-106 at this time).

The base case closure condition identified for C-106 risk assessment is described as follows:

- Residual waste will be retrieved to a maximum of 360 ft^3 residual waste using oxalic acid dissolution.

- Grout[*] fill will be placed in the tank.
- The tank will be isolated to prevent inadvertent entry of waste or other materials (e.g., rainwater) into the tank.
- An 8,000-gal leak of solution during retrieval is assumed to occur.
- Ancillary equipment adjacent to the tank (e.g., pipes, valves, valve pits, etc.) will remain in place and may contain currently-unquantified amounts of residual waste.
- The existing vadose zone contamination adjacent to the tank will remain in place after component closure activities.

A hypothetical retrieval leak is applied to the waste retrieval action at C-106 based on the current plan to use a high-volume liquid retrieval method. The hypothetical retrieval leak contributes most of the estimated long-term impacts to groundwater related to this tank. For the purposes of this component closure activity plan, the selected risk metrics examined are incremental lifetime cancer risk (ILCR) (target is less than 1.0×10^{-5}), the non-carcinogenic hazard index (target is less than 1.0), the DOE drinking water beta/photon dose limit (target is less than 4.0 mrem/yr effective dose equivalent [EDE]), and the individual-constituent maximum contaminant levels (MCLs) defined by the federal primary drinking water standards (target is no exceedence). The results of the long-term impact estimate for the closure conditions described above are summarized in Table 4-1 for the selected closure metric exposure scenario (i.e., the industrial worker scenario). The individual contributions of source terms and other variables are described in the following subsections. The values presented in Table 4-1 are peak values identified over the 10,000-year simulation period. For the base case retrieval of C-106, there is approximately a four-fold reduction in ILCR if the tank is retrieved to TPA goals. However, the major contributing source term is the retrieval leaks. If retrieval leaks are mitigated (i.e., they do not occur), then there is a six-fold reduction in ILCR.

Table 4-1. Summary of Long-Term Groundwater Impacts Based on Selected Closure Conditions for C-106. (2 Pages)

Groundwater Risk Metric	Pre-Retrieval Value (Peak)	C-106 Closure Value (Peak)	Closure Target Value	Major Contributing Source Term
ILCR (unitless) (Industrial Worker Scenario)	4.9 E-07	1.3 E-07	<1.00 E-05	Hypothetical 8,000-gal retrieval leak
Non-Carcinogenic Hazard Index (unitless) (Industrial Worker Scenario)	3.7 E-03	9.8 E-04	<1.00 E+00	Residual Tank Waste

[*] See Preface in *SST System Closure Plan* (RPP-13774).

Table 4-1. Summary of Long-Term Groundwater Impacts Based on Selected Closure Conditions for C-106. (2 Pages)

Groundwater Risk Metric	Pre-Retrieval Value (Peak)	C-106 Closure Value (Peak)	Closure Target Value	Major Contributing Source Term
Ionizing Radiation Dose via Drinking Water Exposure (mrem/yr EDE) (2 L/day consumption))	5.7 E-02	1.5 E-03	<4.00 E+00	Hypothetical 8,000-gal retrieval leak
MCLs (Primary Drinking Water Standards)	Not Evaluated	No Exceedences	No Exceedences	Hypothetical 8,000-gal retrieval leak

EDE = effective dose equivalent
ILCR = incremental lifetime cancer risk
MCL = maximum contaminant level

4.1 INTRODUCTION AND RELATIONSHIP TO WMA C CUMULATIVE RISK ASSESSMENT

The risk assessment metric values and data presented in this section are derived from the WMA C cumulative risk assessment data and are intended to describe closure conditions for C-106. The WMA C cumulative risk assessment includes quantitative estimates of long-term risk impacts to a wide variety of hypothetical receptors and exposure scenarios. The WMA C cumulative risk assessment was prepared in a manner consistent with the approach to closure risk assessment for SSTs described in the Framework Plan.

Only a summary of the results for WMA C are provided in this attachment (Single-Shell Tank 241-C-106 Component Closure Activity Plan). The Addendum C1 provides for the complete WMA C risk assessment. Section 3.0 of the addendum provides the methodology, assumptions, and conceptual model; Section 4.0 provides the numerical results and sensitivity analysis; Section 5.0 lists exposure scenarios; Section 6.0 gives the limitations and uncertainties; Section 7.0 provides the long-term risks related to groundwater; while Sections 8 and 9 provides short-term risk assessment related to closure activities.

4.2 C-106 RETRIEVAL AND CLOSURE EFFECTS ON SELECTED LONG-TERM RISK METRICS

The projected effects of residual waste retrieval and other component closure activities on selected long-term risk metrics are described in this subsection. The long-term effects are organized as follows:

- By contaminant source (i.e., residual tank waste, past leaks, ancillary equipment inventory, and hypothetical retrieval leaks)
- By risk metric within each source term (i.e., ILCR, hazard index, groundwater dose, and drinking water standards)

- By exposure scenario/receptor within each metric (i.e., industrial worker, residential)
- Cumulative effects of applicable source terms at selected "representative" conditions and receptors.

4.2.1 Residual Tank Waste Inventory

The baseline assumption for residual waste inventory remaining in the tank after retrieval is based on the following conditions:

- All liquid-phase waste identified in the pre-retrieval BBI is removed from the tank.
- Waste retrieval for C-106 consisted of an oxalic acid wash (see Section 4.3.1 in Addendum C1). However, no inventory post-retrieval inventory has been calculated using this retrieval method. Therefore, the most conservative method, selected phase removal (Addendum C1, Section 3.6.1), for calculating post-retrieval inventory was used to apply an inventory to this tank. This inventory will be compared to the inventory calculated after a post-retrieval sample has been taken. .
- The waste is retrieved to a maximum remaining volume of 360 ft^3 residual waste.
- The remaining solids are uniformly distributed over the area of the tank bottom.
- The remaining residual waste inventory is encapsulated between a cementitious tank fill and the reinforced concrete tank structure and/or partially incorporated into the tank fill material itself. A diffusion-limited waste constituent release mode was selected to simulate contaminant release from the final encapsulated waste form.

The effects of tank residual waste inventory on selected risk metrics presented below are derived from these assumptions.

The estimated peak values for ILCR, hazard index, and dose for receptors via long-term exposure to contaminated groundwater resulting from residual tank waste are shown in Table 4-2.

Table 4-2. Estimated Peak Values for Groundwater Risk Assessment Cumulative Metrics related to Residual Waste Volume in C-106.

Metric	Industrial Receptor		Residential Receptor		Year of Peak
	Pre-Retrieval	Retrieved to 360 ft^3	Pre-Retrieval	Retrieved to 360 ft^3	
Radoactive Chemicals ILCR[a] (unitless)	4.9 E-07	7.8 E-08	9.7 E-06	1.5 E-07	5610
Hazard Index[b] (unitless)	3.7 E-03	9.9 E-04	2.2 E-02	5.5 E-03	5614

Table 4-2. Estimated Peak Values for Groundwater Risk Assessment Cumulative Metrics related to Residual Waste Volume in C-106.

Metric	Industrial Receptor		Residential Receptor		Year of Peak
	Pre-Retrieval	**Retrieved to 360 ft^3**	**Pre-Retrieval**	**Retrieved to 360 ft^3**	
Radiological Dose via Drinking Water[c] (mrem/yr EDE)	2.04 E-02	3.4 E-03	5.7 E-02	1.0 E-03	5612

[a] ILCR target value is < 1.00 E-05

[b] Non-carcinogenic Hazard Index is < 1.00

[c] Groundwater dose target values is < 4 mrem/yr (1 L/day ingestion for 250 days for industrial, and 2 L/day for 365 days for residential)

EDE = effective dose equivalent

ILCR = incremental lifetime cancer risk

4.2.2 Past Leaks

No past leaks have been attributed to either C-106 or its associated adjacent ancillary equipment. Vadose zone monitoring performed in the vicinity of C-106, however, indicates vadose zone contamination in the immediate vicinity of the tank. A summary of vadose zone monitoring results is presented in Section 4.3 of this component closure activity plan. Because no documented past leaks or releases have been recorded for this tank and/or its adjacent ancillary equipment, no past leak inventory was created for C-106. Development of the past leak source term inventory, if appropriate, will be performed as either sampling and analysis results or additional historical information become available to support the inventory development.

4.2.3 Residual Ancillary Equipment Waste Inventory

Ancillary equipment immediately adjacent to C-106 is shown schematically in Figure 5-2 and includes the pump pit, heel pit, sluice pit, ventilation equipment, and aboveground and underground piping connecting the tank to other components. Existing information does not support development of a detailed inventory for waste remaining in ancillary equipment associated with this tank. An estimate of possible impacts from ancillary equipment residuals was prepared and included in the source uncertainty discussion presented in Section 5.0 of the WMA C Closure Action Plan. The potential residual waste inventory contained in ancillary equipment immediately adjacent to C-106 is not included in this risk analysis. Development of the ancillary equipment source-term inventory for this component will be delayed until such time as either sampling and analysis results or adequate historical information become available to support the inventory development.

4.2.4 Hypothetical Retrieval Leaks

Application of the hypothetical retrieval leak source term to specific components is determined by the waste retrieval method selected for the individual component. Acid dissolution, using

approximately 1 molar oxalic acid solution in water, is the selected approach for retrieval of waste from C-106 (see Addendum C1 Section 4.3.1 for more information on the oxalic acid wash). Current waste retrieval plans exclude the application of high-volume liquid retrieval methods in tanks with known or suspected integrity problems. Although C-106 is currently believed to be a sound tank, application of relatively high-volume liquid retrieval systems in the tank presents the opportunity for a retrieval leak in the event of a tank integrity failure. An 8,000-gal leak of retrieval fluid was selected to characterize this hypothetical event. The inventory associated with this leak is given in Addendum C1 Section 3.6.1. The retrieval leak source term consists of 8,000 gal of that solution released at the bottom of the tank. The potential effects of the hypothetical retrieval leak on the selected risk metrics are presented in Table 4-3.

Table 4-3. Estimated Peak Values for Groundwater Risk Assessment Cumulative Metrics related to Hypothetical Retrieval Leak from C-106.

Metric	Industrial Receptor	Residential Receptor	Year of Peak
	8,000-gal Retrieval Leak	8,000-gal Retrieval Leak	
Radioactive Chemical ILCR[a] (unitless)	1.3 E-07	2.5 E-06	2082
Hazard Index[b] (unitless)	9.4 E-04	5.6 E-03	2082
Radiological Dose via Drinking Water[c] (mrem/yr EDE)	5.0 E-03	1.5 E-02	2082

[a] Incremental Lifetime Cancer Risk target value is < 1.00E-05

[b] Non-carcinogenic Hazard Index is < 1.00

[c] Groundwater dose target values is < 4 mrem/yr (1 L/day ingestion for 250 days for industrial, and 2 L/day for 365 days for residential)

EDE = effective dose equivalent

ILCR = Incremental Lifetime Cancer Risk

4.2.5 C-106 Effects on Drinking Water Standards

Estimated long-term groundwater quality effects are compared to the primary drinking water standards (MCLs) in Table 4-4.

Table 4-4. Summary of Groundwater Impacts from C-106 Closure Conditions Compared to Concentration-Based Primary Drinking Water Standards (MCLs). (2 Pages)

Constituent	Post-Retrieval Tank Residual Contribution	Hypothetical Retrieval Leaks Contribution	Drinking Water Standard (MCL)
Technetium-99	3.9 pCi/L	7.0 pCi/L	900 pCi/L[a]
Iodine-129	0.032 pCi/L	0.038 pCi/L	1 pCi/L[a]
Carbon-14	0.021 pCi/L	0.127 pCi/L	2,000 pCi/L[a]
Nitrate	4.6 E-05 mg/L	1.7 E-04 mg/L	44 mg/L[b]
Nitrite	3.1 E-04 mg/L	3.4 E-03 mg/L	3.3 mg/L[b]

Table 4-4. Summary of Groundwater Impacts from C-106 Closure Conditions Compared to Concentration-Based Primary Drinking Water Standards (MCLs). (2 Pages)

Constituent	Post-Retrieval Tank Residual Contribution	Hypothetical Retrieval Leaks Contribution	Drinking Water Standard (MCL)
Chromium	2.2 E-04 mg/L	1.4 E-04 mg/L	0.10 mg/L
Fluoride	9.2 E-06 mg/L	3.7 E-05 mg/L	4 mg/L

[a] The radionuclide concentrations shown are the "C4" concentration, which is the concentration of the individual nuclide in drinking water that would result in an annual dose of 4 mrem/yr using the target organ dose methodology specified by the Washington State Environmental Policy Act.

[b] The MCLs for nitrate and nitrite are defined in terms of nitrogen in the form of nitrate or nitrite. The values presented in this table have been converted to the corresponding concentration values for the respective ions to match the reported concentration values.

- MCL = maximum contaminant level

4.3 CUMULATIVE EFFECTS OF REPRESENTATIVE COMPONENT SOURCE TERMS

The base case evaluated for C-106 includes contribution to risk metrics from residual tank waste after retrieval to 360 ft^3 and the hypothetical 8,000-gal retrieval leak. Past leak and adjacent ancillary equipment source terms are identified as applicable; however, these source terms are addressed cumulatively at the WMA C level risk assessment. The cumulative pre- and post-retrieval effects of contributions to ILCR, hazardous index for the industrial receptor, and drinking water dose from C-106 compared to the cumulative WMA C effects are shown graphically in Figures 4-1 through 4-6. Figures 4-7 and 4-8 provide these comparisons for the HSRAM Residential Scenario which shows C-106 below the target value of 1.0 E-05, but that the WMA C above the target value of 1.0 E-05 for approximately 6,500 years. Note that log scale is used for the metric value axes of these graphs to facilitate presentation of the relatively small contributions from C-106. These results are based on comparison of fenceline average concentrations for the sources.

Figure 4-1. Comparison of Incremental Lifetime Cancer Risk Contribution from C-106 to Cumulative WMA C for Tank Contents Incremental Lifetime Cancer Risk – Pre-Retrieval.

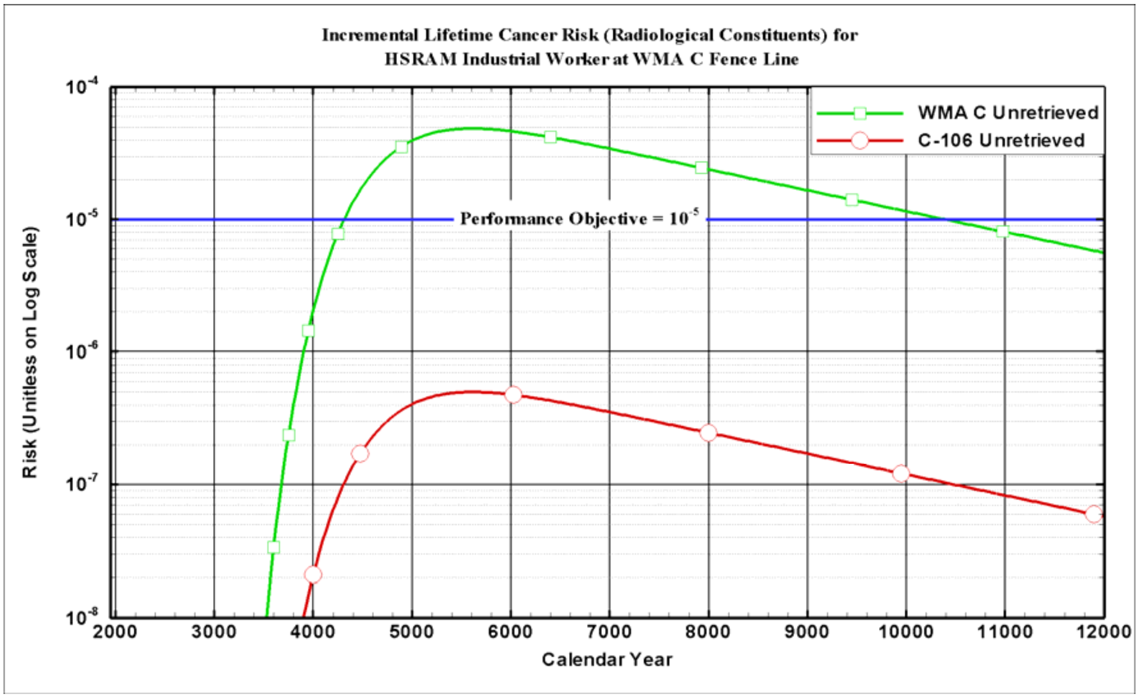


Figure 4-2. Comparison of Incremental Lifetime Cancer Risk Contribution from C-106 to Cumulative WMA C Incremental Lifetime Cancer Risk – Post-Retrieval.

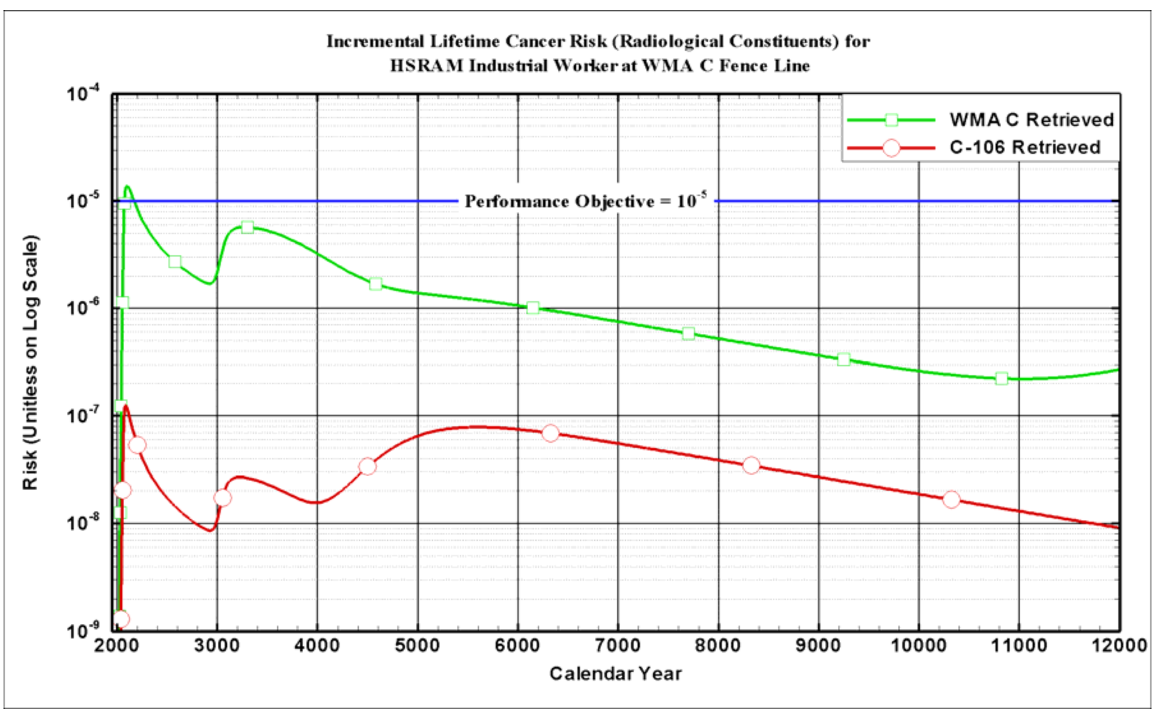


Figure 4-3. Comparison of Hazardous Index Contribution from C-106 to Cumulative WMA C for Tank Contents Hazardous Index – Pre-Retrieval.

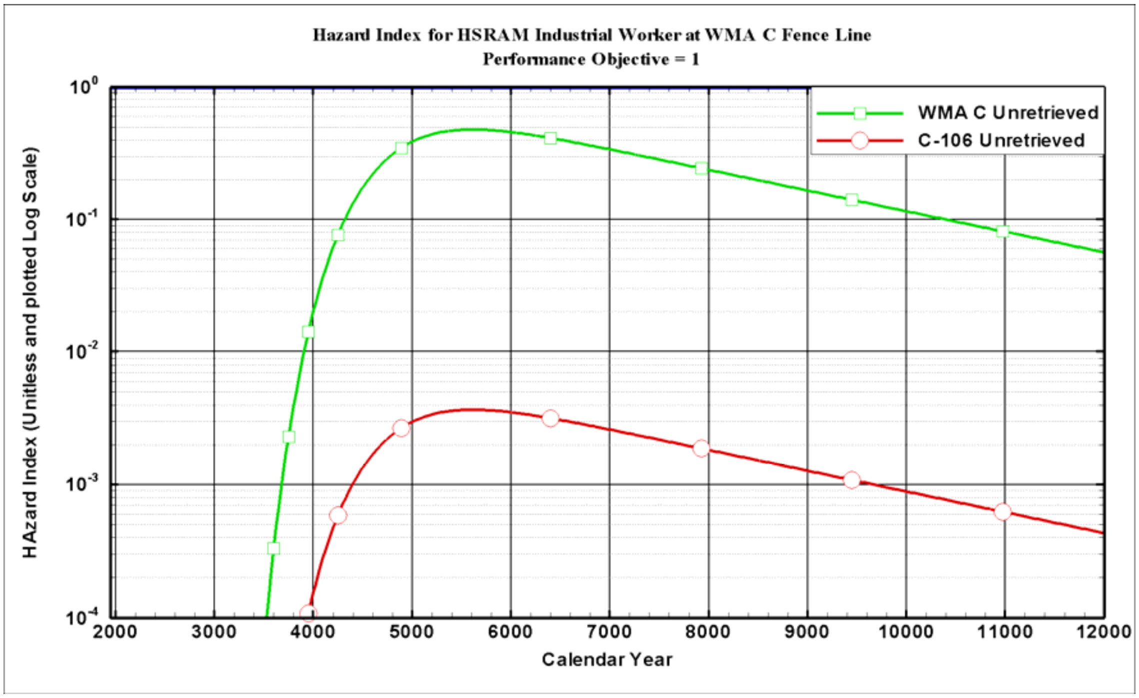


Figure 4-4. Comparison of Hazardous Index Contribution from C-106 to Cumulative WMA C Hazardous Index – Post-Retrieval.

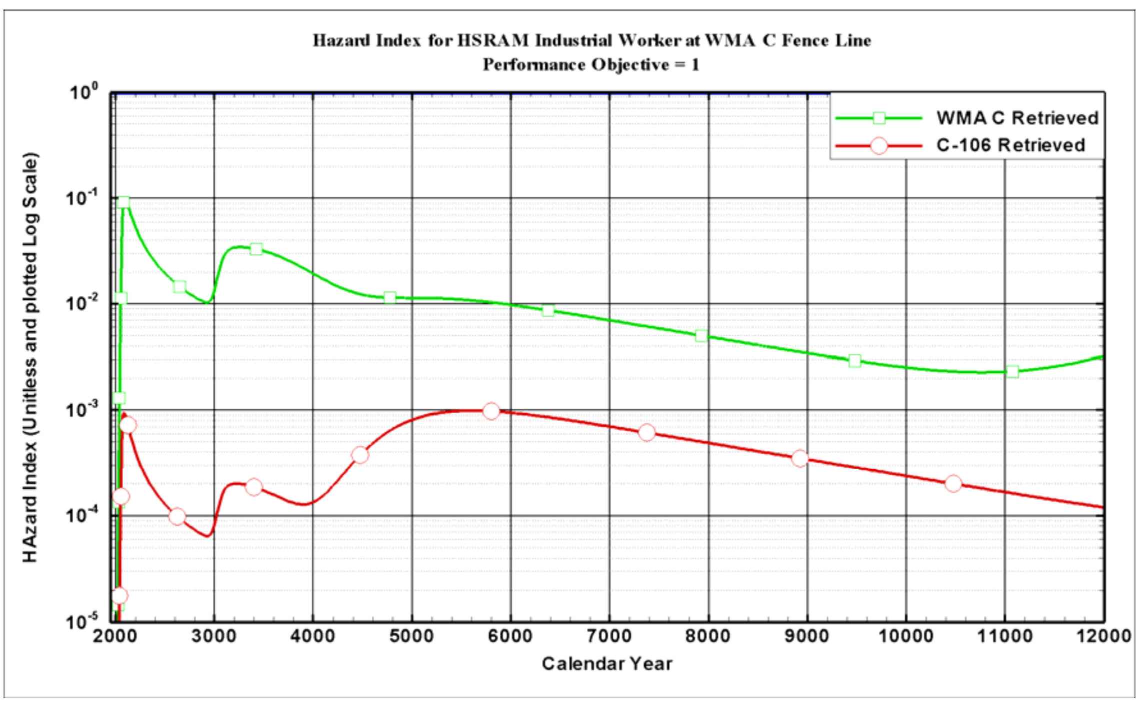


Figure 4-5. Comparison of Dose Contribution from C-106 to Cumulative WMA C Drinking for Tank Contents Industrial Water Dose – Pre-Retrieval.

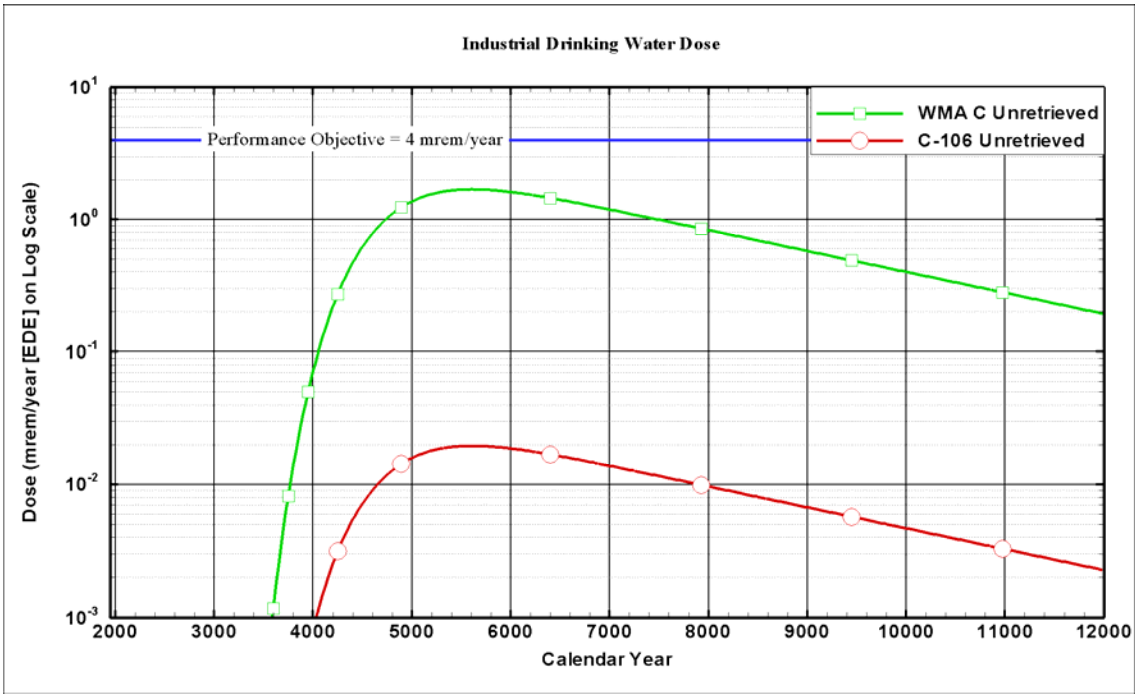


Figure 4-6. Comparison of Dose Contribution from C-106 to Cumulative WMA C Drinking Water Dose – Post-Retrieval.

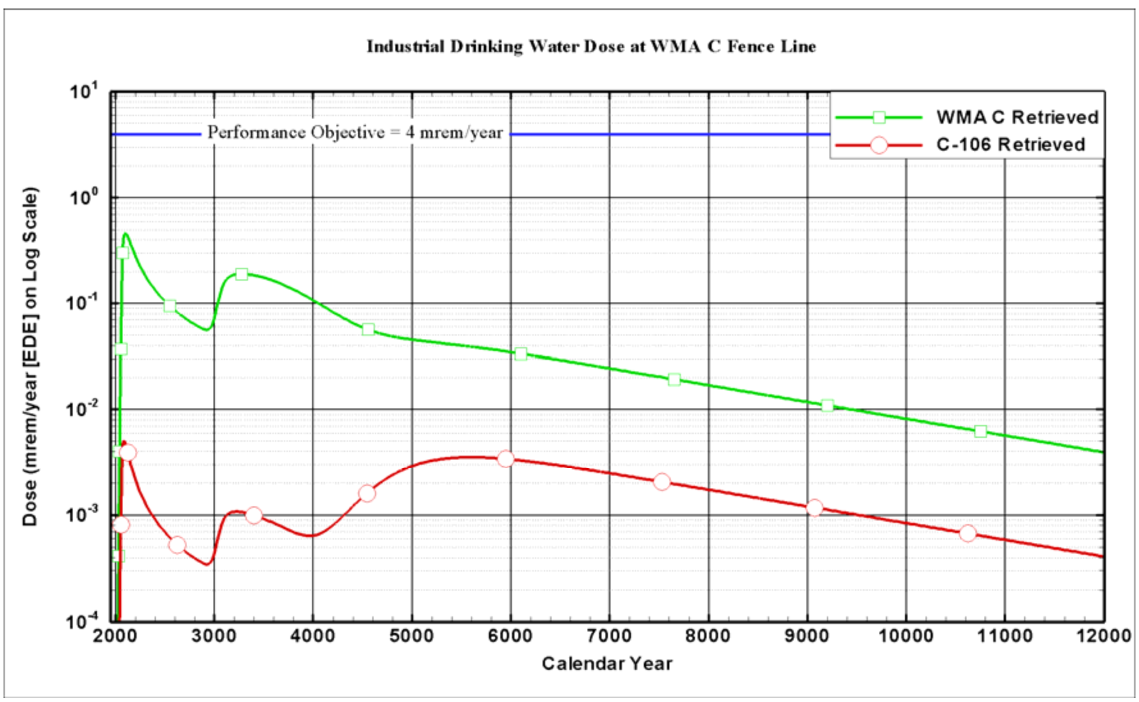


Figure 4-7. Comparison of Residential ILCR Contribution from C-106 to Cumulative WMA C for Tank Contents Incremental Lifetime Cancer Risk – Pre-Retrieval.

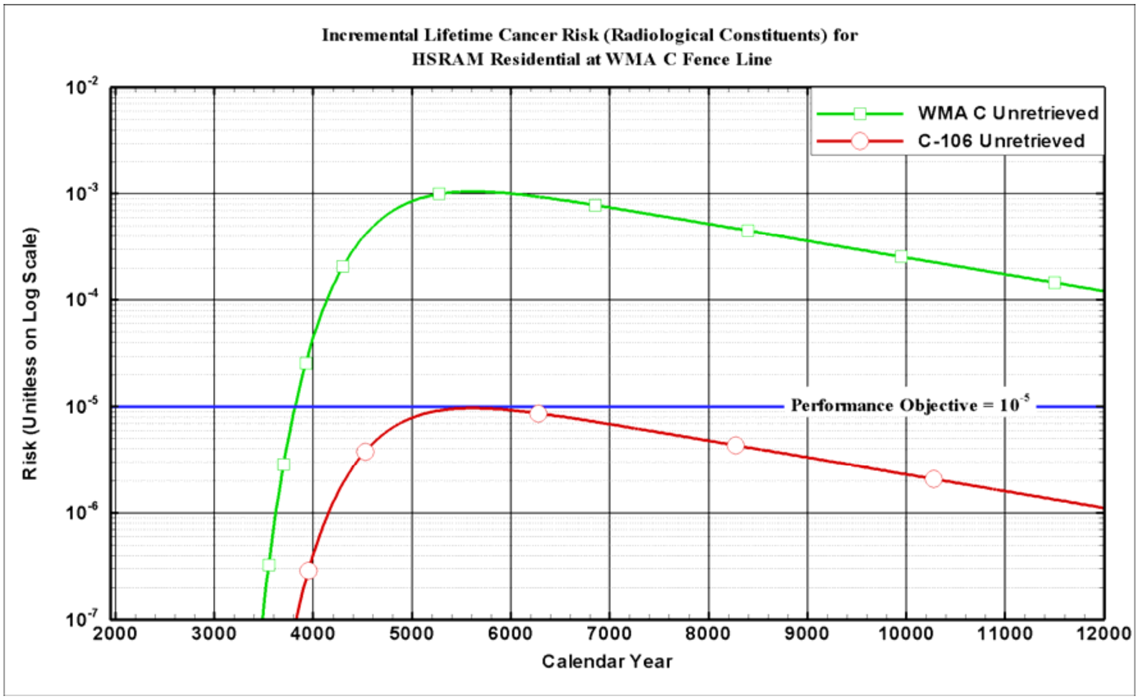
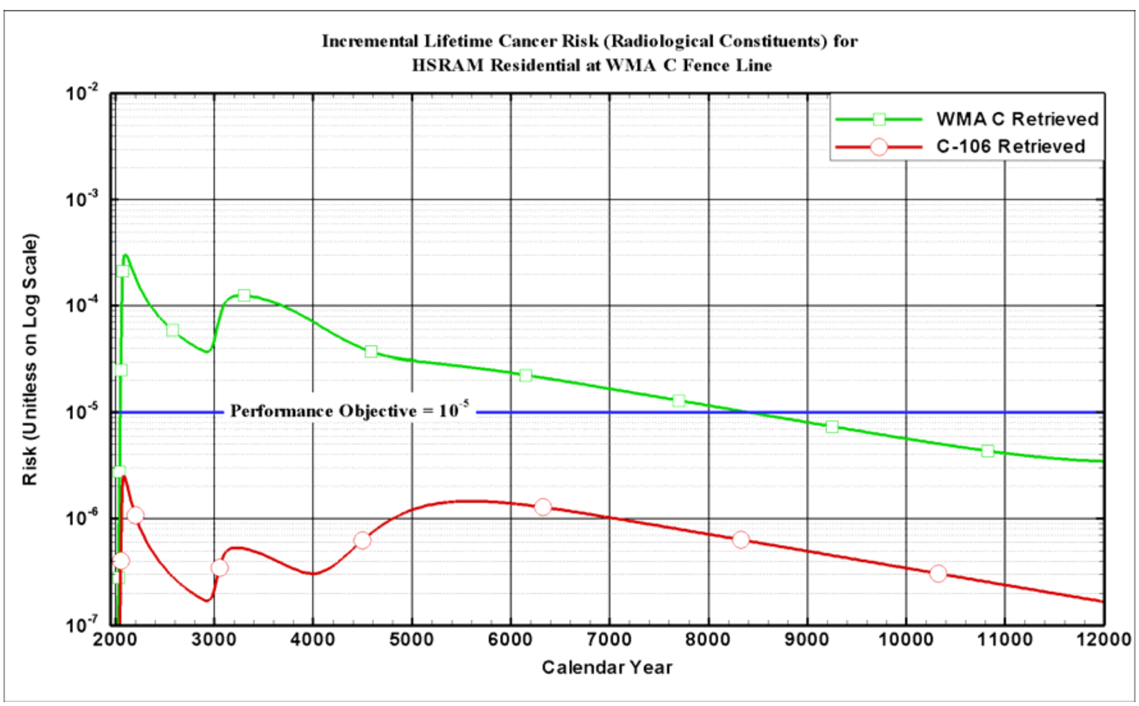


Figure 4-8. Comparison of Incremental Lifetime Cancer Risk Contribution from C-106 to Cumulative WMA C Incremental Lifetime Cancer Risk – Post-Retrieval.



4.4 CONCLUSIONS

The contribution to risk metrics from closure conditions of C-106 is small compared to the cumulative effects of all source terms in WMA C. Comparison of the metrics considered in this analysis with those of WMA C post-retrieval generally indicate the C-106 contribution to be approximately two orders of magnitude lower than the cumulative WMA C for hypothetical retrieval leaks and approximately one order of magnitude lower for tank residuals. Pre-retrieval results indicate that C-106 contribution would be approximately two orders of magnitude lower than those of the total WMA C.

Hypothetical retrieval leak losses and tank residuals are approximately equal in value for the risk analysis for the C-106 base case.

Large uncertainties remain at this time, primarily related to waste inventory (both volume and content) and source release mechanisms. Post-retrieval sampling and analysis are planned to address inventory and waste release behavior uncertainty.

There is ongoing work to further refine this preliminary risk assessment. In particular, aquifer testing in the vicinity of WMA C, sampling and analysis of tank residual waste contents to further refine the inventory, drilling of the vadose zone in the vicinity of the unplanned releases, and three-dimensional modeling.

5.0 COMPONENT CLOSURE ACTIVITIES

Actions to be performed as part of the C-106 component closure activity are described in the following subsections.

5.1 C-106 MEASUREMENTS, SAMPLING, AND ANALYSIS

This section addresses the in-tank measurements (volume), sampling, and analysis needed to address closure criteria and applicable regulatory requirements (WAC-173-303, Site-Wide Permit, and HFFACO) for C-106 component closure activities.

5.1.1 C-106 Data Quality Objectives Process

The overall tank closure characterization effort is discussed in the Framework Plan. A DQO process will be conducted for the component closure activities within the WMA. The DQO process is undertaken to ensure appropriate data are collected to support the component closure activities. The DQO document generated from the DQO process will include all sampling and analytical activities required for the respective component closure activity (e.g., sampling residual waste to support the tank component closure activity). DOE will request approval of the DQO by Ecology. Pertinent sampling and analysis information will be summarized in sampling and analysis plans, the component closure plans, and if appropriate, the associated WMA closure action plan.

The DQO process was used to identify the specific data needs for the C-106 component closure activities. These data needs include the composition of the residual waste and the volume of the residual waste. The DQO process also identifies the specific requirements for quality control, quantitation limits, and error tolerance for the data generated by the sampling and analysis process. As of November 2003, the draft C-106 DQO (*Tank 241-C-106 Component Closure Action Data Quality Objectives* [RPP-13889]) had been prepared, reviewed by Ecology, and was in the comment resolution process. Upon completion of comment resolution, the C-106 DQO will be attached to the C-106 component closure activity plan as Supplement C2.

5.1.2 C-106 Sampling and Analysis Plan

The sampling design is presented in the C-106 DQO (Supplement C2). Table 5-1 provides a cross walk between the C-106 DQO and the sampling and analysis plan requirements. As a condition of the permit, a sampling and analysis plan for C-106 will be submitted within 45 days of the effective date of the permit for Ecology's approval.

5.1.2.1 Objectives. The objectives of the sampling and analysis for C-106 are as follows:

- Determine the volume of waste remaining in the tank at the completion of the retrieval actions.
- Collect and analyze liquid waste samples at the end of the retrieval activities to support determination of the concentrations of chemical and radiological constituents of the tank constituents.
- Collect and analyze solid waste samples to determine the concentrations of chemical and radiological constituents remaining in the tank at the completion of the retrieval actions.
- Collect and analyze solids to obtain additional data (such as leach rates) to support the risk assessment methodology.

5.1.2.2 Liquid Sampling Activities. The liquids in the tank will be sampled at the completion of waste retrieval activities. Sampling will occur prior to pumping the last batch of liquid used for waste retrieval out of the tank.

A sampling strategy was developed during the DQO process to obtain the most representative samples of the residual liquid waste. The current plan is to obtain the liquid samples after completion of the final washing activity and prior to pumping the remaining liquid out of the tank. These samples should 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 than after final pumping) will increase the likelihood of obtaining sufficient liquid samples with current grab sampling techniques.

A minimum of two liquid samples (a sample and a duplicate sample) are required by the DQO. The quantity of liquid in one of the samples must be sufficient to obtain a duplicate analysis. In addition, two bottles are required to conduct the volatile organic compound (VOC) analyses (sample and duplicate sample) and another two are required to conduct the semi-volatile organic compound (SVOC) analyses (sample and duplicate sample). The contents from each pair of bottles can be combined (if insufficient sample material is available) for the rest of the required analyses.

5.1.2.3 Solids Sampling Activities. Samples of any residual solids will be obtained after retrieval is completed. Residual solids on the bottom of C-106 will be sampled using clamshell samplers. This sampler will be able to sample a small waste depth, but does not have off-riser sampling capability at this time. Sampling devices capable of off-riser sampling are being developed, but may not be available before C-106 waste sampling is required.

After retrieval activities are completed, a possibility exists that insufficient residual solids or the location of the residual solids may prevent the collection of a sample. For this reason, pre-retrieval samples of the solids in C-106 were obtained. These samples were collected using the existing finger trap sampler and archived.

At the end of the final waste washing activity, an attempt will be made to move any solid waste, which cannot be retrieved, under a tank riser available for sampling. This will be attempted to facilitate sampling and increase the probability of collecting sufficient waste for the planned analyses. In the current retrieval plans, only one riser (riser 14) will be available for waste sampling because the other risers will contain equipment. Sampling from one riser (i.e., one location) may be adequate because the retrieval activities will mobilize and mix the solid waste within the tank.

A minimum of two solid samples (a sample and a duplicate sample) will be collected for the analyses specified in the DQO. A sample will be composed of multiple clamshells to obtain the amount of sample material needed for testing and analysis. It is desirable that the two samples contain as much as 300 grams and 150 grams of solids, respectively.

5.1.2.4 Volume Measurements. Volume measurements will be made of the waste remaining in the tank after completion of waste retrieval.

The current method for determining the residual waste volume in a tank is the video camera and modeling system. This system, used for the initial baseline measurements of C-106 (RPP-12547), can be deployed without additional development. Residual waste volume measurements are obtained by inserting a video camera into a tank riser and obtaining a videotape of the tank interior. The videotape is used to identify the physical shapes of the waste and to develop a three-dimensional model of the waste surface. The model is developed using a configuration of the tank. The modeling methodology is being refined to include information on accuracy of the volume estimate.

5.1.2.5 Quality Assurance Requirements. The Quality Assurance Project Plan (QAPjP) requires that laboratories performing analyses specified in the C-106 DQO shall maintain a quality assurance (QA) plan. The plan shall meet the *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL-98-28 1998) baseline requirements for laboratory quality systems.

All sampling events will be conducted using controlled procedures. Recommendations for ensuring sample integrity prior to analysis are provided in SW-846 (EPA 1996). The recommendations include type of sample container, holding time, preservation, and zero headspace in samples (for volatile components). Details for sampling requirements are presented in the C-106 DQO.

The analytical data from the laboratory are entered into Labcore, the Laboratory Information Management System at 222-S Laboratory. Then it is transferred to the Tank Waste Information Network System (TWINS) per the TWINS/Labcore Configuration Control Desk Manual upon release of the concurrent data report. The data report from the 222-S Laboratory will be a Format IV data package which includes data for all samples and associated blanks taken and analyzed during a single sampling activity. A Format IV data package, as defined in HNF-SD-CP-QAPP-016 (2003), 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. The Format IV data package will be evaluated against the applicable Level C data validation requirements of

WHC-SD-EN-SPP-001, Rev 1, *Data Validation Procedure for Radiochemistry Analyses,* or WHC-SD-EN-SPP-002, Rev 2, *Data Validation Procedures for Chemical Analyses*, as appropriate. Other qualified and approved validation requirements may be used. The data package shall be issued as a document approved for public release via an Engineering Data Transmittal form.

5.1.3 Data Quality Assessment.

A data quality assessment (DQA) process is used to determine the adequacy of the data to support the decisions established in the DQO. The DQA process includes a review of the data to determine if it meets data quality requirements and to compare the data to the decision rules defined in the DQO. The DQA process will be accomplished using the subjective and quantitative DQA methods described below:

- <u>Examine the data</u>. This includes reviewing the data to determine if it meets the data quality requirements defined in the DQO. If the data do not meet DQO requirements for sampling and analysis, either additional samples must be obtained or the DQO requirements will need to be reevaluated.

- <u>Review the project DQO</u>. This includes comparing the data to the decision rules defined in the DQO. Decision rules 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. Decision rules are expressed as “if then” statements that incorporate the parameter of interest, the scale of decision making, the action level, and the actions that would result from resolution of the decision rule.

The DQO process and the DQA process described above will be applied to C-106 residual waste characterization described in Section 2.5.5.

Table 5-1. Sampling and Analysis Crosswalk

Sampling and Analysis Plan Requirement	C-106 DQO Location (Section) [a]
Analytical Parameters (General)	4.1
Organics analytical parameters, methods, and methodology	4.1.1
Inorganics analytical parameters, methods, and methodology	4.1.2
Radiological analytical parameters, methods, and methodology	4.1.3
Quality Control (General)	4.2
Type of sample containers	4.2
Holding Times	4.2
Sample Preservation	4.2
Data Package	4.2
Quantitation Limits	4.3
Action Levels	4.3
QAPjP Requirements	4.2
Sampling Constraints	5.2
Error Tolerance	7.0
Sampling Design (General)	8.0
Volume Measurement	8.1
Liquid Sampling	8.2
Solids Sampling	8.2
Number of Samples	8.2
Sample Locations (Riser availability)	8.2

[a] Supplement C1 of the C-106 component closure activity plan

5.2 TANK STABILIZATION

Tank stabilization activities are initiated subsequent to satisfying HFFACO Milestone M-45-05H. Tank stabilization activities will provide information as a demonstration for subsequent tank closures. Various testing activities will occur in the laboratory, in the field, and during C-106 filling to obtain data regarding the performance and logistics of placing fill in an SST.

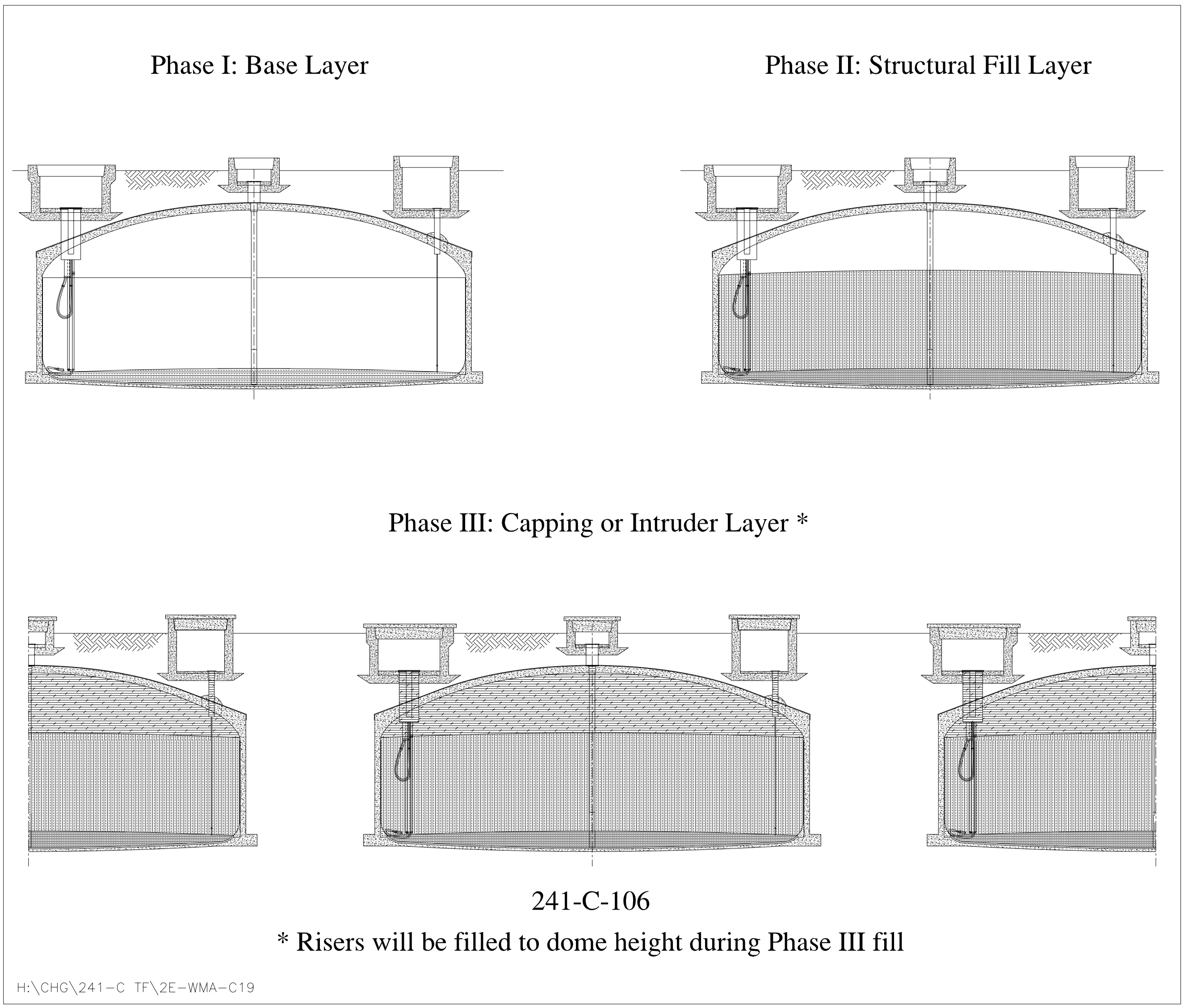
Tank stabilization will be accomplished by adding grout[*] or other structural material in layers into C-106. Phase I fill will be composed of a free-flowing grout[*] and will cover the waste residuals and debris on the tank bottom and provide structural support for subsequent fills. The Phase II fill will provide structural stability and fill the majority of the tank volume. The Phase

[*] See Preface in *SST System Closure Plan* (RPP-13774).

III fill will be a high-compressive-strength grout* placed in the remaining void space between the Phase II grout* and the tank dome and fill tank risers to the maximum dome height. The function of the Phase III grout* is to discourage intruder access. The entire fill system, consisting of Phases I, II, and III, provides structural support to the tank dome to prevent subsidence and degradation of the surface barrier placed at the time of WMA C closure.

Figure 5-1 displays the planned multi-phased approach to tank stabilization for final closure.

Figure 5-1. Conceptual Tank Stabilization and Closure.



* See Preface in *SST System Closure Plan* (RPP-13774).

5.2.1 Phase I Fill: Base Layer*

The Phase I grout addition to C-106 will involve adding a 30- to 90-cm (12- to 36-in.) base layer of grout to the tank.

Cementitious grout will be produced offsite and transported by truck to the C Tank Farm, or a mix plant located on the Hanford Site may be used. As defined in the *Accelerated Tank Closure Demonstration Basis of Design* (RPP-12331), the grout will be formulated to be free-flowing and of sufficient volume so as to cover the residual waste at the bottom of the tank and form a base grout layer. The grout may be placed in approximately 30-cm (12-in.) lifts through an existing riser (RPP-12331). Up to three lifts may be placed in the tank. Although an uneven residual waste surface is expected, sufficient grout will be placed in the tank to cover the residual waste volume at the bottom of the tank, hence substantially reducing in-tank dose rates. An in-tank video system will be used to document and provide information to confirm the placement and lift thickness.

Some debris will not be covered by Phase I grouting (discarded equipment may protrude above the initial grout layer and residual waste may be on the walls above the grout level). The bottom portion of pumps or other equipment may also extend into this Phase I base layer.

Active ventilation with a high-efficiency particulate air (HEPA) filtration system will be used during grouting activities to control potential release of contaminants to the environment. Appropriate air permits will be obtained. Information will be obtained during the placement of the Phase I layer of grout on how operations are affected, such as impact on HEPA filter change-out.

The performance objectives of the Phase I grout are as follows:

- Provide sufficient compressive strength to support the Phase II and Phase III fill layers.
- Completely cover the residual waste.
- Exhibit a relatively low heat of hydration.
- Be free-flowing, self-compacting, self-leveling, and low-shrink.

The following information is expected to be obtained during the demonstration of Phase I grout addition to C-106 during this component closure activity.

- **Field deployment of grout production and placement equipment.** There are numerous logistical and risk considerations for working in and around the tank farms, especially for initial implementation of a new activity. Gaining essential experience and identifying potential problems during the mobilization and deployment phase can only be accomplished in the field. The information gained during the demonstration will help to better anticipate and avoid future problems and worker and environmental risks.

* See Preface in *SST System Closure Plan* (RPP-13774).

- **Placement and distribution of grout in tank.** In this demonstration, flowable grout will be placed in C-106. This part of the demonstration will help to determine flowability characteristics of the grout as it is distributed in the tank and grout behavior within the in-tank environment.

- **Physical response of tank residual to grout during placement.** Residual waste behavior when grout is dispersed throughout the tank in the actual tank environment will be better understood from this demonstration. This demonstration will provide insight into whether any remaining residuals stay in place or are relocated during grout placement. Further information will be obtained on how any remaining liquid will interact with the grout, potentially affecting distribution and placement.

- **Worker exposure measurements/mitigation.** In addition to addressing the logistical issues of deployment of grout production and the placement of equipment, the demonstration will help determine how to improve worker safety in the actual working environment.

- **Project costs and efficiencies.** One of the key elements of the demonstration is to gain information on how placement of grout in a tank can be more efficient and cost-effective in the future, based on lessons learned.

Test plans for tank fill formulation and placement will be developed. The development program will recommend a grout formula based on variables such as compressive strength, flow, gel time, set time, bleed water, air content, hydraulic conductivity, and porosity.

Grout placement performance information will be gathered through use of video cameras. Distribution of grout and displacement of residuals will be understood through visual observation. Radiological measurements during and after fill placement can be obtained through existing or planned monitoring activities.

During placement of the Phase I base layer, it will be determined whether adjustments need to be made to grout material specifications, methods of placement, or introduction of other measures. During previous tank fill demonstrations at DOE's Savannah River Site in South Carolina, a dry material "top dressing" was used to incorporate the residual liquid into grout. Savannah River Technology Center is formulating a top dressing material for Hanford based on their tank filling experience. If a portion of the waste is displaced by the grout, the specially formulated granular grout material (top dressing) may be used to adsorb the excess liquid prior to placement of additional grout. Failure to evaluate the potential for liquid waste heel displacement and incorporation of the liquid into the initial grout layer via the Phase I base layer addition demonstration for C-106 increases the difficulties during future tank closure activities. Savannah River Technology Center will conduct laboratory, bench, and large-scale (up to a 6-m- [20-ft]-diameter swimming pool) cold tests at their facility during Hanford SST grout formulation and specification development efforts.

5.2.2 Phases II and III: Structural and Intruder Layers*

The initial conditions of the tank prior to the addition of the Phase II and III tank layer assumes that 30- to 90 cm (12- to 36 in) of waste stabilizing grout will exist in the tank. The Phase II layer is intended to provide structural integrity to the tank. Phase III is an intruder (capping) grout, which is composed of a high-compressive-strength grout. The Phase III grout is intended to inhibit postclosure intruder access into the tank (for example, as a result of drilling activities).

Phases II and III will install multiple layers of cementitious grout on top of the Phase I base layer. The specific grout mix design specifications have not yet been determined, but are intended to meet the following performance objectives:

- Provide sufficient compressive strength to maintain the structure of the tank wall (Phase II).
- Provide sufficient strength to maintain the integrity of the tank dome (Phase III).
- Create a cover of grout to mitigate liquid infiltration that could mobilize remaining residuals (Phases II and III).
- Create a high-strength grout to discourage or prevent intruder access by excavation or drilling (Phase III).
- Exhibit a relatively low heat of hydration.
- Be free-flowing, self-leveling, self-compacting, and low-shrinking.

The grout may be placed in approximately 90-cm (36-in.) lifts through existing risers (RPP-12331). Final design of the grout will be documented prior to emplacement. An in-tank video camera will be used to document and provide information to confirm the proper emplacement and lift thickness. During placement of the Phase III grout to the tank dome, the grout may partially fill risers penetrating the tank dome. Completion of grout placement in the tank risers to the top of the riser will be performed as part of the component closure activities, or at the time of WMA C closure.

During grouting operations, active ventilation will be maintained to control potential release of contaminants to the environment. Appropriate air permitting will be obtained.

In addition, grouting operations in C-106 will be conducted in such a manner that grout does not flow through the cascade line connecting C-105 to C-106. This will be accomplished, with the aid of in-tank video camera surveillance, by stopping the grout fill operation at the point grout has just reached the top of the 7.6-cm (3-in.) diameter cascade line. The grout will then be allowed to cure before proceeding with additional lifts. The cured grout will form a plug at the

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* See Preface in *SST System Closure Plan* (RPP-13774).

lower end of the cascade line, thus preventing flow of grout uphill through the cascade line into C-105.

5.3 ISOLATION OF TANK INFRASTRUCTURE FROM ANCILLARY/SUPPORT EQUIPMENT

During the period between this component closure activity and final WMA C closure, which could span several years, the possibility exists, without the implementation of appropriate controls, for the inadvertent re-introduction of waste into C-106 through various pathways. Without controls, it also is possible while grouting* C-106 to prematurely introduce grout* into C-105 through the cascade line connecting the two tanks. This will be controlled as described in Section 5.2.2.

With the exception of the cascade line to C-105, C-106 has been isolated from all of the original waste transfer pipeline network installed when the tank was constructed. C-106 also has been isolated from piping installed for the saltwell pumping campaigns conducted in the 1970s. Isolation has been documented on the drawings and verified to the extent possible by in-pit video inspections. Figure 5-2 illustrates the line and riser locations into and around C-106, along with their current status.

The pipelines that have the potential to re-introduce waste into C-106 are the supernate and slurry lines installed between C-106 and AY-102 in the late 1990s to resolve the C-106 high-heat issue, and the original cascade line from C-105. The supernate and slurry lines currently rely on administrative controls, but will be capped or rerouted to another tank. The cascade line from C-105 will be isolated with administrative controls and left open until tank fill blocks the line. An over-ground transfer line connected to the heel pit for the waste retrieval efforts will be removed after retrieval is completed.

Since the bottom of the above-tank pits are higher than the inside apex of the tank dome, premature grouting* of adjacent tanks or facilities is considered implausible. The inlet sides of the supernate and slurry lines (at the pit nozzles) are approximately 10 m (33 ft) above the bottom of the tank, and the cascade line is approximately 4.9 m (16 ft) above the tank bottom.

This project will maintain or implement administrative isolation actions for these components (such as through procedural changes) pending final regulatory reviews and approvals. The administrative actions will include actions to prevent water infiltration and inadvertent transfers into the closed tank. Final closure of the ancillary equipment will be addressed in future documents.

Thirty-six pathways enter tank C-106 or its associated pits. The pathways include lines, risers, pit drains, weep holes and ventilation ducts. Eighteen pathways into C-106 have already been isolated, as shown on Table 5-3. DOE will take isolation actions on all remaining pathways, as

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* See Preface in *SST System Closure Plan* (RPP-13774).

shown on Table 5-4 to prevent introduction of new wastes or the intrusion of other liquids into the tank. DOE will use isolation methods based on engineering analysis that do not preclude future remediation. Actions will be implemented via established Engineering Change Notice (ECN) and work control processes.

Figure 5-3 shows major potential pathways into C-106, and also identifies lines previously used to carry tank waste.

Table 5-2. Tank 241-C-106 Previously Isolated Lines. (2 Pages)

Line Number	Description	Tank Waste Transfer Line	Isolation Technique & Status	Verification
8202	Waste Line from Diversion Box to Pump Pit	Yes	Physically Isolated: U-1 Nozzle Capped in Pump Pit	Video, 10/24/02
8232	Waste Line from Diversion Box to Pump Pit	Yes	Physically Isolated: U-2 Nozzle Capped in Pump Pit	Video, 10/24/02
8310	Spare Waste Line	Never Used	Physically Isolated: Capped Outside Pump Pit and U-4 Nozzle Capped	Video, 10/24/02
8232	Conduit	No	Physically Isolated: U-5 Nozzle Capped	Video, 10/24/02
8301	Conduit	No	Physically Isolated: U-6 Nozzle Capped	Video, 10/24/02
8336	Conduit	No	Physically Isolated: U-7 Nozzle Capped	Video, 10/24/02
8260	Steam Line from Heel Pit to Old Gang Valve	No	Physically Isolated: U-1 Nozzle Capped	Video, 09/20/02
8256	Waste Line (Line T's Into 8202 Above)	Yes	U-2 Nozzle Has Jumper Grapple in Place. 8202 is Capped at Both Ends.	Video, 09/20/02
8316	Spare Waste Line	Never Used	Physically Isolated: Capped Outside Heel Pit and U-3 Nozzle Capped	Video, 09/20/02
8235	Waste Line from Diversion Box to Sluice Pit	Yes	Physically Isolated: U-1 Nozzle Capped in Sluice Pit	Video, 10/24/02
8214	Waste line from Diversion Box to Sluice Pit	Yes	Physically Isolated: U-2 Nozzle Capped in Sluice Pit	Video, 10/24/02
8322	Spare Waste Line	Never Used	Physically Isolated: Capped outside Sluice Pit and U-3 Nozzle Capped	Video, 10/24/02

Table 5-2. Tank 241-C-106 Previously Isolated Lines. (2 Pages)

Line Number	Description	Tank Waste Transfer Line	Isolation Technique & Status	Verification
8279	Spare Waste Line	Never Used	Physically Isolated: Capped Outside Sluice Pit and U-4 Nozzle Capped. Line is also Designated as 8379 on Some Drawings	Video, 10/24/02
8328	Spare Waste Line	Never Used	Physically Isolated: Capped Outside Sluice Pit and U-5 Nozzle Capped	Video, 10/24/02
C1	Spare Nozzle through Tank Wall Near Cascade Line	Never Used	Spare Inlet, Capped Outside Tank, Never Used. (Partially filled with waste or grout)	Video, 07/14/00
C2	Spare Nozzle Through Tank Wall Near Cascade Line. Never Used.	Never Used	Spare Inlet, Capped Outside Tank, Never Used. (Partially filled With Waste or Grout)	Video, 07/14/00
C3	Spare Nozzle Through Tank Wall Near Cascade Line	Never Used	Spare Inlet, Capped Outside Tank, Never Used. (Partially filled With Waste or Grout)	Video, 07/14/00
C4	Spare Nozzle Through Tank Wall Near Cascade Line	Never Used	Spare Inlet, Capped Outside Tank, Never Used. (Partially Filled With Waste or Grout)	Video, 07/14/00

Table 5-3. Tank 241-C-106 Currently Open Lines. (2 Pages)

Line	Description	Tank Waste Transfer Line	Planned Isolation Technique
SL-100	Encased Slurry Line (RCRA-compliant) from AY-102 installed by Project W-320	Yes	Cap Line in AY Farm. Potential Use in Other C Farm Retrievals
ENC-100	Encasement for SL-100	No	Cap in C Farm
CWR-850	Chill Water Line in the Vicinity of the Tank	No	Cut and Cap Outside Process Building
CWS-803	Chill Water Line in the Vicinity of the Tank	No	Cut and Cap Outside Process Building
SN-200	Encased Supernate Line (RCRA-compliant) from AY-102 Installed by Project W-320	Yes	Cap in AY Farm. Potential Use in Other C Farm Retrievals
ENC-200	Encasement for SN-200	No	Cap in C Farm
DR-302	Encased Process Building Drain Line	No	Insert Blank Between Flanges in the Process Building (ECN 720997)

Table 5-3. Tank 241-C-106 Currently Open Lines. (2 Pages)

Line	**Description**	**Tank Waste Transfer Line**	**Planned Isolation Technique**
DR-301	Encased Process Building Drain Line	No	Grout/Foam Inlet Side in Process Building (ECN 721029). Also, Remove Jumpers and Cap (in Sluice Pit)
ENC-M26a	Drain Line Encasement from Process Building Drain Line	No	Same as DR-301 Above
ENC-302	Drain Line Encasement from Process Building Drain Line	No	Same as DR-302 Above
RAW-601	Raw Water Supply Line	No	Cut and Cap at the Supply End
Nozzle B	Cascade Line from C-105	Yes	Administrative Controls on C-105. Leave Line Open Until Tank Fill Blocks Line
Pump Pit Floor Drain to R-5	Pit Floor Drain Routed to Riser 5	No	Leave Open and Weather Proof Pit Covers
R-15 (in Condenser Pit)	Pit Floor Drain Routed to Riser 15	No	Leave Open and Weather Proof Pit Covers
Heel Pit Floor Drain to R-13	Pit Floor Drain Routed to Riser 13	No	Leave Open and Weather Poof Pit Covers
Sluice Pit Floor Drain to R-4	Pit Floor Drain Routed to Riser 4	No	Leave Open and Weather Proof Pit Covers
HVAC to Riser 2	Part of Ventilation System Used During Retrieval	No	Cut and Cap Lines (ECN 720975 in Preparation)
HVAC to Riser 15	Part of Ventilation System Used During Retrieval	No	Remove Valve and Install Blank (ECN 720974 in Preparation)

Notes:

All over ground transfer lines (hose-in-hose) will be removed from Pit-06A, Pit-06B and Pit-06C upon completion of retrieval.

Risers 16 through 19 penetrate the Exhaust Hatchway (sometimes called the Condenser Pit) cover, but not the tank dome. The dome penetration is designated R15. Blank flanges have been installed on R17 and R19, and on a flange in the Process Building to block the duct to R16. The inlet filter bank previously installed on R15 has been replaced with a breather filter assembly. R18, a ½" pressure tap, has an instrument package installed, effectively blocking this penetration.

A flush water line is attached to the ductwork on R16, but terminates at a quick disconnect hose fitting. The raw water line used for high heat control water additions has been removed.

Weep holes will be plugged with foam, and pit covers will be weather proofed at completion of isolation.

1 Figure 5-2. Current Configuration of C-106.

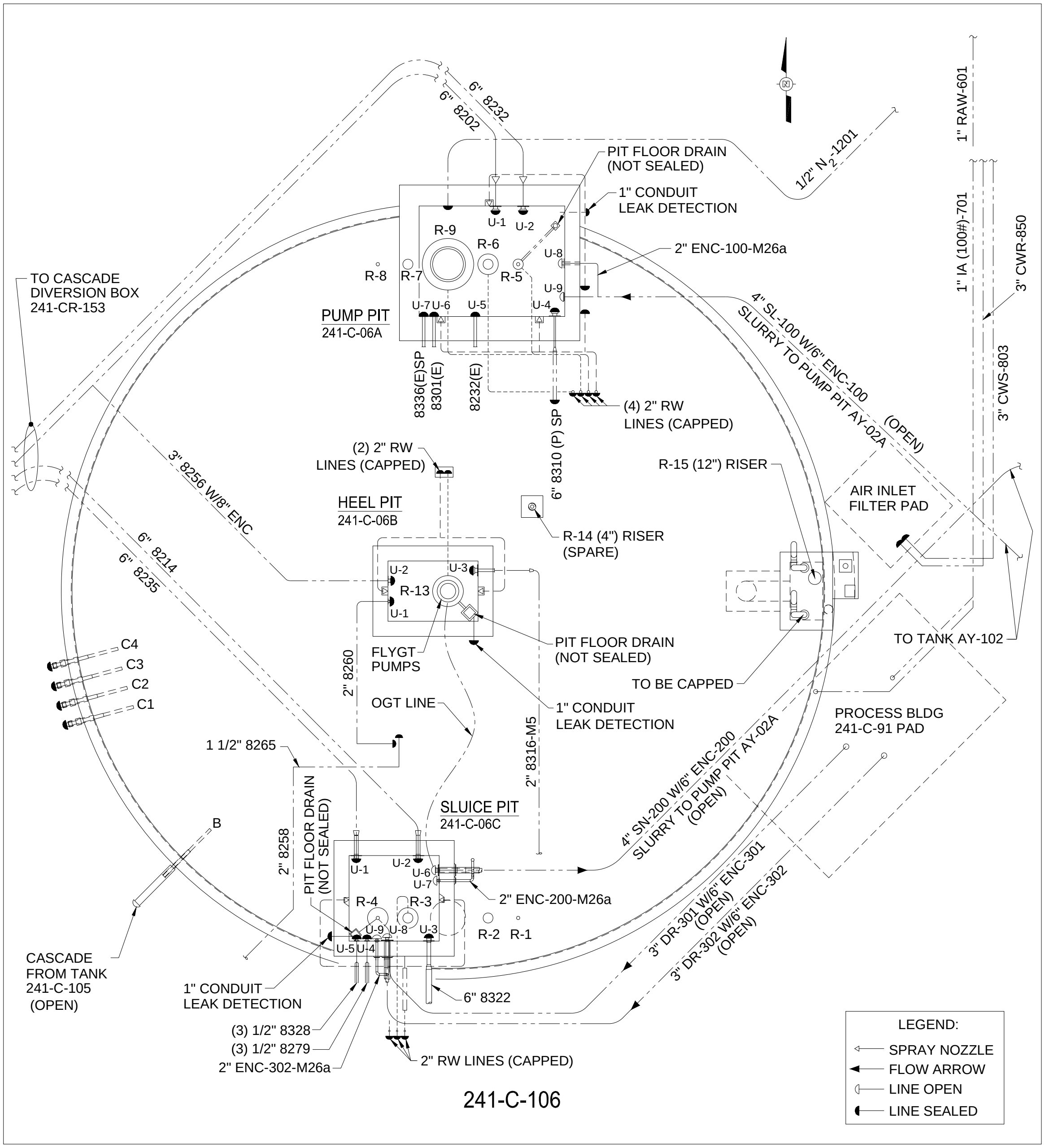

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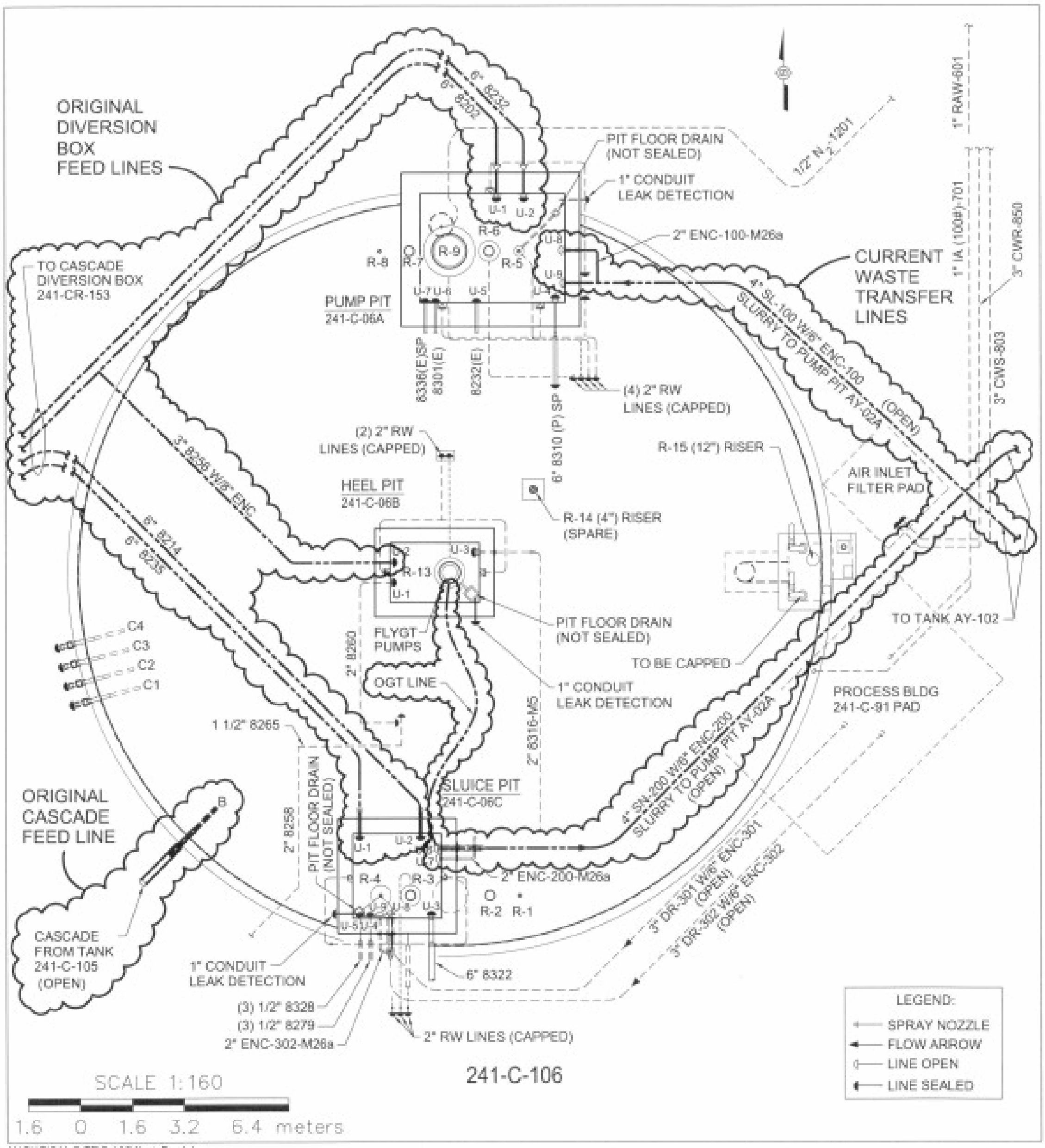
Figure 5-3. Tank 241-C-106 Plan View with Tank Waste Transfer Lines Clouded.



5.4 LAND DISPOSAL RESTRICTIONS COMPLIANCE

Retrieval of as much waste as technically possible will be pursued according to HFFACO requirements; however, DOE must consider the possibility of leaving some waste residuals in place at closure. In the event that waste is not satisfactorily removed from C-106, the RCRA land disposal restrictions (LDR) treatment standards (WAC 173-303-140 and 40 CFR 268) will apply. A site-specific treatability variance is needed to allow an alternative approach to protecting human health and the environment from the land disposal of dangerous waste (to be approved by Ecology separately from this closure plan) for the following reasons:

- The residual waste cannot be treated by the technology specified by regulations for some of the applicable waste codes (vitrification for high-level radioactive wastes exhibiting the characteristics of corrosivity and toxicity for metals).

- Treatment to performance-based treatment levels for other applicable waste codes is likely unachievable.

- 40 CFR 268.48 Table 1 treatment standards are expected to be unachievable in the short-term for the tank and abandoned equipment.

Enhanced containment is the proposed treatment action for C-106. Enhanced containment is achieved through placement of a Phase I cemetitious grout* fill and the Phase II structural fill followed by the Phase III intruder fill as described in Section 5.2. The Phase I fill will stabilize residuals and provide an infiltration barrier within the tank, providing some protection from water intrusion. The combined protectiveness of the fill material and the existing concrete tank shell and dome reduces the potential for migration of hazardous constituents. Enhanced containment complies with the requirements for an LDR treatment standard (42 USC 6924(m)) because it substantially reduces the mobility of the waste by reducing infiltration, and minimizes the threat to human health and the environment as part of an integrated approach to meeting closure performance standards of WAC 173-303-610(2) during the C-106 component closure activities. The addition of the Phase II and Phase III fills will further enhance the reduction of infiltration for the tank walls and abandoned equipment.

5.5 WASTE MANAGEMENT

Retrieved waste will be pumped to the DSTs for storage pending treatment in the waste treatment plant and disposal at an offsite geologic repository. Fill and isolation activities are not expected to generate significant wastes. Wastes generated include personal protection equipment, failed equipment, and tools used during the execution of component closure activities. Materials will be decontaminated and reused, or packaged and disposed of appropriately. Decontamination will be conducted in accordance with standard tank farm

* See Preface in *SST System Closure Plan* (RPP-13774).

procedures. Disposal will follow approved waste acceptance criteria for the appropriate storage and/or disposal facility.

5.6 PERSONNEL TRAINING

In accordance with WAC 173-303-806(4)(a)(xii), the *Hanford Facility Dangerous Waste Permit Application, General Information Portion* (DOE/RL-91-28) must contain two items: (1) "an outline of both the introductory and continuing training programs by owners or operators to prepare persons to operate or maintain the TSD facility in a safe manner as required to demonstrate compliance with WAC 173-303-330" and (2) "a brief description of how training will be designed to meet actual job tasks in accordance with the requirements in WAC 173-303-330(1)(d)." The Site-Wide Permit, Condition II.C (Personnel Training) contains requirements applicable to Hanford facility personnel and non-facility personnel.

Compliance with these requirements is discussed in Chapter 8.0 of DOE/RL-91-28 (Attachment 33 of Site-Wide Permit) and the following subsections.

5.6.1 Introductory and Continuing Training Programs

The introductory and continuing training programs are designed to prepare personnel to manage and maintain the TSD unit in a safe, effective, and environmentally sound manner. In addition to preparing personnel to manage and maintain TSD units under normal conditions, the training programs ensure that personnel are prepared to respond in a prompt and effective manner should abnormal or emergency conditions occur.

Introductory training includes general Hanford training and TSD unit-specific training. General Hanford Facility training is described in Section 8.1 of DOE/RL-91-28, and is provided in accordance with the Site-Wide Permit, Condition II.C.2. TSD unit-specific training is provided to Hanford personnel allowing personnel to work unescorted. Hanford personnel cannot perform a task for which they are not properly trained, except to gain required experience while under the direct supervision of a supervisor or co-worker who is properly trained. Hanford personnel assigned the job title of Emergency Coordinator and alternates to this position performing tasks described in WAC 173-303-360 (such as Building Emergency Directors) are thoroughly familiar with applicable contingency plan documentation, operations, activities, location, and properties of all waste handled, location of all records, and the unit/building layout.

Continuing training meets the requirements for WAC 173-303-330(1)(b) and includes general Hanford training and TSD unit-specific training. General Hanford training is the same as described for introductory training. TSD unit-specific training provides an annual review of emergency response training and an annual review of training necessary to ensure TSD unit operations are in compliance with WAC 173-303.

5.6.2 Description of Training Design

Proper design of a training program ensures personnel who perform duties on the Hanford Site related to WAC 173-303-330(1)(d) are trained to perform their duties in compliance with WAC 173-303. Actual job tasks, referred to as duties and responsibilities, are used to determine training requirements.

Elements of WAC 173-303-330(1)(d) applicable to C-106 component closure activities include the following:

- Procedures for using, inspecting, repairing, and replacing emergency and monitoring equipment
- Communications or alarm systems
- Response to fires or explosions
- Shutdown of operations.

Hanford personnel who perform these duties and have these responsibilities receive training pertaining to their duties and responsibilities. The written training plan documentation as required by WAC 173-303-330(2) contains specific information regarding the types of training that Hanford personnel receive.

5.6.3 Description of Training Plan

Unit-specific training plan documentation is maintained outside of the *Hanford Facility Dangerous Waste Permit Application* (DOE/RL-91-28) and the Site-Wide Permit. Therefore, changes made to the written training plan documentation are not subject to the Site-Wide Permit modification process.

Training plan documentation is prepared to comply with WAC 173-303-330(2). Documentation prepared to meet the training plan requirement could consist of hard copy or electronic media as provided by Site-Wide Permit, Condition II.I.1. The training plan documentation could consist of more than one document or a training database as long as the components are identified in a core document.

The following describes how Dangerous Waste Training Plan (DWTP) documentation meets the three items in WAC 173-303-330(2):

1. -330(2)(a): "The job title, job description, and name of the employee filling each job. The job description must include requisite skills, education, other qualifications, and duties for each position."

   Description: The specific personnel job titles and duties for each position are maintained in the core DWTP document. Duties (responsibilities) for positions

relating to WAC 173-303 are described in the DWTP core document and are listed under the specific job title to ensure training for personnel are determined properly.

Names of Hanford Facility personnel who carry out activities are maintained. Names could be maintained within the DWTP core document or by other means referenced in the DWTP core document.

Prerequisite skills, education, and other qualification requirements are addressed by making general statements in the DWTP and referencing where this information is maintained (such as the human resources department). Specific information concerning job title, requisite skills, education, and other qualifications for personnel might not be included in the DWTP core document if this information can be provided upon request.

2. -330(2)(b): "A written description of the type and amount of both introductory and continuing training required for each position."

   Description: In addition to the discussion provided in Section 8.1 of DOE/RL-91-28, courses developed to comply with the introductory and continuing training programs are identified and discussed in the DWTP documentation. The frequency for retraining is specified in the DWTP documentation.

3. -330(2)(c): "Records documenting that personnel have received and completed the training required by this section. The Department may require, on a case-by-case basis, that training records include employee initials or signature to verify that training was received."

   Description: Training records are maintained consistent with DOE/RL-91-28, Section 8.3.

5.7 C-106 COMPONENT CLOSURE ACTIVITY CONTACT POINT

DOE will be the official contact for C-106 during and after the component closure activity at the following address:

Tank Closure Program Manager
Office of River Protection
U.S. Department of Energy
PO Box 450 (H6-60)
Richland, Washington 99352

5.8 C-106 COMPONENT CLOSURE ACTIVITY SCHEDULE

The current schedule for C-106 component closure activities are contained in the HFFACO Milestone M-45 series and will be modified, if needed, according to the HFFACO change process. Table 5-4 lists the HFFACO Milestones associated with the C-106 retrieval and component closure activities.

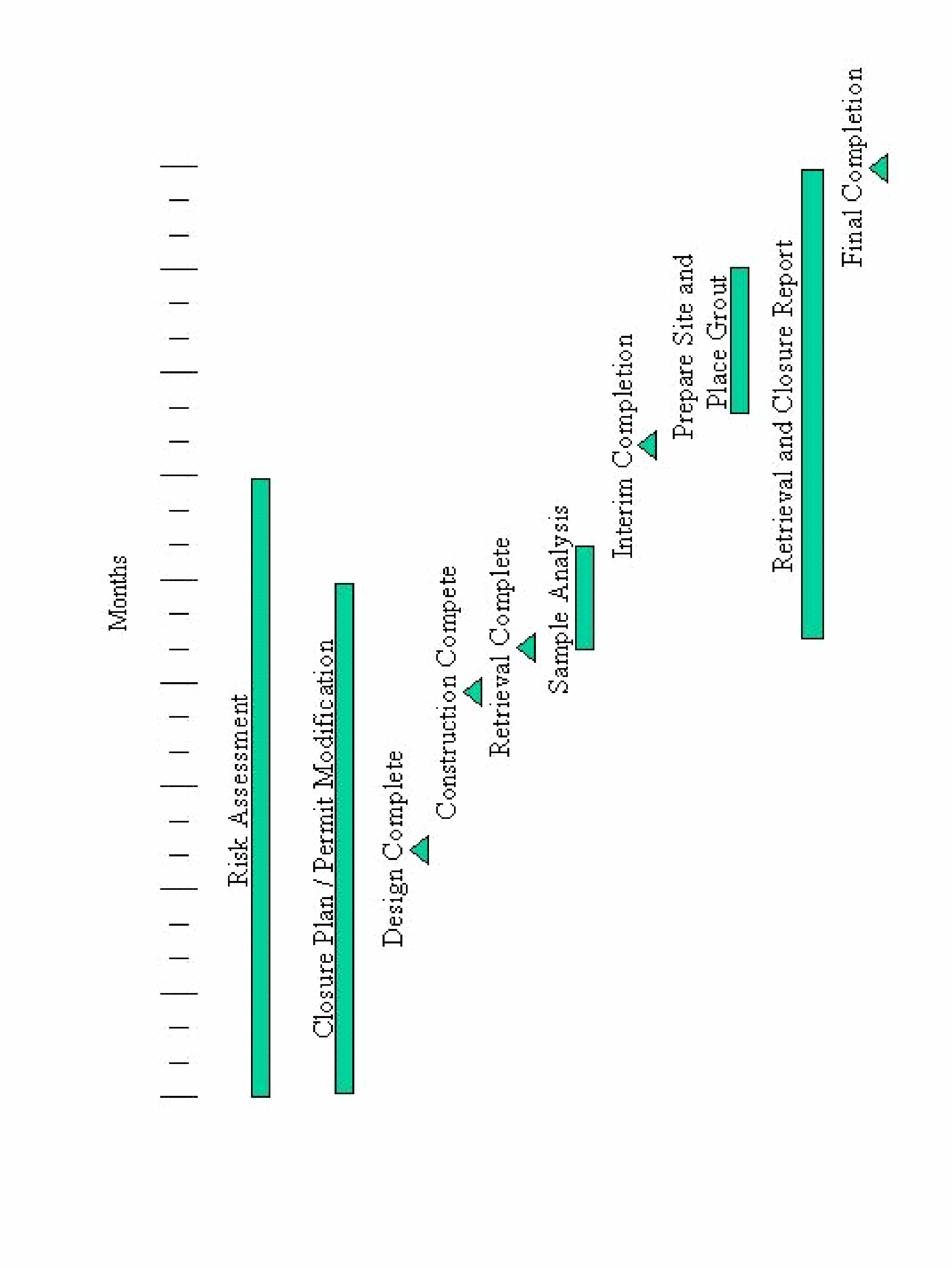
Table 5-4. HFFACO Milestones for C-106 Retrieval and Component Closure.

Milestone	Activity	Date
M-45-06A	Submit a certified (framework) SST system closure plan modification and C-106 retrieval and closure demonstration plan to Ecology.*	12/19/2002
M-45-05I-T01	Conduct C-106 waste retrieval and closure demonstration project 30% design consultation.	1/31/2003
M-45-05J-T01	Complete C-106 waste retrieval and closure demonstration project design.	4/30/2003
M-45-05K-T01	Complete C-106 waste retrieval and closure demonstration project construction.	9/30/2003
M-45-05L-T01	Complete full-scale C-106 waste retrieval.	11/01/2003
M-45-05M-T01	Submit C-106 waste retrieval results, analysis of residual waste(s), and (if appropriate) request for exception to the criteria pursuant to Agreement Appendix H.	2/27/2004
M-45-05H	Interim completion of C-106 SST waste retrieval and closure demonstration project.	4/30/2004
M-45-05N-T01	Final completion of C-106 SST waste retrieval and closure demonstration project.	12/31/2004

* Certification obtained for RPP-13774, Rev. 0

Figure 5-4 is a summary schedule of the major C-106 component closure activities.

Figure 5-4. Major C-106 Component Closure Activities.



5.9 FUTURE AMENDMENT OF C-106 COMPONENT CLOSURE ACTIVITY PLAN

This component closure activity plan will be amended whenever changes in component closure activities occur that would constitute a Class 1, 2, or 3 modification to the permit (WAC 173-303-830).

5.10 REPORT OF C-106 COMPONENT CLOSURE ACTIVITY

Within 60 days of the completion of each phase of activities at C-106, DOE will submit to Ecology a letter report documenting activities that have been conducted in accordance with the specifications contained within the approved plan, as amended, and as contained in the permit.

6.0 CARE OF C-106 AFTER COMPONENT CLOSURE ACTIVITIES

This section describes activities DOE will undertake to provide care for C-106 between the time DOE completes component closure activities and the time DOE closes WMA C. While conducting closure actions under HFFACO schedules of compliance and permit requirements, the tank system must continue to comply with interim-status standards.

DOE will maintain control over WMA C for the foreseeable future. Roadways to the unit and site access will remain administratively restricted to use by authorized personnel only. Posted warning signs restrict access from the Columbia River. A chain-link fence surrounds WMA C. The 200 Areas are under 24-hour security surveillance. DOE will inspect security systems and controls on a routine basis.

The current vadose zone and groundwater monitoring programs will continue after component closure activities are completed. Current restrictions ensuring that groundwater is not used as a drinking water source in the 200 Areas will continue after component closure activities.

Isolation techniques were discussed in Section 5.3. Administrative isolation of C-106 will be continued pending WMA C closure.

6.1 FUTURE POSTCLOSURE ACTIONS

Final closure of C-106 through closure of WMA C will require compliance with the postclosure provisions contained in WAC 173-303-610(7) and -665(6). Closure activities contained in this component closure activity plan, however, will not constitute final closure for C-106. Final postclosure actions for C-106 will occur as part of the postclosure plan for WMA C. At that time, WMA C will enter a control period during which monitoring and maintenance will take place. Administrative controls such as deed restrictions also may be defined.

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SUPPLEMENT C1
C-106 DATA QUALITY OBJECTIVES REPORT

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RPP-13889
Revision 0

TANK 241-C-106 COMPONENT CLOSURE ACTION DATA QUALITY OBJECTIVES

D. L. Banning
CH2M HILL Hanford Group, Inc.

Date Published
August 2003

CH2MHILL
Hanford Group, Inc.
Post Office Box 1500
Richland, Washington

Prepared for the U.S. Department of Energy
Office of River Protection

Contract # DE-AC27-99RL14047, Modification M030

RPP-13889 Rev. 0

SIGNATURE PAGE

The signatories concur with this document as of the signature dates. The signatories shall concur with any revisions made to this document. This signature page shall be updated before the release of any revisions and will be the formal concurrence with any revisions made to the document.

______________________________ 7/23/03
U.S. Department of Energy, Office of River Protection — Date

______________________________ 8/13/03
State of Washington Department of Ecology — Date

E A Fredenburg 7/17/2003
CH2M HILL Hanford Group, Inc., Tank Closure Project — Date

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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
GFAA	graphite furnace atomic absorption
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
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
TIC	tentatively identified compound
UCL	upper confidence limit
UHC	underlying hazardous constituent
Tri-Party Agreement	*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 the 241-C-106 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.
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 removal of the remaining single-shell tank (SST) waste and final closure of the SST farms. 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 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 from risk assessment tests on residual solids. The concentration and the volume of the residual waste will provide the inventory of the constituents in the residual waste.

An important step in the closure of the SST farms will be the component closure actions of tank 241-C-106. In order to obtain the concentrations of the constituents of concern, samples of the residual waste (liquid and solids) will be required. Liquid grab samples 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 Plan for Tank 241-C-106 Closure* (May 2003). Retrieval actions will be complete prior to permit issuance. Retrieval activities are included in the 241-C-106 component closure activity plan for information purposes only in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) M-45-00 milestone issues.

This document describes the Data Quality Objective (DQO) process undertaken to ensure appropriate data are collected to support the component closure activities for tank 241-C-106 and will cover all sampling and analytical activities for that purpose. Final component closure activities will be addressed in the SST Closure Plan and determined in the site wide permit. The DQO process was implemented in accordance with *Data Quality Objectives for Sampling and Analyses*, TFC-ENG-CHEM-C-16, Rev. A (Banning 2003) and the U.S. Environmental Protection Agency (EPA) QA/G4, *Guidance for the Data Quality Objectives Process* (EPA 2000), with some modifications to accommodate project or tank specific requirements and constraints. The DQO process is an iterative process. Therefore, changes to this document will be made during the project if information is obtained that changes the requirements stated in this document.

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 Tri-Party Agreement, 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 (tank 241-C-106 component closure action) 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 tank 241-C-106.
- This DQO will not address soil sampling and analysis or any ancillary equipment in the tank farm. Therefore, the component closure action boundary for tank 241-C-106 will be the exterior of the tank walls. However, the closure action criteria will be consistent with and support final closure of the C Tank Farm. Because the development of this DQO did not focus on soil and ancillary equipment (pipes, pits, vaults, etc.) in the tank farm, this DQO does not adequately serve as a basis for final closure of the C Tank Farm. These issues will be addressed separately.

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

> Conduct component closure activities for tank 241-C-106 in a manner that is contributive to final closure of the C Tank Farm.

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 shown above is:

> Does the residual waste in tank 241-C-106 meet the Tri-Party Agreement 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

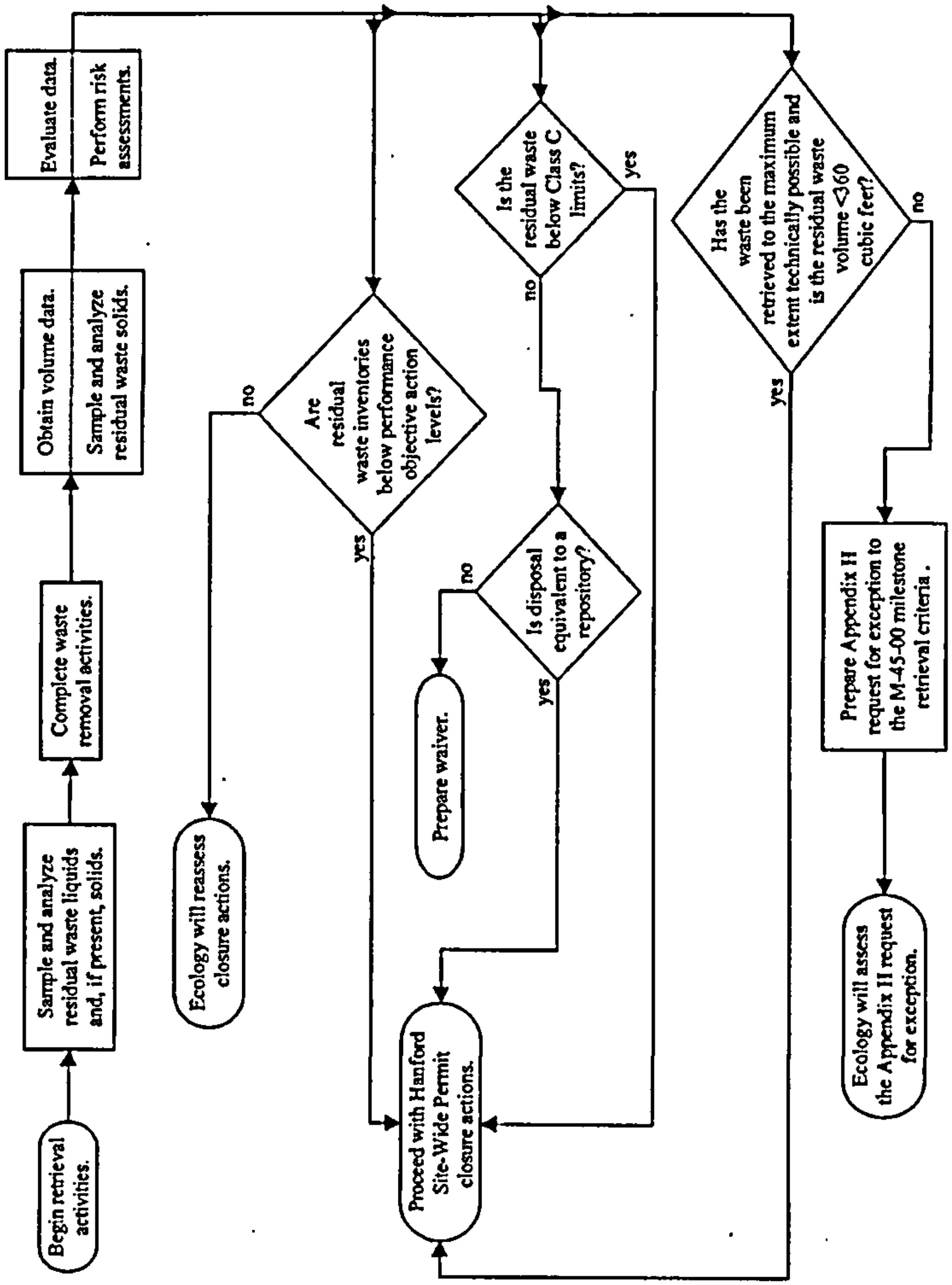
Decision statements link alternative actions with the principal study question and express a choice between alternative actions. Decision statements are created by combining the study questions with alternative actions. Using this formula, the decision statement can be expressed as:

> Determine whether or not the residual waste in tank 241-C-106 meets the Tri-Party Agreement M-45-00 milestone volume requirements and supports the WAC 173-303-610 (2) closure performance standard for protection of human health and the environment and allows the component closure actions to proceed, or reassessment of the component closure actions will be required.

Figure 3-1 shows the general logic flowchart for the component closure action of tank 241-C-106. The flowchart shows the decisions and activities that are covered by this DQO and are needed to address the tank 241-C-106 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 decision rules must be addressed to proceed with Hanford Site-Wide Permit closure actions. The decision rules are discussed in Section 6.0.

Figure 3-1. 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 tank 241-C-106: volume data, constituent concentrations including radionuclides, and release rates of critical constituents. 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). This work will be governed by a test plan that will be submitted to Ecology for concurrence.

4.1 ANALYTICAL PARAMETERS

An analytical strategy for the component closure action of tank 241-C-106 was developed during the 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. The secondary constituents (those constituents that can be detected with the analytical methods being used but not a Part A, UHC, or 10 CFR 61.55 constituent) 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 (EPA 1986) analytical methods and the Part A, UHC, and 10 CFR 61.55 (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 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, radiolytic, and volatile, 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 to effectively evaluate the tentatively identified compounds (TIC). 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.

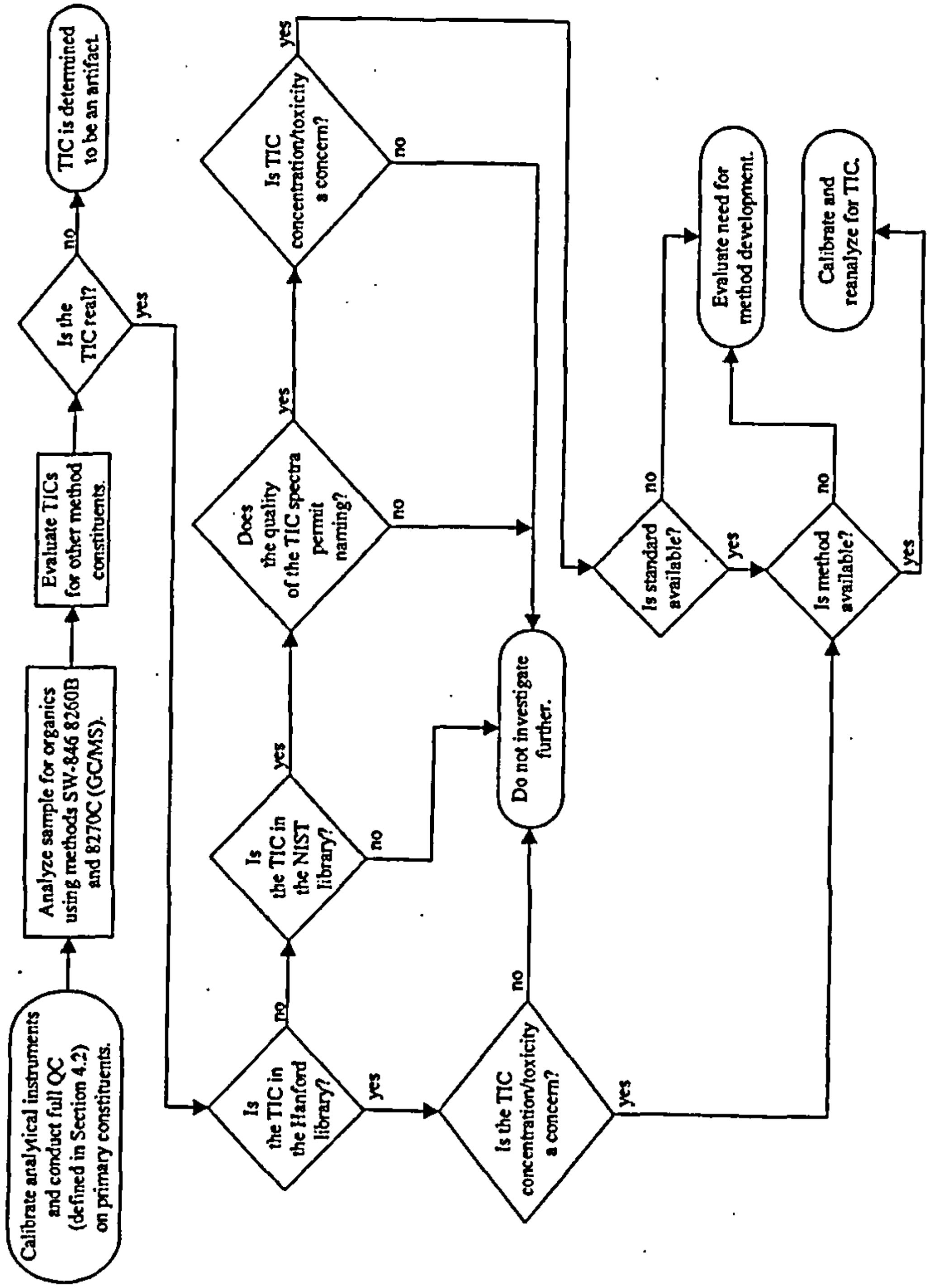
Because the volatile organic analysis (VOA) calibration standards are normally prepared in methanol, this constituent cannot be included as an analyte. Methanol is not expected to be present in tank waste, and because it is highly soluble in water, it should be removed when the liquid waste is retrieved.

Organic constituents that are detected and not part of the calibration mix (Part A and UHC constituents) are TICs. 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. If the TIC is determined to be an artifact of the testing, no further evaluation is needed. 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") will be composed of constituents that have been identified as possibly being present in Hanford Site waste in the Regulatory DQO (Wiemers et al. 1998) except those already identified as primary constituents.

The "Hanford Library" is under development and will be completed prior to analyzing samples from tank 241-C-106. The "Hanford Library" is developed by running single standards of the constituents on the laboratory's gas chromatography/mass spectrometry (GC/MS) systems. The results of these analyses will provide accurate retention time information and mass response factors for these compounds and permit a better evaluation of the TIC. If a TIC is positively identified in the "Hanford Library" of compounds, a semi-quantitative estimate of its concentration will be made and evaluated. If the concentration of the TIC is significantly below the level of concern, then no further investigation is needed. However, if the concentration level of the TIC is considered significant, then a further evaluation of the TIC will be conducted (see Figure 4-1). This could be as simple as recalibrating and reanalyzing or as complex as developing a new 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 technology and results shall be used in the tank assessments until improved methods are available. These methods shall be applied to future samples where these TICs may be identified

The 222-S Laboratory follows the Contract Laboratory Program approach to identifying and estimating TICs. The Reconstructed Ion Chromatogram is evaluated for TICs by identifying any peaks that have not already been identified as target compounds. Any TIC peaks identified that are greater than 10 percent of the nearest internal standard (IS) area free from interferences will be reported. A library search will be performed and evaluated by the responsible chemist. An estimate of the concentration will be made based on the concentration of the IS used and a response factor of 1. All TIC results will be flagged with a "J" to indicate that the result is an estimate and an "N" if the identification of the unknown is based on a library search.

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 (Wiemers et al. 1998). 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 For VOC Analyses. (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	
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	

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

Constituent	CAS	Reason for Inclusion	Comments
Toluene	108-88-3	A, U, W	
trans-1,3-dichloropropene	10061-02-6	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 an alternate method.
A Part A constituent.
U UHC constituent.
W Constituent in Wiemers et al. (1998).

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 (Wiemers et al. 1998).

Table 4-2. Method 8270C For SVOC Analyses. (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	
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	

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

Constituent	CAS	Reason for Inclusion	Comments
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	

Notes:

CAS Chemical Abstracts Service
* Constituent may be analyzed by an alternate method.
A Part A constituent.
U UHC constituent.
W Constituent in Wiemers et al. (1998).

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. This reflects 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 (Wiemers et al. 1998) 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	Tributyl phosphate	126-73-8
Hexafluoroacetone*	684-16-2	1,1-Dimethylhydrazine	57-14-7
2-Butenaldehyde (2-Butenal)	4170-30-3	Methylhydrazine	60-34-4
Methyl isocyanate	624-83-9		
n-Propionaldehyde	123-38-6		
3-Heptanone	106-35-4		
Chloromethane	74-87-3		
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		

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

Method 8260B VOC	CAS	Method 8270C SVOC	CAS
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 QC of these secondary constituents may fall outside of the 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. This means these constituents must meet the highest level of quality for data evaluation. 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), then 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.

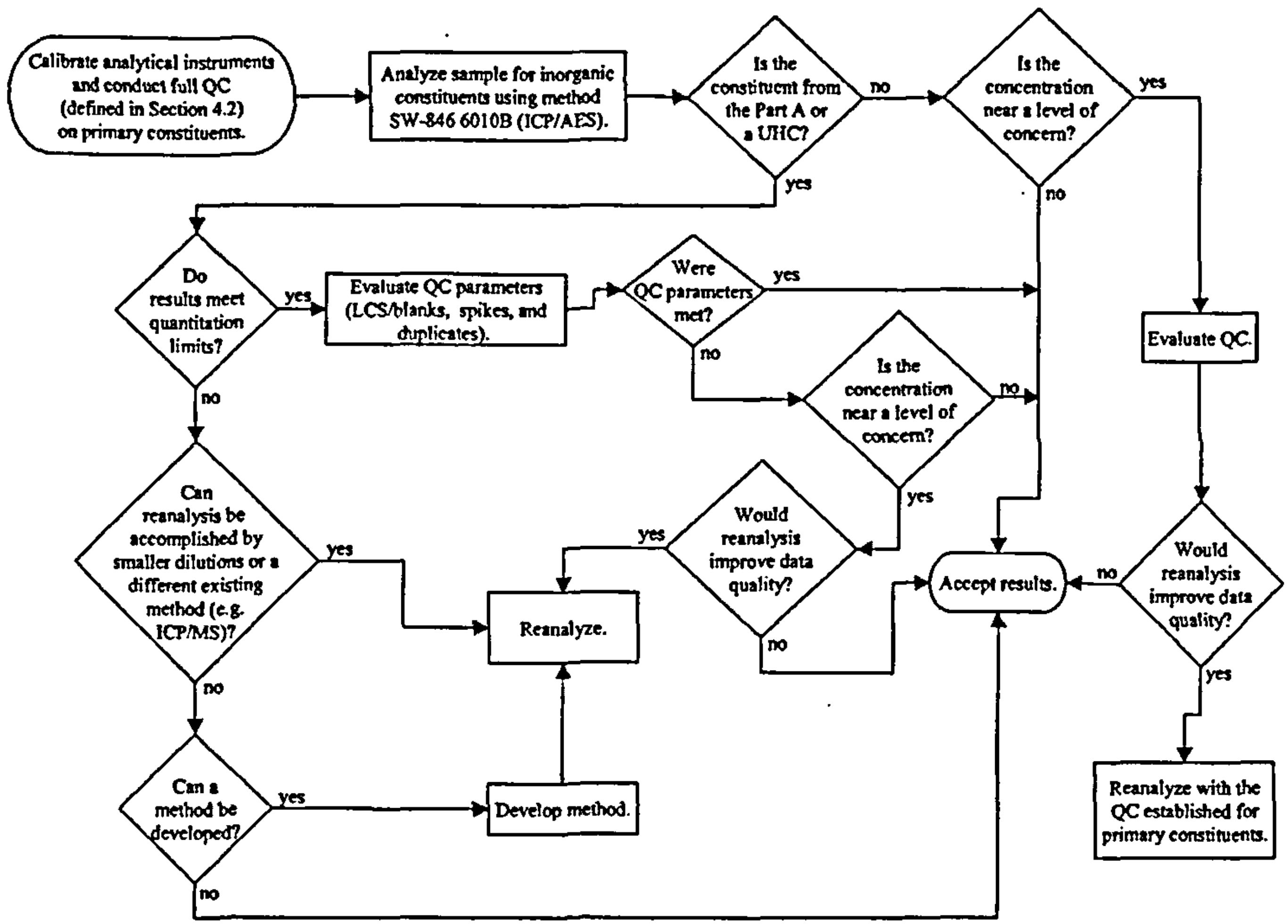
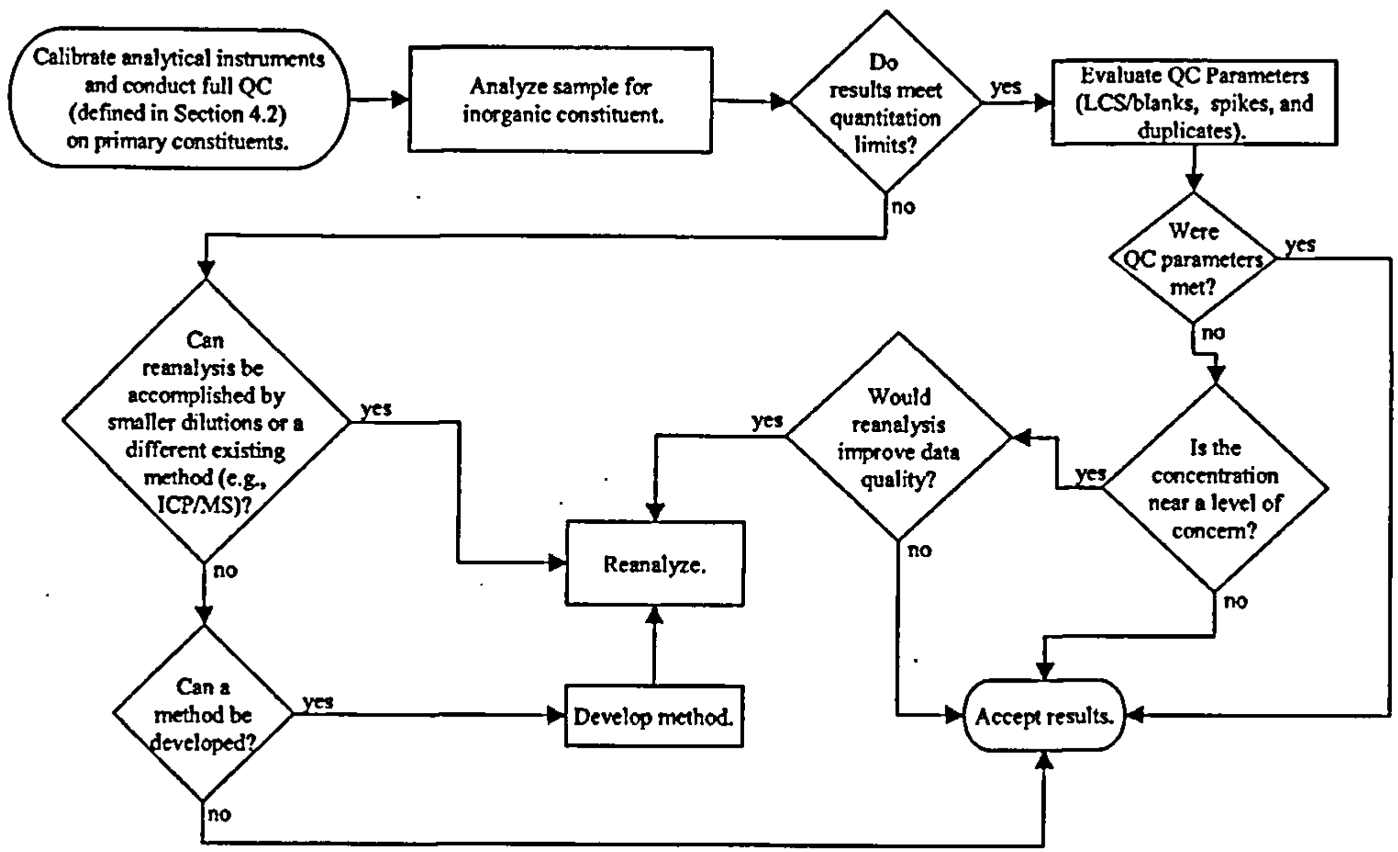


Figure 4-3. Strategy for Inorganic Single Constituent Analytical Method.



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 or graphite furnace atomic absorption (GFAA) as noted in the table. The atomic absorption methods are single constituent analytical methods and do not provide any secondary constituent information.

Three anions (fluoride, sulfide and cyanide) are identified as primary constituents. Fluoride is 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.

Although not in the Part A or a UHC constituent, ammonia and hydroxide were added to the primary constituent list in the DQO process meetings.

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 on a water digestion of the waste. Because of the volatile nature of ammonia in alkaline solutions, it is important to stabilize by acidifying as soon as possible.

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
Arsenic As	A, U, W	6010B (ICP/AES)	6020 (ICP/MS) and 7060A (GFAA)
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)
Lead Pb	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Nickel Ni	U, W	6010B (ICP/AES)	6020 (ICP/MS)
Seleniun Se	A, U, W	6010B (ICP/AES)	6020 (ICP/MS) and 7740 (GFAA)
Silver Ag	A, U, W	6010B (ICP/AES)	6020 (ICP/MS)
Thallium Tl	U, W	6010B (ICP/AES)	6020 (ICP/MS)
Chromium Cr	A, U, 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)	
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^+	W	9056 (IC)	
Hydroxide OH^-	W	Titration or pH (see text)	

Notes:

A	Part A constituent.
U	UHC constituent.
W	Constituent in Wiemers et al. (1998).
CVAA	Cold vapor atomic absorption
GFAA	Graphite furnace atomic absorption
IC	Ion chromatograpy.
ICP/AES	Inductively coupled plasma/atomic emissions spectroscopy.
ICP/MS	Inductively coupled plasma/mass spectrometry

The 222-S Laboratory presently does not have a procedure for sulfide analysis. However, work was done several years ago to develop a microdistillation process to prepare samples for sulfide analyses using the ion-specific electrode (ISE) method (SW-846 method 9215). This work will have to be completed to analyze for sulfides.

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. These may be determined by microdistillation and measurement by ion selective electrode or titration methods.

The secondary inorganic constituents are identified in Table 4-5. Most of these constituents are identified in the Regulatory DQO (Wiemers et al. 1998, 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 many of the constituents (e.g., aluminum) in Table 4-5 are considered secondary because of their 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)**
Aluminum Al	Bromide Br^-
Antimony Sb	Chloride Cl^-
Boron B	Nitrate NO_3^-
Bismuth Bi	Nitrite NO_2^-
Calcium Ca	Phosphate PO_4^{3-}
Cobalt Co	Sulfate SO_4^{2-}
Copper Cu	Acetate $C_2H_3O_2^-$
Iron Fe	Formate CHO_2^-
Potassium K	Glycolate $C_2H_3O_3^-$
Lithium Li	Oxalate $C_2O_4^{2-}$
Molybdenum Mo	
Magnesium Mg	
Manganese Mn	
Sodium Na	
Phosphorus P	
Rhodium Rh	
Sulfur S	
Silicon Si	
Tin Sn	
Tantalum Ta	
Tungsten W	
Yttrium Y	
Zirconium Zr	
Uranium U	
Sulfur S	
Cerium Ce	
Europium Eu	
Lanthanum La	
Niobium Nb	
Neodymium Nd	
Palladium Pd	
Praseodymium Pr	

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

Constituent	Constituent
Method 6010B (ICP/AES)	Method 9056 (IC)
Rubidium Rb	
Ruthenium Ru	
Samarium Sm	
Strontium Sr	
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 essentially the same as the inorganic analytical strategy but the radionuclides have more single constituent analytical methods. Therefore, the strategy for determining the radionuclides can be seen in Figures 4-2 and 4-3 by substituting radionuclides for inorganic constituents. 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.

Table 4-6. Primary Radiochemistry Constituents. (2 Sheets)

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	ICP/MS
^{63}Ni	10 CFR 61.55	Liquid Scintillation Counting	
^{90}Sr	10 CFR 61.55	Beta Proportional Counting	
^{99}Tc	10 CFR 61.55	Liquid Scintillation Counting	ICP/MS
^{79}Se	Risk assessment	Liquid Scintillation Counting	ICP/MS
^{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	

Table 4-6. Primary Radiochemistry Constituents. (2 Sheets)

Constituent	Reason for Inclusion	Analytical Method	Alternate Method
^{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 & $^{239/240}Pu$	ICP/MS
^{241}Am	10 CFR 61.55	Alpha Counting	
^{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. ^{129}I also may be measured by ICP/MS but sensitivity is not as good unless a collision cell is used to eliminate ^{129}Xe interference.

Like ^{129}I, ^{79}Se may be determined by ICP/MS if collision cell technology is used to eliminate argon interferences. 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.

In addition to the constituents discussed above, a bulk density 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 1998) 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 is required for each preparation batch. Other laboratory QC for the inorganic and radiochemistry constituents will be conducted according to the criteria outlined in Table 4-7.

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

Constituents	Method	QC Acceptance Criteria		
		LCS % Recovery[a]	Spike% Recovery[b]	Duplicate RPD[c]
As, Ba, Be, Cd, Pb, Ni, Se, Ag, Tl, Cr, V, Zn	ICP/AES	80 – 120%	75 – 125%	≤20%
Hg	CVAA	80 – 120%	75 – 125%	≤20%
F^-, NH_4^+	IC	80 – 120%	75 – 125%	≤20%
CN^-	9014 (Spectrophotometric)	80 – 120%	75 – 125%	≤20%
S^{2-}	9215	80 – 120%	75 – 125%	≤20%
OH^-	Titration	80 – 120%	N/A	≤20%
	pH (see text)	± 0.1 pH Units	N/A	N/A
PCB	GC/ECD	70 – 130%	50 – 150%	≤30%
VOC	GC/MS	70 – 130%	50 – 150%	≤30%
SVOC	GC/MS	70 – 130%	50 – 150%	≤30%
% H_2O	TGA	80 – 120%	N/A	≤20%
Bulk Density	Gravimetric	N/A	N/A	≤20%
^{233}U ^{234}U, ^{235}U ^{236}U, ^{238}U, ^{237}Np, ^{230}Th, ^{232}Th	ICP/MS	80 – 120%	70 – 130%	≤20%
^{228}Th	Calculation	N/A	N/A	N/A
^{60}Co, ^{137}Cs	GEA	80 – 120%	N/A[e]	≤20%

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

Constituents	Method	QC Acceptance Criteria		
		LCS % Recovery[a]	Spike% Recovery[b]	Duplicate RPD[c]
^{152}Eu, ^{154}Eu, ^{155}Eu	GEA	80 – 120%	N/A[e]	≤20%
^{129}I	GEA	75 – 125%	N/A[d]	≤20%
^{14}C, ^{3}H	Liquid scintillation counting	80 – 120%	70 – 130%	≤20%
^{63}Ni	Liquid scintillation counting	70 – 130%	N/A[d]	≤20%
^{90}Sr	Beta counting	75 – 125%	N/A[d]	≤20%
^{99}Tc	Liquid scintillation counting	80 – 120%	70 – 130%	≤20%
^{79}Se	Liquid scintillation counting	NP	N/A[d]	≤20%
^{238}Pu, $^{239/240}Pu$	Alpha counting	80 – 120%	N/A[d]	≤20%
^{241}Pu	Calculation from ^{238}Pu & $^{239/240}Pu$	N/A	N/A	N/A
^{241}Am, ^{242}Cm, $^{243/244}Cm$	Alpha counting	80 – 120%	N/A[d]	≤20%

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 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 is used to correct for constituent loss during sample preparation and analysis. The result generated using the carrier 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 (EPA 1996). 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 or finger-trap sampling methods. New methods are also being evaluated (e.g., clamshell device). 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.

- Holding time - The extra precautions required to sample Hanford Site tank waste either lengthen the time required for each sampling, shipping, and analysis step or create 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 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

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

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, solids samples are shipped to the laboratory in the sample device to minimize radiation exposure to the workers.

While all of the above recommendations cannot be met for every sample, efforts shall be made to minimize the potential impacts and the duration between sampling and analysis of the samples. 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 Clark (2003), 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, the data package will not receive a third party validation. 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 describing the methods used and 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. The action levels for the tank 241-C-106 component closure action analytical data depend on development of the risk assessment criteria and presently are not available.

Because the action levels, needed to determine the detection limits, are under development, 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 risk 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 4-12 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 4-8. Comparison of WAC 173-340 Limits to MDLs for Primary Organic Constituents (2 Sheets)

CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8260B[a] (VOC) Estimated MDLs mg/kg	CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8270C[b] (SVOC) Estimated MDLs mg/kg
67-64-1	Acetone (2-Propanone)	3.21E+00	0.1	83-32-9	Acenaphthene	9.79E+01	40
71-43-2	Benzene	4.48E-03	0.1	117-84-0	Bis-2-ethylhexyl phthalate (Dioctylphthalate)	5.32E+05	40
71-36-3	Butanol; n- (n-butyl alcohol)	6.62E+00	0.1	85-68-7	Butylbenzylphthalate	8.93E+02	40
75-15-0	Carbon disulfide	5.65E+00	0.1	95-57-8	Chlorophenol; 2-	9.43E-01	40
56-23-5	Carbon tetrachloride	3.10E-03	0.1	108-39-4	Cresol; m- (3-Methylphenol)	3.20E+00	40
108-90-7	Chlorobenzene	8.74E-01	0.1	95-48-7	Cresol; o- (2-Methylphenol)	4.66E+00	40
67-66-3	Chloroform	3.81E-02	0.1	106-44-5	Cresol; p- (4-Methylphenol)	3.20E-01	40
107-06-2	Dichloroethane; 1,2-	2.32E-03	0.1	1319-77-3	Cresylic acid (cresol, mixed isomers)	Note (d)	0.4
75-35-4	Dichloroethylene; 1,1- (Dichloroethene)	5.22E-04	0.1	108-94-1	Cyclohexanone	3.20E+02	0.4
75-09-2	Dichloromethane (methylene chloride)	2.54E-02	0.1	84-74-2	Dibutylphthalate (Di-n-butylphthalate)	1.14E+01	0.4
542-75-6	Dichloropropene; 1,3,- (trans-)	1.41E-03[c]	0.1	95-50-1	Dichlorobenzene; 1,2- (ortho-)	7.03E+00	40
141-78-6	Ethyl acetate	1.61E+02	0.1	121-14-2	Dinitrotoluene; 2,4-	1.89E-01	40
60-29-7	Ethyl ether (Diethyl ether)	9.09E+00	0.1	110-80-5	Ethoxyethanol; 2-	2.56E+01	0.4
100-41-4	Ethylbenzene	6.05E+00	0.1	206-44-0	Fluoranthene	6.31E+02	40
78-83-1	Isobutyl alcohol (Isobutanol)	5.47E+01	0.1	87-68-3	Hexachlorobutadiene	6.05E+00	40
78-93-3	Methyl ethyl ketone (2-Butanone)	2.18E+01	0.1	67-72-1	Hexachloroethane	2.49E-01	40
108-10-1	Methyl isobutyl ketone (4-methyl-2-pentanone)	1.28E+01	0.1	128-37-0	methylphenol; 2,6-Bis(tert-butyl)-4-	None	0.4
79-46-9	Nitropropane; 2-	1.84E-05	0.1	59-50-7	methylphenol; 4-Chloro-3- (p-Chloro-m-cresol)	None	52
79-34-5	Tetrachloroethane; 1,1,2,2-	1.23E-03	0.1	91-20-3	Naphthalene	4.46E+00	0.4
127-18-4	Tetrachloroethene; 1,1,2,2-	9.10E-03	0.1	98-95-3	Nitrobenzene	5.11E-02	40
108-88-3	Toluene	7.27E+00	0.1	88-75-5	Nitrophenol; o-	None	40
76-13-1	trichloro-1,2,2-trifluoroethane; 1,1,2-	1.92E+03	0.1	621-64-7	Nitroso-di-n-propylamine; N-	5.60E-05	0.4
71-55-6	Trichloroethane; 1,1,1-	1.58E+00	0.1	59-89-2	Nitrosomorpholine; N-	None	0.4
79-00-5	Trichloroethane; 1,1,2-	4.27E-03	0.1	129-00-0	Pyrene	6.55E+02	40
79-01-6	Trichloroethylene; 1,1,2-	2.60E-02	0.1	110-86-1	Pyridine	3.87E-01	0.4
75-69-4	Trichlorofluoromethane	7.23E+01	0.1	120-82-1	Trichlorobenzene; 1,2,4-	2.98E+00	40
75-01-4	Vinyl chloride (1-Chloroethene)	1.84E-04	0.1	95-95-4	Trichlorophenol; 2,4,5-	5.75E+01	40
1330-20-7	Xylenes	9.14E+01	0.1	88-06-2	Trichlorophenol; 2,4,6-	9.24E-02	40
108-38-3	Xylene; m-	8.44E+01	0.1				
95-47-6	Xylene; o-	9.19E+01	0.1				
106-42-3	Xylene; p-	1.72E+02	0.1				
		Constituent Limits 0.05[c] mg/kg	**Method 8082 PCBs MDL mg/kg**				
11104-26-2	Aroclor 1221	Note c	0.082				
11141-16-5	Aroclor 1232	Note c	0.026				
2674-11-2	Aroclor 1016	Note c	0.46				
53969-21-9	Aroclor 1242	Note c	0.084				
126572-29-6	Aroclor 1248	Note c	0.027				
11097-6999-1	Aroclor 1254	Note c	0.016				
11096-82-5	Aroclor 1260	Note c	0.113				

Table 4-8. Comparison of WAC 173-340 Limits to MDLs for Primary Organic Constituents (2 Sheets)

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

Notes:

CAS	Chemical Abstracts Service
VOC	Volatile Organic Compound
SVOC	Semivolatile Organic Compound
MDL	Method Detection Limits
Shaded Limits	Constituents where the limits are close to or below MDLs.
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] 8260B MDL basis SW-846 5g sample, 222-S Laboratory 0.25g sample. The ratio of dilution factor is 5g/0.25g = 20. Example: SW-846 estimated quantitation limit (EQL) = 5mg/g, 222-S Laboratory EQL = 5mg/g x 20 = 100mg/g.
[b] 8270C MDL basis 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.
[c] 0.05 mg/kg is for total PCBs.
[d] 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)
[e] 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	CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8270C (SVOC) Estimated MDLs mg/kg
123-86-4	Acetic acid, n-butylester	None	0.1	98-86-2	Acetophenone	6.40E+00	0.4
75-05-8	Acetonitrile	2.82E-01	0.1	309-00-2	Aldrin	5.04E-03	28
107-02-8	Acrolein (propenal)	1.06E+00	0.1	50-32-8	Benzo[a]pyrene	1.37E-01	40
107-13-1	Acrylonitrile	3.33E-04	0.1	92-52-4	Biphenyl; 1,1'-	7.55E+02	0.4
107-05-1	Allyl chloride (3-Chloropropene)	3.20E+00	0.1	4170-30-3	Butenaldehyde; 2- (2-Butenal)	None	0.4
74-83-9	Bromomethane	5.18E-03	0.1	100-00-5	Chloronitrobenzene (p-Nitrochlorobenzene)	6.56E-02	0.4
106-99-0	Butadiene; 1,3-	3.55E-04	0.1	541-73-1	Dichlorobenzene; 1,3-	None	40
75-45-6	Chlorodifluoromethane	None	0.1	106-46-7	Dichlorobenzene; 1,4- (para-)	3.00E-02	40
74-87-3	Chloromethane	3.34E-02	0.1	53-70-3	Diebenzo[a,h]anthracene	1.37-01	40
110-82-7	Cyclohexane	1.30E+03	0.1	60-57-1	Dieldrin	2.82E-03	28
110-83-8	Cyclohexene	None	0.1	57-14-7	Dimethylhydrazine; 1,1-	1.35E-04	0.4
287-92-3	Cyclopentane	None	0.1	100-25-4	Dinitrobenzene; 1,4- (para-)		0.4
76-14-2	Dichloro-1,1,2,2-tetrafluoroethane; 1,2-	None	0.1	88-85-1	Dinoseb (2-sec-Butyl-4,6-dinitophenol)	2.80E-02	0.4
75-71-8	Dichlorodifluoromethane	2.90E+01	0.1	122-39-4	Diphenylamine; N,N-	1.60E+00	0.4
75-34-3	Dichloroethane; 1,1-	4.37E+00	0.1	72-20-8	Endrin	4.40E-01	34
75-43-4	Dichlorofluoromethane	None	0.1	118-74-1	Hexachlorobenzene	1.50E-02	40
78-87-5	Dichloropropane; 1,2-	3.30E-03	0.1	319-84-6	Hexachlorocyclohexane; alpha- (alpha-BHC)	5.45E-04	18
10061-01-5	Dichloropropene; 1,3- (cis-)	1.41E-03[a]	0.1	319-85-7	Hexachlorocyclohexane; beta- (beta-BHC)	2.27E-03	18
123-91-1	Dioxane; 1,4-	3.18E-02	0.1	1335-87-1	Hexachloronaphtahlene	None	0.4
64-17-5	Ethyl alcohol	None	0.1	684-16-2	Hexafluoroacetone	None	0.4
75-00-3	Ethyl chloride (Chloroethane)	3.03E-02	0.1	591-78-6	Hexanone; 2-	None	0.4
106-93-4	Ethylene dibromide (1,2-Dibromoethane)	2.83E-06	0.1	465-73-6	Isodrin	None	0.4
75-21-8	Ethylene oxide (Oxirane)	1.83E-04	0.1	58-89-9	Lindane (gamma-BHC)	2.09E-03	28

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	CAS No.	Chemical Name	WAC 173-340 Limits mg/kg	Method 8270C (SVOC) Estimated MDLs mg/kg
76-44-8	Heptachlor	3.78E-03	26	563-80-4	Methy-2-butanone; 3-	None	0.4
142-82-5	Heptane; n-	None	0.1	126-98-7	Methyl-2-propenenitrile; 2-	6.57E-03	0.4
110-43-0	Heptanone; 2-	None	0.1	60-34-4	Methylhydrazine	3.18E-04	0.4
106-35-4	Heptanone; 3-	None	0.1	627-13-4	Nitric acid, propyl ester	None	0.1
123-19-3	Heptanone; 4-	None	0.1	62-75-9	Nitrosodimethylamine; N-	6.86E-06	0.4
110-54-3	Hexane; n-	9.62E+01	0.1	2234-13-1	Octachloronaphthalene	None	0.4
624-83-9	Methyl isocyanate	None	0.1	1321-64-8	Pentachloronaphthalene	None	0.4
110-12-3	Methyl-2-hexanone; 5-	None	0.1	82-68-8	Pentachloronitrobenzene (PCNB)	1.35E-03	?
75-65-0	Methyl-2-Propanol; 2-	None	0.1	87-86-5	Pentachlorophenol	1.15E-02	132
107-87-2	Methylcyclohexane	1.54E+03	0.1	109-66-0	Pentane; n-	None	0.4
78-92-2	Methylpropyl alcohol; 1-(2-butanol)	None	0.1	108-95-2	Phenol	4.39E+01	40
111-84-2	Nonane; n-	None	0.1	123-38-6	Propionaldehyde; n-	None	0.4
111-65-9	Octane; n-	None	0.1	1335-88-2	Tetrachloronaphthalene	None	0.4
107-87-9	Pentanone; 2-	None	0.1	8001-35-2	Toxaphene	1.53E-01	?
96-22-0	Pentanone; 3-	None	0.1	126-73-8	Tributyl phosphate	None	0.4
107-12-0	Propionitrile (Ethyl cyanide)	None	0.1	121-44-8	Triethylamine	5.19E-02	0.4
67-63-0	Propyl alcohol; 2-	None	0.1				
71-23-8	Propyl alcohol; n- (1-propanol)	None	0.1				
100-42-5	Styrene	3.28E-02	0.1				
109-99-9	Tetrahydrofuran	None	0.1				

Notes:

CAS	Chemical Abstracts Service
VOC	Volatile Organic Compound
SVOC	Semivolatile Organic Compound
MDL	Method Detection Limits
Shaded Limits	Constituents where the WAC 173-340 limits are below MDLs.
?	MDL estimate 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] Constituent limit is for 1,3-Dichloropropene (CAS 542-75-6) instead of the isomer trans-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	Alternate Method 7060A/7740 (GFAA)[c] MDLs mg/kg
Arsenic As	3.40E-02	34.2	2	1
Barium Ba	9.23E+02	27.8	2.00E-02	
Beryllium Be	6.32E+01	29.5	2.00E-02	
Cadmium Cd	5.00E+00 (in soil)	30.7		
Lead Pb	2.50E+02	51.2		
Nickel Ni	1.30E+02	29.3		
Seleniun Se	5.20E+00	34.8	2	1
Silver Ag	1.36E+01	6.8	6.00E-03	
Thallium Tl	1.59E+00 can be met with alternate methods	21.4	4.00E-03	

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	Alternate Method 7060A/7740 (GFAA)[c] MDLs mg/kg
Chromium Cr	2.00E+00 (Total Cr)	30.7		
Vanadium V	5.60E+02	32.2		
Zinc Zn	5.97E+03	28.6	6.00E-02	
	Constituent Limits mg/kg	**Primary Method 7470/71 (CVAA) MDLs mg/kg**		
Mercury Hg[d]	2.09E+00	0.016		
Anions	**Constituent Limits mg/kg**	**Primary Method 9056 (IC)[e] MDLs mg/kg**		
Fluoride F^-	1.60E+01	3		
NH_4^+	Not regulated	20		
	Constituent Limits mg/kg	**Primary Method 9010B/9014 (Spec.) MDLs mg/kg**		
Cyanide CN^- [f]	8.00E-01	2.5		
Ferrocyanide $FE(CN)^{3-}$	Analyzed as cyanide			
	Constituent Limits mg/kg	**Primary Method 9030B/9215 (ISE) MDLs mg/kg**		
Sulfide S^{2-}	None	In Development		

Notes:

Shaded Limits	Constituents where the limits are close to or below MDLs.
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 lmits.

(a) ICP/AES assumes dilution factor = 1000, 0.5g-50 mL-1mL-10. ICP MDLs based on 3050 digest.
(b) ICP/MS based on dilution factor (2000) x EQL factor 10.
(c) As and Se by GFAA assume DF = 100 from acid digest.
(d) Hg assumes a 0.0016 µg detection limit and a 0.1g sample size.
(e) IC assumes a dilution factor = 100 for water digest and a 50 µL loop and AS15 column.
(f) CN^- assumes 0.1 g solid with EDTA dissolution.

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	Anions	WAC 173-340 Limits mg/kg	Method 9056 (IC) MDLs mg/kg
Aluminum Al	4.52E+01	32.7	Bromide Br^-	None	30
Antimony Sb	5.42E+00	27.6	Chloride Cl^-	1.00E+03	4
Boron B	1.12E+01	17.9	Nitrate NO_3^-	4.00E+01 (as nitrogen)	30
Bismuth Bi	None	92.5	Nitrite NO_2^-	4.00E+00 (as nitrogen)	30
Calcium Ca	None	41.7	Phosphate PO_4^{3-}	None	30
Cobalt Co	None	30.4	Sulfate SO_4^{2-}	1.00E+03	30
Iron Fe	1.32E+03	33.2	Acetate $C_2H_3O_2^-$	None	20
Potassium K	None	52.6	Formate CO^-	None	20
Lithium Li	None	28	Glycolate $C_2H_3O_3^-$	None	20
Molybdenum Mo	1.63E+01	21.5	Oxalate $C_2O_4^{2-}$	None	30
Magnesium Mg	None	27.1			
Manganese Mn	5.02E+01	28.3			
Sodium Na	None	52.5			
Phosphorus P	None	25.6			
Rhodium Rh	None	27.4			
Sulfur S	None	17.3			
Silicon Si	None	18			
Tin Sn	2.50E+04	19.4			
Tantalum Ta	None	32.8			
Tungsten W	None	57.7			
Yttrium Y	None	12.9			
Zirconium Zr	None	18.5			
Copper Cu	2.63E+02	29			
Uranium U	1.32E+00	43.7			
Cerium Ce	None	23.6			
Europium Eu	None	12.9			
Lanthanum La	None	30.1			
Niobium Nb	None	5.0			
Neodymium Nd	None	15			
Palladium Pd	None	98.7			
Praeseodynium Pr	None	16.8			
Rubidium Rb	None	1121			
Ruthenium Ru	None	11.4			
Samarium Sm	None	11.4			
Strontium Sr	2.92E+03	28.1			
Tellurium Te	None	41			
Thorium Th	None	16.9			
Titanium Ti	None	19			

Notes:

Shaded 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 lmits.

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

Analyte	Analytical Method	Alternate Analytical Method	Limits			MDLs µCi/g
			Source RESRAD-15 µCi/g	Source RESRAD-GW µCi/g	Source 10 CFR 61.55 Class C Waste µCi/g	
^{137}Cs	GEA		2.34E-05		3.07E+03	1.25E-02
^{60}Co	GEA		4.90E-06			9.00E-03
^{152}Eu	GEA		1.14E-05			1.80E-02
^{154}Eu	GEA		1.03E-05			1.25E-02
^{155}Eu	GEA		4.26E-04			2.20E-02
^{14}C	Liquid Scintillation Counting			2.91E-04	5.33E+00	4.00E-04
^{3}H	Liquid Scintillation Counting			4.10E-03		4.60E-04
^{129}I	Low Energy Gamma Counting	ICP/MS		2.02E-06	5.33E-02	5.00E-02 1.06E-04 [a]
^{63}Ni	Liquid Scintillation Counting		4.03E-03		4.67E+02	5.00E-03
^{90}Sr	Beta Proportional Counting		2.41E-03		4.67E+03	1.70E-03
^{99}Tc	Liquid Scintillation Counting	ICP/MS		1.71E-04	2.00E+00	5.00E-03 1.73E-04 [a]
^{79}Se	Liquid Scintillation Counting		1.97E-01			1.00E-04
^{233}U	ICP/MS				9.00E-03	3.85E-06
^{234}U	ICP/MS			3.95E-05 (as $^{233/234}U$)	9.00E-03	2.50E-06
^{235}U	ICP/MS			3.92E-06 (as $^{235/236}U$)	9.00E-03	8.64E-10
^{236}U	ICP/MS					2.59E-08
^{238}U	ICP/MS			3.81E-05	9.00E-03	1.68E-09
^{237}Np	ICP/MS	Alpha Counting	5.92E-05		9.00E-03	2.82E-07 6.00E-02 [a]
^{238}Pu	Alpha Counting	ICP/MS	4.70E-04		9.00E-03	1.70E-03 6.84E-03 [a]
^{239}Pu	Alpha Counting	ICP/MS	4.25E-04		9.00E-03 (as $^{239/240}Pu$)	1.70E-03 (as $^{239/240}Pu$) 2.51E-05 [a]
^{240}Pu	Alpha Counting	ICP/MS	4.26E-04		9.00E-03 (as $^{239/240}Pu$)	1.70E-03 (as $^{239/240}Pu$) 9.08E-05 [a]
^{241}Pu	Calculate from ^{238}Pu & $^{239/240}Pu$	ICP/MS	1.11E-02		3.50E+03	4.12E-02 [a]
^{241}Am	Alpha Counting		3.35E-04		9.00E-03	5.50E-03
^{242}Cm	Alpha Counting				9.00E-03	5.50E-03

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

Analyte	Analytical Method	Alternate Analytical Method	Limits			MDLs µCi/g
			Source RESRAD-15 µCi/g	Source RESRAD-GW µCi/g	Source 10 CFR 61.55 Class C Waste µCi/g	
^{243}Cm	Alpha Counting		1.10E-04		9.00E-03	5.50E-03 (as $^{243/244}$Cm)
^{244}Cm	Alpha Counting		7.44E-04		9.00E-03	5.50E-03 (as $^{243/244}$Cm)
^{228}Th	Calculation	GEA	7.73E-06			6.00E-01 (for GEA)
^{230}Th	ICP/MS		2.01E-05			8.20E-06
^{232}Th	ICP/MS		4.80E-06			4.76E-05

Notes:

Shaded Limits	Constituents where the limits are close to or below MDLs.
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.

[a] Method detection limits for alternate methods.

Action levels are available for some of the radiochemistry constituents (see Tables 6-1 and 6-2). These action levels are shown in Table 4-12 in the 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 tank 241-C-106. 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 separately.

The data collected will be used to support tank 241-C-106 component closure actions. The temporal boundary for the data collected per this DQO will be the final closure of the tank farm or until the residual waste in the tank is altered. Because the data will represent the condition of the residual waste in tank 241-C-106, 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 tank 241-C-106 will 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 tank 241-C-106 after completion of waste retrieval activities. This decision rule is:

> If the waste has been retrieved to the maximum extent technically possible and the maximum estimated residual waste volume within tank 241-C-106 is less than 360 cubic feet, then component closure actions for tank 241-C-106, as specified in the Hanford Site-Wide Permit, can proceed; otherwise, prepare an Appendix H request for an exception to the Tri-Party Agreement milestone M-45-00 retrieval criteria (Ecology et al. 1998).

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. Under ideal circumstances, confidence intervals are derived by statistical evaluation methods. However, for this decision rule, statistical confidence intervals cannot be established because of the method (see Section 8.1) of determining the

volume estimate for tank 241-C-106. The uncertainty in the measurements for this decision rule is discussed in Section 7.0.

The second decision rule addresses the concentration of constituents of concern within the residual waste in tank 241-C-106. The second decision rule is:

> If the inventories of the radiological and nonradiological constituents of concern in the residual waste within tank 241-C-106 are below the action levels, then component closure actions for tank 241-C-106, as specified in the Hanford Site-Wide Permit, can proceed; otherwise, the State of Washington Department of Ecology (Ecology) will reassess the component closure actions.

The actual action levels for the second decision rule will be developed with the risk assessment process. When the action levels are established, they will be compared to an agreed to confidence interval. Actual action levels can be incorporated as the risk assessment criteria mature and will be compared to the upper confidence limits at that time.

The third decision rule addresses Class C radiological waste concentrations in the residual waste. The residual waste 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 waste is greater than Class C, then either a Class C waiver or an evaluation for equivalent disposal is required (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 waste 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 analyzed waste is greater than Class C.

Figure 6-1. Class C Waste Evaluation.

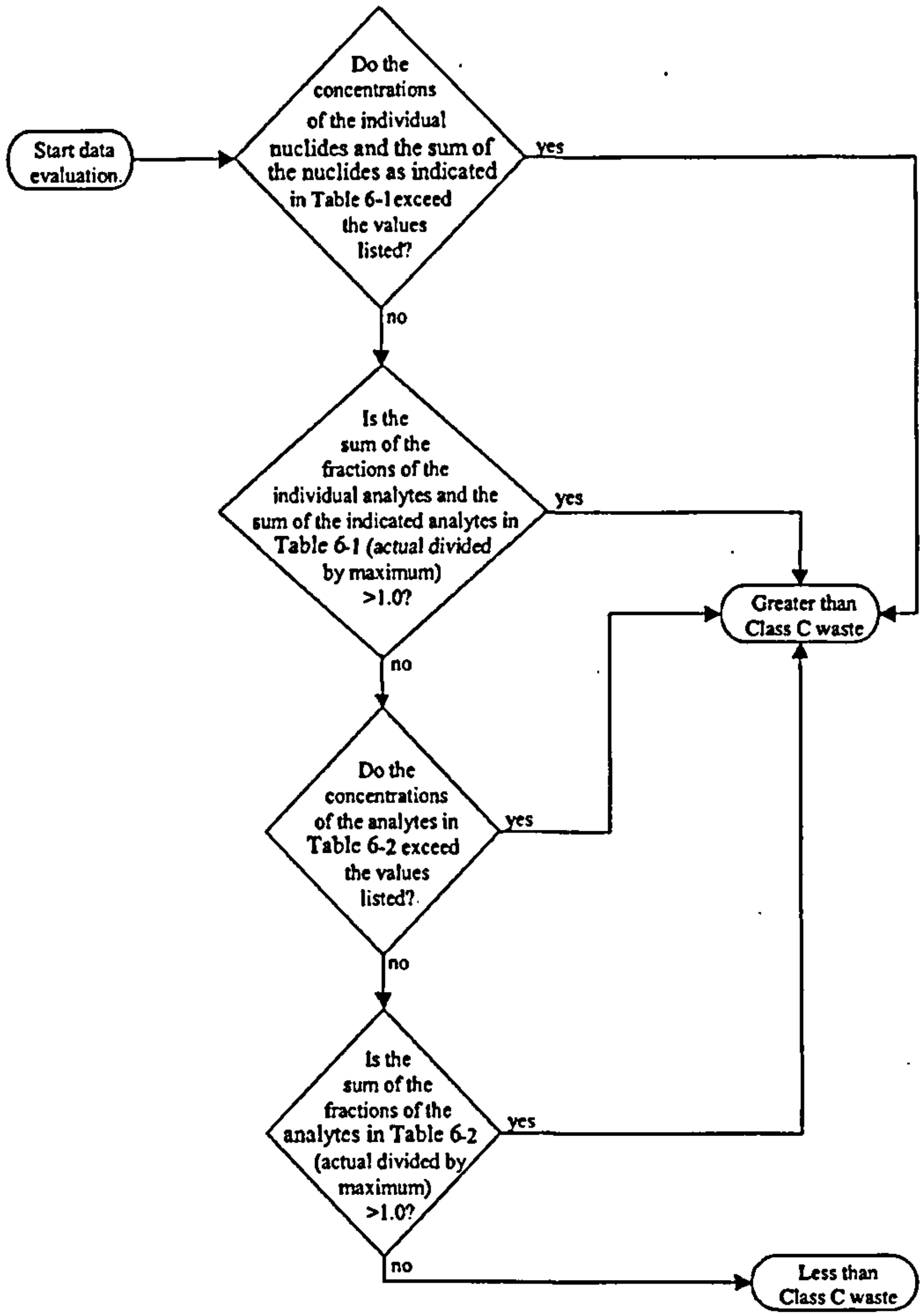


Table 6-1. Upper Limits of Class C Waste (10 CFR 61.55 Table 1).

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 waste 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 not greater 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 not greater 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 not greater 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 not greater 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.

The third decision rule can be stated as:

> If the 95% upper confidence limit of the radiological activity in the residual tank waste does not exceed the greater than Class C waste definition, then component closure actions for tank 241-C-106, as specified in the Hanford Site-Wide Permit, can proceed; otherwise, an evaluation for equivalent disposal (disposal equivalent to a repository) is required or a Class C waiver is required.

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. While an action limit exists for decision rule 1, statistical confidence intervals cannot be established because of the volume data collection method (see Section 8.1).

The uncertainty for the volume data collection has been estimated to be plus or minus 20 percent of the residual waste. The method to determine the error estimate was presented to Ecology at the Single-Shell Tank Closure Planning – C3T[2] Staff Workshop on January 23, 2003. As discussed at the workshop, the sources of error in estimating residual waste volume using a computer-aided design (CAD) created waste surface topography, based on video records, are as follows:

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

[2] C3T = Cleanup Constraints and Challenges Team

Human error in creating the representation of the waste surface topography in the CAD program is considered the most significant error source. The estimate of plus or minus 20% error in the waste volume estimate using the video camera CAD modeling system is based on engineering judgment. The video camera CAD modeling system will be validated before making a final decision on the component closure action for tank 241-C-106 and will be governed by a test plan. Concurrence of the test plan will be obtained from the organizations signing the concurrence page of this document. Depending on the outcome of the validation, the estimate of a plus or minus 20% error may be revised.

Because a statistical confidence interval cannot be established, the uncertainty in the residual volume is accounted for by using the upper estimated residual waste volume value to determine if the action level is met.

The actual action levels for the decision rule 2 will be developed with the risk assessment process and are not available at this time. Therefore, the uncertainties associated with this decision rule cannot be compared to an action level. Actual action levels can be incorporated as the risk assessment criteria mature. When the action levels are established, a confidence interval can be compared to the action levels as described below for decision rule 3.

The third decision rule contains action levels and a confidence interval. Therefore, the 95% upper confidence limit can be calculated (see below) and compared to the action level for this decision rule.

It is assumed that all radionuclides will be measured on multiple samples (see Section 8.2). It is also assumed that there is at least one set of duplicate measurements (primary and duplicate) per laboratory batch. In each instance, the estimates of the means and standard deviations of the means are calculated using a one-way analysis of variance model to account for unbalanced as well as balanced data. For balanced data ($n_i = n$), the analysis of variance estimate of the mean is usually the arithmetic mean of the observations. If the observations are unbalanced, the estimate of the mean will be the restricted maximum likelihood (REML) estimates.

It is also assumed that 95% confidence is desired. Therefore, in the upper confidence limit (UCL) calculations below the t-statistic will be calculated using $\alpha = 0.05$. If it is predetermined that another level of confidence is needed, α may be calculated using the formula

$$\alpha = \frac{(100\% - confidence\,level)}{100\%}$$

Table 6-1 lists sixteen radionuclides with maximum concentration limits. The first five (^{14}C, ^{99}Tc, ^{129}I, ^{241}Pu, and ^{242}Cm) have corresponding concentration limits while the last ten (^{241}Am, ^{243}Cm, ^{244}Cm, ^{237}Np, ^{238}Pu, $^{239/240}Pu$) have an upper limit to compare the sum of the concentrations.

For each of the first five radionuclides, a one-way analysis of variance model is used to obtain an estimate of the mean concentration and standard deviation of the mean. That is, let

$$\overline{X}_i \; and \; S.D(\overline{X}_i), \; i = 1,2,...5$$

denote the five means and standard deviations, respectively. The upper limit to a one-sided $100(1-\alpha)\%$ UCL on the mean is

$$UCL_i = \overline{X}_i + t_{(\alpha,df)} \times S.D(\overline{X}_i), i = 1,2,...5$$

In this equation, $t_{(\alpha,df)}$ is the quantile from Student's t distribution, with $100(1-\alpha)\%$ confidence and df (generally the number of samples minus 1) degrees of freedom. For each radionuclide, the UCL is compared to the maximum concentration limit given in Table 6-1. If the UCL is greater than the corresponding concentration limit for any radionuclide, then the waste is greater than Class C.

For the second set of ten radionuclides in Table 6-1, let $A_{ij}, B_{ij},...F_{ij}$ denote the measured values of ^{241}Am, ^{243}Cm, ...$^{239/240}$Pu (each of the ten alpha emitting radionuclides with a half-life greater than five years), respectively, where i=1, 2, ...a, and j=1, 2, ...n_i denote the sample number and replicate value. Also, let

$$S_{ij} = A_{ij} + B_{ij} + ... + F_{ij}$$

Again (since S_{ij} are replicate observations from multiple samples), a one-way analysis of variance is used to estimate the mean and standard deviation of the mean. Let the estimate of the mean and standard deviation of the mean be denoted by $\overline{S}$ and $S.D(\overline{S})$, respectively. The UCL on the mean is

$$UCL = \overline{S} + t_{(\alpha,df)} \times S.D(\overline{S})$$

where $t_{(\alpha,df)}$ is the appropriate quantile from Student's t distribution with df, degrees of freedom, and $100(1-\alpha)\%$ confidence. If the UCL is greater than the corresponding concentration limit from Table 6-1, then the waste is greater than Class C.

For the radionuclides in Table 6-2, the methodology is the same. Let X_{ij}, Y_{ij}, and Z_{ij} denote the measured values of ^{63}N, ^{90}Sr, and ^{137}Cs, respectively, where i=1, 2, ...a, and j=1, 2, ...n_i denote the sample number and replicate value. Each of X_{ij}, Y_{ij}, and Z_{ij} are replicate observations from multiple samples. Consequently, a one-way analysis of variance is used to estimate the means and standard deviations of the means. Let the estimates of the means and standard deviations of the means be denoted by

$\overline{X}, \overline{Y}, and\; \overline{Z}$ and by

$SD(\overline{X}), SD(\overline{Y}), and\; SD(\overline{Z}),$

respectively. The one-sided $100(1-\alpha)\%$ confidence intervals (CIs) for each radionuclide are

Ni-63: $\bar{X}+t_{(\alpha,df)}\times SD(\bar{X})$
Sr-90: $\bar{Y}+t_{(\alpha,df)}\times SD(\bar{Y})$
Cs-137: $\bar{Z}+t_{(\alpha,df)}\times SD(\bar{Z})$

where $t_{(\alpha,df)}$ is the appropriate quantile from Student's t distribution with df (generally the number of samples minus 1) degrees of freedom and $100(1-\alpha)\%$ confidence.

To compare the sum of the fractions, the following methodology is used.

The sum of the fractions of each radionuclide is a linear combination of the observations. That is, for the five radionuclides and the sum of the ten radionculides from Table 6-1 denoted by X_1, X_2, X_3, X_4, X_5, and S, respectively,

$$R=C_1X_1+C_2X_2+C_3X_3+C_4X_4+C_5X_5+C_6S$$

where C_1 through C_6 are $\frac{1}{corresponding\ concentration\ value}$ for each radionuclide from Table 6-1.

The preferred method to compute an upper confidence limit is to combine the individual observations by sample. They are combined, using the constants C_1 through C_6, into a primary duplicate pair and/or primary values. A one-way analysis of variance model is fit to the data to provide estimates of the mean, $\bar{R}$, and the standard deviation of the mean, $SD(\bar{R})$. The upper limit to the one-sided $100(1-\alpha)\%$ CI on the mean is

$$UCL=\bar{R}+t_{(\alpha,df)}\times SD(\bar{R})$$

where $t_{(\alpha,df)}$ is the appropriate quantile from Student's t distribution with df (generally the number of samples minus 1) degrees of freedom and $100(1-\alpha)\%$ confidence. If UCL > 1.0, then the waste is greater then Class C.

The same methodology is applied to the radionuclides in Table 6-2 with ^{63}Ni, ^{90}Sr, and ^{137}Cs denoted by Y_1, Y_2, and Y_3, respectively. The linear combination is

$$R=C_1Y_1+C_2Y_2+C_3Y_3$$

where C_1, C_2, and C_3 are $\frac{1}{\textit{corresponding concentration value}}$ for each radionuclide from Table 6-2. The upper limit to the one-sided $100(1-\alpha)\%$ CI on the mean is

$$UCL = \overline{R} + t_{(\alpha,df)} \times SD(\overline{R})$$

where $t_{(\alpha,df)}$ is the appropriate quantile from Student's t distribution with df (generally the number of samples minus 1) degrees of freedom and $100(1-\alpha)\%$ confidence. If UCL > 1.0, then the waste is greater then Class C.

8.0 SAMPLING DESIGN

Random sampling cannot be accomplished because of the operational constraints (e.g., sample location restrictions due to riser restrictions and 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. Minimum 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 188 g of solids and 500 mL of liquid. Therefore, the total amount of sample material needed to perform the testing and analyses are approximately 308 g of solids and 650 mL of liquid.

The only requirement for the sample sent to PNNL is the quantity of material. Requirements in Section 8.2 only pertain to the sample material sent to the 222-S Laboratory.

8.1 VOLUME MEASUREMENTS

The current method for determining the residual waste volume in a tank is the video camera and modeling system. This system, used for the initial baseline measurements of tank 241-C-106 (RPP-12547, Riess 2002), can be deployed without additional development. Residual waste volume measurements are obtained by inserting a video camera into a tank riser and obtaining a videotape of the tank interior. The videotape is used to identify the physical shapes of the waste and to develop a three-dimensional model of the waste surface. The model is developed using a CAD program. The residual waste volume is then estimated using the dimensions and configuration of the tank. The modeling methodology is being refined to include information on accuracy of the volume estimate.

A second method, the tank volume measurement system (TVMS), consists of a television camera and a laser range finder. The TVMS is inserted into a tank riser and the camera and laser range finder are used to map the surface of the residual waste in the tank. The TVMS will be used in

tank 241-C-106 if developed in time and determined to be a more effective and accurate method for waste volume measurements. However, the specific volume estimate methodology and accuracy have not been developed. It is expected that the TVMS map in conjunction with a CAD program will be used to calculate an estimated volume.

8.2 WASTE SAMPLING

Both liquid and solid samples of any residual waste are required for the component closure actions of tank 241-C-106. The flowchart for sampling liquids and solids is shown in Figure 8-1.

A sampling strategy was developed in the DQO process meetings to obtain the most representative samples of the residual liquid waste. The current plan is to obtain the liquid samples after completion of the final washing activity and prior to pumping the remaining liquid out of the tank. These samples should 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.

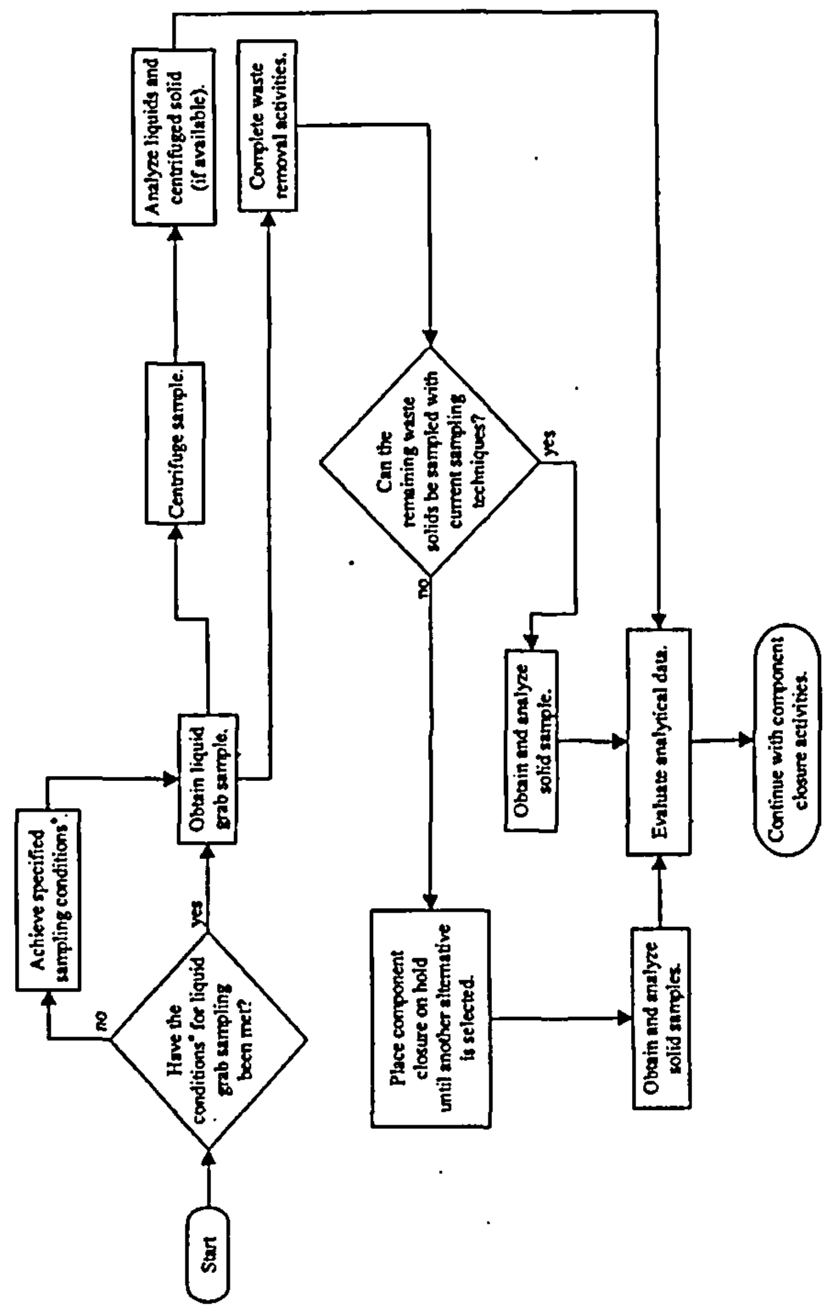
A minimum of two liquid samples (a sample and a duplicate sample) is required by this DQO. The quantity of liquid in one of the samples must be sufficient to obtain a duplicate analysis. Therefore, one sample should contain approximately 350 mL and the other sample approximately 150 mL. In addition, the liquid samples must be obtained in four separate bottles. Two bottles are required to conduct the VOC analyses (sample and duplicate sample) and the other two are required to conduct the SVOC analyses (sample and duplicate sample). The contents from each pair of bottles can be combined (if insufficient sample material is available) for the rest of the required analyses.

Inline sampling during retrieval is not available and is currently not an option.

As shown in Figure 8-1, samples of any residual solids will be obtained after retrieval is completed. The current available sampling device for solids is the finger trap and is not capable of off-riser sampling. The number of samples and the ability of the finger trap sampler to obtain waste samples will be determined by the waste configuration and the depth of waste remaining after retrieval. From the mouth of the sampler to where the fingers begin to open is 1.25 inches on the initial sampler. Therefore, to obtain any sample, the waste depth must be greater than 1.25 inches. However, a modification of the sampler reduced the minimum height of the finger trap sampler to 0.6 inches. Both samplers are presently available.

Another solid waste sampler underdevelopment is the "clamshell" sampler. This sampler will be able to sample a small waste depth but will not have off-riser sampling capability at this time. Sampling devices capable of off-riser sampling are being developed but may not be available before tank 241-C-106 waste sampling is required.

Figure 8-1. Sampling Strategy for the 241-C-106 Component Closure



*Conditions for Liquid Sampling

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

After retrieval activities are completed, a possibility exists that insufficient residual solids or the location of the residual solids may prevent the collection of a sample. For this reason, pre-retrieval samples of the solids in tank 241-C-106 were obtained. These samples were collected using the existing finger trap sampler and archived. After all retrieval activities have been concluded and agreement is reached (by the organizations on the signature page) that a sample of the remaining solids cannot be obtained, analyses of the archived sample will be conducted if that is the alternative action (see Figure 8-1) agreed to by the organizations on the signature page. Before analyses, the archived samples will undergo laboratory simulated retrieval activities. For example, if oxalic acid is added to the tank to facilitate retrieval, the samples will be subjected to oxalic acid of the same concentration prior to analyses.

At the end of the final waste washing activity, an attempt will be made to move any solid waste, which cannot be retrieved, under a tank riser available for sampling. This will be attempted to facilitate sampling and increase the probability of collecting sufficient waste for the planned analyses. In the current retrieval plans, only one riser (riser 14) will be available for waste sampling because the other risers will contain equipment. Sampling from one riser (i.e., one location) may be adequate because the retrieval activities will mobilize and mix the solid waste within the tank.

A minimum of two solid samples (a sample and a duplicate sample) will be collected for the analyses specified in this DQO. A sample may be composed of more than one grab. A grab in this instance is defined as the deployment of one sampling device. Multiple grabs may be required to obtain enough material for the complete analysis.

The optimum amount of solid sample material to accomplish the analytical requirements in this DQO is approximately 188 g. This would allow enough material to optimize detection limits. While approximately 188 g is the optimum amount of sample, the analyses required by this DQO could be accomplished with a minimum of approximately 80 g. However, an 80 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.

The optimum amount of material needed for the VOC and SVOC analyses is approximately 24 g for the sample with the duplicate analysis and 18 g for the other sample. The optimum amount of material for the remaining analyses is 88 g for the sample with the duplicate analysis and 58 g for the other sample. In addition, sufficient sample quantities (see Section 8.0) will be required for PNNL to conduct risk assessment tests.

The solids sampling strategy, described above, is dependent on the ability of the retrieval equipment to mobilize the solids and move the residual solids under riser 14. If the final configuration of the residual solids is different from the anticipated, alternatives (e.g., use the pre-retrieval sample material, samples from a different riser, wait until off-riser sampling is available, etc.) will be evaluated.

In addition to the analyses mentioned above, the liquid samples will be centrifuged and any solids obtained will be analyzed (see Figure 8-1). It is unlikely sufficient centrifuged solids will

be obtained to analyze 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.

9.0 REFERENCES

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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	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 mg/L	MCL[b] mg/L	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	Overall GW Cleanup Level		3-Phase Partitioning Model Equation for Soil Protection of GW				
CAS No.	Chemical Name	Carcin ogen mg/kg	Non-car-cinogen mg/kg	Carcin ogen mg/L	Non-car-cinogen mgL	MCL[b] mg/L	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	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 mg/L	MCL[b] mg/L	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
126-98-7	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
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

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	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	MCL[b] mg/L	mg/L	Source	Kd uL/g	Source	Henry's Law Constant	Source	Soil Conc. for GW Protection mg/kg
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

04-TPD-010

ATTACHMENT 2

Certification for the Hanford Facility Dangerous Waste Permit Application Documentation, RPP-13774, Revision 2, Single-Shell Tank System Closure Plan

Consisting of 2 pages,
including the coversheet

PART B CERTIFICATION [K]

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Owner/Operator
Roy J. Schepens, Manager
U.S. Department of Energy
Office of River Protection

1/19/04
Date

*Co-operator
Edward S. Aromi Jr., President and General Manager
CH2M HILL Hanford Group, Inc.

1/16/04
Date

*Co-operator under the U.S. Department of Energy, Office of River Protection Contract Number DE-AC27-99RL14047

RPP-13774, Rev. 2

04-TPD-010

ATTACHMENT 3

RPP-13774, Revision 1, Single-Shell Tank System Closure Plan Comment Responses

Consisting of 109 pages,
Including the coversheet

RPP-13774, Rev. 1 Single-Shell Tank System Closure Plan
Comment Responses

Comment Number	Position in Document	Comment/Response	Comment Closure Date
		General Comments	
DH-1	General Comment – entire Closure Plan	Throughout most of this closure plan, general regulatory requirements have been omitted. Considering the significant nature of the SST closure process as well as the extended schedule necessary to properly accomplish closure (many years – possibly several decades), and to comply with regulatory requirements, it is necessary to include all applicable general requirements in all appropriate sections as follows: Required Notices (WAC 173-303-290), General Waste Analysis (WAC 173-303-300), Personnel Training (WAC 173-303-330), Construction Quality Assurance Program (WAC 173-303-335), Procedures to Prevent Hazards (WAC 173-303-310, 320, 340), Contingencies and Emergencies (WAC 173-303-350, 360), Facility Reporting/Recordkeeping (WAC 173-303-390, 395), Precautions for Ignitable, Reactive, or Incompatible Wastes [WAC 173-303-395(1)], Other State and Federal Regulations [WAC 173-303-395(2)], Storage Time Limit for Impoundments/Piles [WAC 173-303-395(5)], Labeling for Containers/Tanks [WAC 173-303-395(6)], Air Emission Standards – WAC 173-303-640(11) describes the Air requirements as 40 CFR Subparts AA, BB, CC incorporated by reference in WAC 173-303-690 through 692. These requirements could be consolidated into one section of each tier. It is expected that each requirement will be described to the maximum extent possible in the upper tiers, with the lower tiers providing additional specific details while referencing requirements previously described in the upper tiers. *Response: Comment will be resolved through development of permit conditions*	Parking Lot #9 (Ecology) Closed
BBK-1	All Tiers	The title of the "FRAMEWORK PLAN FOR SINGLE-SHELL TANK SYSTEM CLOSURE" is not used consistently throughout the different tiers of the document (i.e., Tier II, Section C1.2, first paragraph refers to the Tier I document as "Framework Plan for Closure of the Single-Shell Tank System." Search all three Tiers for inconsistent titles and replace with the correct title. *Response: All tiers searched and replaced, where appropriate, with the correct title.*	Action Item #1 (S Muns) Closed
		Framework Plan for Single-Shell Tank Closure	
DH-2	General Comment – Tier 1	Revise the "Framework" (Tier 1) portion of the closure plan to include a Glossary. Include all terms/words used in all three tiers as well as attachments/addendums of this closure plan that have a unique meaning relative to regulations and Hanford. Move Section 1.1.1 "Key definitions" into the glossary as well as all other definitions throughout the closure plan.	Action List #3 (J von Reis)
BR-1	General Comment	This large multi-tiered document has no index. An index would be extremely helpful. If it is not possible to provide an index then much more cross-referencing to other sections of the document is needed. *Response: Comment noted. Attempts were made in latest edits to cross-reference between documents.*	CLOSED 12/12/03

RPP-13774, Rev. 1 Single-Shell Tank System Closure Plan
Comment Responses

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-1	General Comment – Tier 1	While the Tier 1 document acknowledges that contaminated groundwater is to be addressed during closure of the SST system, the documents do not adequately cite WAC 173-303-645. The Tier 1 document estimates a volume of leaked waste from the SSTs as approximately 1,000,000 gallons. As such WAC 173-303-645 is applicable. The Tier 1 document correctly (as per TPA Section 6.3) identifies the applicable final closure performance standards of WAC 173-303-610. WAC 173-303-610(3)(a)(vi) requires the closure plan include: "a detailed description of other activities necessary during the closure period to ensure that all partial closures and final closure satisfy the closure performance standards, including, but not limited to, ground water monitoring, leachate collection, and run-on and run-off control." The Tier 1 document does not identify how applicable groundwater monitoring requirements will be satisfied. While the Tier 1 document identifies (see Section 1.1.4) that corrective action will occur via an integrated Site Wide permit action via RCRA corrective action permit conditions, the document does not identify that applicable groundwater monitoring requirements are being or will be met. The Tier 1 document must include an identification that the groundwater monitoring requirements of WAC 173-303-645 are applicable as closure performance standards. Provide the following additional permit language: **"Groundwater monitoring requirements of WAC 173-303-645 will be satisfied as part of SST component and SST system closure actions. Tier 2 and 3 permit conditions will specify how SST component and SST system closure actions will ensure that groundwater monitoring requirements are satisfied. Specifically, and at a minimum, compliance groundwater program monitoring requirements of WAC 173-303-645(10) will be satisfied for Waste Management Areas (WMAs) A-AX, B-BX-BY, C, S-SX, T, TX-TY, and U."** (AH) *Response: Comment will be resolved through development of permit conditions*	Parking Lot #4 (ORP/CH) Closed
AH-2	General Comment – Tier 1	Generally, and throughout the entire Tier 1 document, all references to CERCLA Records of Decision (RODs) must distinguish between "interim" and "final" RODs. The distinction is necessary due to the differences in legal standing between "interim" and "final" RODs. (AH) *Response: Text added, where approporiate.*	Action List #9 (S Muns) Closed
AH-3	General Comment – Tier 1	Due to the Tier 1 document's lack of acknowledgement that WMA-specific groundwater monitoring is a performance standard (i.e., a regulatory requirement), it is recommended that an additional section be added to the Tier 1 document which describes that WMA-specific groundwater monitoring will occur at the WMA point of compliance (as defined by WAC 173-303-645(6)) during the active life of the WMA and during postclosure. Provide the following additional permit language: **"During the active life of the WMAs and during post-closure, groundwater monitoring will occur on a WMA-specific basis. WMA-specific monitoring will include WMA-specific point of compliance monitoring as defined by WAC 173-303-645(6)."** (AH) *Response: Comment will be resolved through development of permit conditions*	Parking Lot #4 (ORP/CH) Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-2	Section 1.0, second paragraph	The text states that "As of May 2002, the SSTs contained 125,700,000 L (33,205,000 gal) of radioactive mixed waste." Can this be updated to a more current date/volume? *Response: Volume and date updated as suggested.*	CLOSED 11/18/03 Action Item #2 (J von Reis)
BBK-3	Section 1.0, fifth paragraph	The text refers to the "dangerous waste portion of the *Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*, Rev. 7 (Ecology 2001, hereafter referred to as the Site-Wide Permit)." The title of the permit needs to be changed to "dangerous waste portion of the *Hanford Facility Resource Conservation and Recovery....*" *Response: Suggested text added.*	CLOSED
MJB-1	Sec. 1.1, p. 1-3, ¶ 1	**Sentence 2 states that SST Closure Plan states that a component closure activity plan for tank 241-C-106, the first component closure activity in the SST system, is included in RPP-13774, Rev. 1 under WAC 173-303-610. By the definition in WAC 173-303-040, 241-C-106 is a component (i.e., "the tank or ancillary equipment of a tank system"). Closing that tank must therefore also comply with WAC 173-303-640(8) for tank systems or 173-303-665(6) for landfills. Please specify the appropriate regulatory citation.** *Response: Suggested text added.*	Closed
MJB-2	Sec. 1.1, p. 1-3, ¶ 2	A statement is made that final decisions regarding groundwater may be deferred until final closure of the Central Plateau. The statement implies that no actions will be taken to clean up the groundwater, monitor the path of contaminants, or reduce risk. That statement is somewhat countered on p. 1-7, in Section 1.1.1.9, where an explanation is added about final institutional controls possibly being added after the groundwater operable units in the vicinity are remediated. Ecology regulations require the owner or operator to close a facility to meet the closure performance standards in WAC 173-303-610(2), which includes the need to control, minimize or eliminate...post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated runoff, or dangerous waste decomposition products to the ground, surface water, ground water, or the atmosphere. Action to meet the performance standards cannot be delayed until the closure of the Central Plateau. Please state that groundwater will be remediated and monitored as part of tank closure effort. *Response: Suggested text added.*	Closed
BBK-4	Section 1.1.1.1	Change definition 1.1.1.1 to read "Component. ***Component* is defined in WAC 173-303-040 as either the tank or ancillary equipment of a tank system. The meaning of the word 'component' is being expanded in this SST system closure plan to means a subunit of a dangerous waste management unit associated with the SST ...."** *Response: Suggested text added.*	CLOSED 10/29/03

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-3	Sec. 1.1.1.2, p. 1-5	It is unclear why the authors chose to coin a new term "component closure" to describe closure activities that may take place in one part of a tank farm while the other other parts continue to store waste. The USDOE maintains that the single shell tanks are out of service; however, Ecology has determined that they are active, non-compliant tank storage systems. They will be closed because the USDOE determined that they will not be upgraded to meet tank standards. The WAC contains a definition for "partial closure" in WAC 173-303-040 that appears to address facilities that will not be permitted as compliant units and that describes the activities planned. Replace component closure with "partial closure". *Response: Ecology and DOE have agreed to use of term "component Closure" per telecon with M. Brown on 12/15/03.*	CLOSED 12/10/03 Action List #40
DH-3	Section 1.1.1.2 Page 1-5 and elsewhere throughout the closure plan	Lines 20-22. Revise the text to include other significant/ordinary "considerations". Provide additional text discussing the following: high uncertainty of data in early stages of WMA closure activities, limits of technology, placing component in a holding status following a closure action until enough data is generated through other closure actions to reduce the high uncertainty. Basically, unless clean closure standards are met, insufficient data exists to allow final actions during early stages of WMA closure activities. Also provide text indicating that all closure activities must be approved by Ecology. Revise the document to reflect this concept. *Response: Partially accept. Will add text indicating that all closure activities must be approved by Ecology.*	Closed
BBK-5	Section 1.1.1.3	Change definition 1.1.1.3 to read "Corrective Action. *Corrective action* means the process taken to address past and potential future tank system waste releases to the environment as necessary to protect human health and the environment, including ~~from~~ solid waste management units, ~~and~~ areas of concern at the facility, and ~~including~~ releases that have migrated beyond the facility boundary....." *Response: Suggested text added.*	Closed
MJB-4	Sec. 1.1.1.3 Corrective Action, pp. 1-5 to 1-6	The text states that soil in the B/BX/BY, S/SX, and TX/TY waste management areas is being investigated for possible corrective actions. Further in text (see Sec. 1.1.3), the commitment is made that the RCRA process (RFI/CMS) will be used to document an alternatives analysis, but that soil cleanups may be imposed through closure plans independent of corrective action authority. Please cite WAC 173-303-645(1)(c), for releases from a regulated unit after closure. *Response: Added text and WAC 173-303-645 cite to Section 1.1.1.3*	Closed
MJB-5	Sec. 1.1.1.4 Dangerous Waste Management Unit, p. 1-6	Ecology notes that the examples of equipment listed as ancillary do not include overground transfer lines specifically. Those lines are used in lieu of direct contact pipelines; however, they can be considered as portable because they can be decontaminated and moved among the tank farms. Please ensure that pipelines considered ancillary equipment include overground transfer lines. *Response: Added text to include overground transfer lines in Section 1.1.1.4*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-6	Sec. 1.1.1.5 Dangerous Waste Management Unit, p. 1-6	Explanation is made that a dangerous waste management unit is comprised of a tank farm or group of tank farms that form a contiguous unit. Ecology notes that the definition given here does not address the stipulation in WAC 173-303-040 that such a unit is "a contiguous area of LAND on or in which dangerous waste is placed or the largest area in which there is a significant likelihood or mixing dangerous waste constituents in the same area". The absence of discussion of the land on/in which the tanks and ancillary equipment should be revised. Ecology expects activities in the tank farms DWMU to include corrective actions to clean up releases to the soil, to install groundwater treatment systems, and to eventually install long-term monitoring equipment. *Response: Added suggested text to 1.1.1.5.*	Closed
BBK-6	Section 1.1.1.7	Change definition 1.1.1.7 to read "**Final Closure of the SST System.** *Final closure of the SST system* means the closure of all dangerous waste management units within the facility in accordance with all applicable closure requirements so that dangerous waste management activities are no longer conducted at the ~~SST system~~ facility. For the purposes of this *SST System Closure Plan* and contingent closure and postclosure plan, the SST system is regarded as the "facility." Final closure of the SST system will occur after all components of the SST system have been added to the *SST System Closure Plan* portion of the Site-Wide Permit and all closure actions for WMAs and components have been completed. At final closure, all closure activities will be completed and WMA/component postclosure care activities will be implemented. Postclosure care activities will may include actions such as monitoring or inspection of the component to ensure continued isolation." *Response: Text revised as suggested.*	CLOSED
BBK-7	Section 1.1.1.8	Change definition 1.1.1.8 to read "**SST System Postclosure Permit.** *SST postclosure permit* means the SST system portion of the Site-Wide Permit that ~~remains~~ will be issued after final closure of the SST system should removal or decontamination of all SST components not be achieved. Actions required to comply with the postclosure provisions of WAC 173-303-610 and -665(6) will be contained in this permit" *Response: Text revised as suggested.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-8	Section 1.1.1.9	Change definition 1.1.1.7 to read "Postclosure Actions. *Postclosure actions* mean actions taken after final closure of a WMA or closure of the entire SST system, if ~~with~~ contaminants are left in place that require postclosure monitoring and maintenance. ~~Final p~~Postclosure actions may include performing maintenance activities, and developing long-term monitoring systems. Some ~~final~~ postclosure actions may not be implemented until after a set of WMAs or all WMAs are ~~completed~~ closed. For example, ~~final~~ institutional control requirements may not be developed until after all SST components are closed and soil and groundwater operable units in the vicinity are remediated. ~~Final p~~Postclosure actions may also include deed restriction and administrative controls, groundwater monitoring, and cover maintenance. Postclosure ~~requirements~~ actions will be detailed in WMA postclosure action plans. Postclosure ~~requirements~~ actions pertaining to the entire SST system ~~on a unified basis or to system components that exist outside WMAs~~ will be detailed in the Framework Plan. ~~Final post closure monitoring must be implemented after development.~~ It is not clear to Ecology why 'postclosure actions' are being differentiated from 'final postclosure actions' and what the difference is. If DOE wants to differentiate between the two a separate definition for 'final postclosure actions' should be developed. *Response: Text revised as suggested.*	CLOSED
DH-4	Section 1.1.1.9, Page 1-7	Lines 6-21. A contingent postclosure plan must be submitted with this closure plan application. This requirement was stated to some degree in the Rev. 0 NOD comments #43 and #115. The request at that time was to supply a "framework" postclosure as part of the Rev 1.closure plan at the tier 1 level. The current text states that SST system postclosure requirements will be detailed in the Framework Plan. Section 8.0 essentially provides no additional detail beyond the Rev. 0 version on which the previous comments are based. This document also indicates that separate postclosure plans will be developed for each WMA. Provide additional detail as well as a schedule for supplying postclosure plans. Requirement: WAC 173-303-640(8)(c), WAC 173-303-610(8), etc. *Response: Partially accept. Issue of contingent postclosure is contained in WMA C Closure Action Plan, Section C8.1 and discussed in this plan in Sections 1.4.1 and 8.0. SST Postclosure requirements are stated in Section 8 of this plan (paragraph 2). Detailed postclosure planning is conceptual at this point and therefore were assigned as a parking lot issue.* *Response: Comment will be resolved through development of permit conditions*	Closed Parking Lot #10 (DH) CLOSED
BBK-9	Section 1.1.2, general	This section should include some text stating that the incorporation of WMAs and component closure actions into the SST System Closure Plan will be conducted in accordance with WAC 173-303-830(4). *Response: Text inserted "New information pertinent to making closure decisions will be provided as necessary in accordance with the WAC 173-303-830 permit modification process." in Section 1.1.2.*	CLOSED Action Item #4 (BBK)
DH-5	Section 1.1.2, Page 1-7	Line 35. Replace "may" with "will". (See Rev. 0 NOD #25) *Response: Accept.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-10	Section 1.1.2, second paragraph	Modify the existing text to read "Final closure of the system will be accomplished on a WMA basis. No individual component closures will be deemed final ~~before~~ until closure of the associated WMA. Each WMA closure must be preceded by a risk assessment." *Response: Accept. Text revised as suggested.*	CLOSED 10/29/03
BBK-11	Section 1.1.3	WAC 173-303-610(2)(b)(i) and 640(8)(a) clearly require soil cleanup during closure. The Hanford Site Wide RCRA Permit Condition II.Y.2.c states that the Permitee will "document that the activities completed under closure and/or post-closure satisfy the requirements for corrective action; or if the activities completed under closure and/or post closure care do not satisfy corrective action requirements, identify the remaining corrective action requirements and the schedule under which they will be satisfied....." If the Permitee intends to complete this work under RPP or CPP processes a reference to the unit and a schedule must be provided. Revise this section accordingly. *Response: Text revised as suggested.*	Closed 10/29/03
DH-6	Section 1.1.3 Page 1-8, Lines 18-23	Hold – Corrective Action Issue ——— *Response: Issue resolved by D. Heggen.*	Closed
AH-4	Section 1.1.4	Section 1.1.4 text states: "Groundwater actions associated with SSTs will be conducted within the integrated, long-term management approach set forth in HFFACO Milestone M-45 and the associated monitoring requirements of Milestone M-24." It should be noted that Milestone M-24 provides a schedule for groundwater monitoring well installation and does not provide a schedule by which groundwater monitoring networks will become compliant with WAC 173-303-645 standards. Include in Section 1.1.4 an identification that groundwater monitoring requirements of WAC 173-303-645 will be satisfied as part of SST component and SST system closure actions. AH *Response: Comment will be resolved through development of permit conditions*	Parking Lot #4 (ORP/CH) Closed
AH-5	Section 1.1.4	Section 1.1.4 text states: "CERCLA Records of Decision (RODs) are accepted for integration within the closure process." To date, no final groundwater RODs have been issued, only "interim" RODs. As such, the text should identify if "interim" RODs are also accepted for integration within the closure process. Furthermore, it is recommended that the Tier 1 document identify, if available, the anticipated date of final groundwater operable unit ROD issuances for each groundwater operable unit that each WMA resides over. Revise the document to reflect the above concerns. AH *Response: Added text to Section 1.1.4.*	CLOSED
AH-6	Section 1.1.4	Section 1.1.4 does not identify when postclosure groundwater monitoring will be initiated. As the Tier 1 document provides for SST component and SST system closure actions, provide schedule information in the Tier 1 document that specifically defines when postclosure groundwater monitoring will be initiated for SST components and for SST systems. AH *Response: Comment will be resolved through development of permit conditions*	Parking Lot #4 (ORP/CH) Action List #10 (AH) CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-7	Section 1.1.4	Section 1.1.4 identifies TPA Milestones M-45-51, -52, -53, -54, and -55 but does not provide a description of the RCRA subpart S corrective action process. Revise the Milestone M-45 flow chart to show how/when the RCRA corrective action process for characterizing the SST releases are placed in the Tier 1 document. In addition, include in this section an identification of where each WMA (U, S-SX, B-BX-BY, T, and TX-TY) is at on the Milestone M-45 RCRA corrective action process flow chart (i.e., the status). AH *Response: Section 1.1.4 text revised.*	CLOSED 12/10/03 Action List #11 (Freestone)
BBK-12	Section 1.1.5	Please provide additional explanation, and an example, for the statement "Closure actions will not be subordinated to long-term stewardship requirements." *Response: Aforementioned sentence was deleted.*	CLOSED
MJB-7	Sec. 1.1.5 Process for Developing SST System Postclosure Permit Conditions, p. 1-9	An assertion is made that closure actions "will not be subordinated to long-term stewardship" but no further explanation is given. Long-term stewardship is no longer the responsibility of Environmental Management within the USDOE. Per the information provided to the U.S. Congress in the FY 2004 Congressional Budget for the Department of Energy (p. 179, February 2003), the Office of Legacy Management will assume that responsibility (i.e., long-term surveillance and maintenance, long-term pump and treat operations). Post closure treatment of groundwater and post-closure monitoring are considered PART of long-term stewardship. Explain what is meant by the statement made concerning subordination; it appears to conflict with the information provided to the 108th Congress by the USDOE. *Response: Deleted last sentence in Section 1.1.5.*	Closed
AH-8	Section 1.1.5	Section 1.1.5 states: "The SST system postclosure permit conditions in the Site-Wide Permit may be developed on a WMA-by-WMA basis." As WMA-specific groundwater monitoring and post-closure care conditions will differ from WMA to WMA, it is appropriate that postclosure permit conditions will be developed on a WMA-by-WMA basis. Provide the following text : **"The SST system postclosure permit conditions in the Site-Wide Permit will be developed on a WMA-by-WMA basis. Postclosure care for each WMA will be performed to satisfy WAC 173-303-610(7) requirements. Postclosure care will be performed on a WMA-by-WMA basis and, at a minimum, will include: groundwater monitoring and reporting as required by WAC 173-303-645 and -665, and maintenance and monitoring of waste containment systems."** AH *Response: Suggested text inserted at the end of Section 1.1.4.*	CLOSED
AH-9	Section 1.1.5	Include text identifying that groundwater monitoring conducted during postclosure will be performed in accordance with performance standards of WAC 173-303-645 and at WMA-specific points of compliance as defined by WAC 173-303-645(6). *Response: Suggested text inserted at the end of Section 1.1.4 as mentioned in Comment AH-8.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-7	Section 1.1.5, Page 1-9	Lines 24-25. Revise the text to clarify the issue of subordination of closure actions. *Response: Accept. Revised per response to comment BBK-12.*	Closed
DH-8	Section 1.2.1, Page 1-9	Line 30. Delete the word "more". This list should be a complete list of components and reflect all components known to DOE at this time. If this is not a "complete, accurate and true" listing of system components, then revise the text to include a near-term schedule to provide a complete list of SST system components. Requirement: WAC 173-303-610(3) *Response: Accept. Deleted "more"*	Closed
DH-9	Section 1.2.1, Pages 1-9, 1-10	Missing is a scale diagram of all components relative to WMA boundaries and adjacent facilities. Provide a schedule to provide diagram(s). This could be accomplished on a WMA by WMA basis. *Response: Comment will be resolved through development of permit conditions*	Parking Lot #9 (Ecology) Action List #19 (J von Reis) CLOSED
DH-10	Section 1.2.1, Page 1-13	Table 1-3. The total waste volume described for transfer piping is listed as 0 gallons of solid and 1,200 gallons of liquid waste (155 cubic feet). That equates to about 600 feet of 3 inch pipe filled/plugged with waste. This seems far too low an estimate of waste contained in old abandoned transfer pipelines. Explain/Revise this estimate. Additionally, no inventory estimate is provided for waste leaked to the vadose zone. Also provide inventory estimates (in gallons) for waste leaked to the soil/vadose zone. *Response: Table 1-3 has been revised and inserted into document.*	CLOSED Action List #20 (J von Reis)
DH-11	Section 1.3 Page 1-13, and throughout the document as appropriate	Provide additional text as follows: Any closure action on SST system components or portions of WMAs that exist outside of the WMA boundary/fenceline must comply with all requirements/approvals set forth in this closure plan and addendums/attachments to this plan. *Response: Accept. Will revise text as suggested.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-10	Section 1.3.1	This section describes groundwater monitoring as an "integration opportunity". While there may be opportunities for integration of the RCRA corrective action remedy design and risk assessment, groundwater monitoring requirements of WAC 173-303-645 represent waste management area-specific closure performance standards and should not be considered standards to be achieved via integration actions that are occurring outside of the closure plan or on different schedules. In other words, the groundwater monitoring requirements of WAC 173-303-645 represent closure performance standards that must be satisfied via the SST system closure process and not deferred to a process that addresses groundwater monitoring across the Central Plateau. Section 1.3.1 text states: "Postclosure monitoring needs should be organized by whole regions, not individual waste sites." This is an inappropriate statement in the Tier 1 document and does not satisfy WAC 173-303-645 or -610 performance standards. Revise the permit language for Tier 1 actions to include the following: **"Groundwater monitoring to satisfy an active and a postclosure status SST component(s) and/or system will be satisfied on a WMA-by-WMA basis. Specifically, and at a minimum, groundwater monitoring requirements of WAC 173-303-645 will be satisfied at the following SST WMAs: A-AX, B-BX-BY, C, S-SX, T, TX-TY, and U. WAC 173-303-645(10) compliance groundwater program monitoring requirements will be satisfied while the SST System WMAs are active and WAC 173-303-645(11) corrective action groundwater program monitoring requirements will b satisfied for postclosure groundwater monitoring."** *Response: Comment will be resolved through development of permit conditions*	Parking Lot #4 (ORP/CH) CLOSED
BBK-13	Section 1.2.1, last paragraph	Delete the sentence "There is, however, considerable potential for integration of SST system closure activities with closure of these other past-practice sites and operable units, as described in Section 1.3 below." See comment 18 below. *Response: Text deleted as suggested.*	CLOSED
BBK-14	Table 1-1 and 1-2	Table 1-1 should include all constituents in the XXXX DQO. Table 1-2 should be deleted from the Tier I document. The COPC list should be developed on, at a minimum, a WMA by WMA basis. The Tier 1 document should include text stating that the COPC list will be developed during the DQO process for each WMA. *Response: Inserted "Partial" to title of Table 1-1 and deleted Table 1-2.*	CLOSED
BBK-15	Table 1-1	Why is the quantity of Strontium reported in "kg" rather than "Ci"? Is this an error? *Response: Quantity for Strontium changed from "kg" to "Ci".*	CLOSED
BBK-16	Table 1-3	Include a column for "Quantity." Provide information on how many MUSTs, how many Vault Tanks, etc. the waste volume is distributed over. *Response: Table 1-3 revised to include "Quantity" and information inserted as suggested.*	CLOSED Action Item #5 (J von Reis)

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-10	Sec. 1.3.1, Integration Opportunities, p. 1-13, ¶ 2	Sentence 2 asserts that closure actions under CERCLA Records of Decision can address RCRA and HWMA requirements and Site-Wide Permit standard condition II.Y.2. While that may be one possible method by which cleanup may be accomplished, Ecology will require cleanup of tank farm facilities to meet the performance standards in WAC 173-303-610(2). Should the USDOE decide to integrate the SST closures with CERCLA actions, Ecology will require that closure and post-closure activities be accomplished under the RCRA and the HWMA as implemented in the State's Dangerous Waste Regulations, WAC 173-303. Modify the sentence to so state. *Response: Added reference to -610 performance standards to last sentence of paragraph two of Section 1.3.1.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-17	Section 1.3.1	Revise text to read "Closure of the SST system will take place within the same time frame as other planned Central Plateau closure actions. These other closure actions involve facilities and operable units currently regulated under both RCRA and CERCLA. Certain facilities and operable units listed for closure are geographically adjacent to parts of the SST system. Closure of these facilities and units may require activities substantively similar to SST closure actions. Additionally, a CERCLA final ROD will ultimately be developed for the Hanford Site 200 Areas. As closure actions proceed for the SST system, achievement of protectiveness pursuant to CERCLA and ARARS, for all hazardous substances, must be considered. The existence of proximate facilities scheduled for closure in the same general time frame as the SST system and involving similar closure activities creates a potential to accelerate cleanup, increase efficiency, and avoid both duplicative effort and regulatory conflicts by integrating closure actions where feasible. While SST system closure must ultimately satisfy RCRA and HWMA requirements, the HFFACO and the Site-Wide Permit standard condition II.Y.2.provides provisions for the coordination of RCRA and CERLA activities. In some instances closure actions accomplished in accordance with CERCLA RODS will can fulfill address RCRA and HWMA requirements. and Site-Wide Permit standard condition II.Y.2. Several specific opportunities for integrated closure and postclosure actions are apparent. • Delete 7 bullets DOE, Ecology, and EPA are presently identifying and evaluating opportunities for integration of closure and postclosure activities on the Central Plateau through the Central Plateau regional strategy effort. As specific opportunities are defined identified for integrating actions involving the SST system, DOE will, in accordance with Site Wide Permit standard condition II.Y.2., modify the Site Wide Permit, to incorporate closure integration opportunities into corresponding proposals into future modifications of this plan and into subsequently submitted WMA closure action plans and component closure activity plans." Ecology is requesting a commitment for integration be included in the Tier I closure plan, but no specific information. If specific information is provided Ecology will have to include the proposals in a compliance schedule to ensure the documentation is submitted on schedule. When specific integration opportunities are identified they should be included in the Tier II or Tier III documents. *Response: Text revised.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-11	Sec. 1.3.1, Integration Opportunities, p. 1-14	Bullet 3 Groundwater Monitoring, Protection, and Risk Assessment states that a common and consistent risk assessment is need of collective groundwater impacts. Per information provided by the US EPA Office to the Hanford Advisory Board, the groundwater cumulative impacts will not be addressed until after 2008 (see Letter, Nicholas Ceto to Todd Martin, "Response to Hanford Advisory Board Advice #148 on the Revised Draft Hanford Solid Waste Environmental Impact Statement," dated August 20, 2003). Please explain how those assessments will be incorporated into the SST closure plans. *Response: Bulleted text was removed per BBK-17.*	Closed per resolution of parking lot item #1
MJB-12	Sec. 1.3.1, Integration Opportunities, p. 1-14	Bullet 6 Regulatory Efficiency, last sentence, states that use of a single Record of Decision for each cleanup zone would create building blocks for completing the overall CERCLA cleanup, which would include delisting. Ecology asks that the USDOE provide information on when the USDOE proposes to delist the 200 Areas and how that action will affect long-term groundwater remediation and monitoring required for an SST Tank Farm that will be closed as a land-based disposal facility by WAC 173-303-610(7) and 173-303-665. *Response: Bulleted text was removed per BBK-17.*	Closed per resolution of parking lot item #1
MJB-13	Sec. 1.3.1, Integration Opportunities, p. 1-14 and 1-15	Bullet 7 Closure of SST System Components Outside of WMAs states that current plans for closure of tank and non-tank pipelines, transfer lines, and related components under CERCLA. Ecology has not surrendered its regulatory authority to regulate the cleanup of the Central Plateau DWMAs to date. As stated in the Hanford Federal Facility Agreement and Consent Order, Article IV, paragraph 17, closure of facilities must comply with both CERCLA (42 USC Sec. 9601 et seq. HWMA corrective action requirements (42 USC Sec. 6924 (u) and (v) and Sec. 3008(h) 42 USC Sec. 6928(h), and meet or exceed all applicable or relevant and appropriate federal and state requirements as required by Sec. 121 of CERCLA, 42 USC Sec. 9621. Releases covered by the HFFACO will be covered by RCRA, RCW Ch 70.15 and the Model Toxics Control Act, which are to be incorporated as ARAR's. Please add the reference to the provisions in Article IV, paragraph 17 after 2. *Response: Bulleted text was removed per BBK-17.*	Closed per resolution of parking lot item #1
DH-12	Section 1.3.2, Figure 1-4	Revise the "Planning and Strategy Documents/Processes" box on Figure 1-4 (for the RCRA/HWMA line) as follows: "RCRA/HWMA requirements and process". Clearly, the RCRA/HWMA performance standards are an important element of planning and strategy documents and processes. This comment is retracted if the Figure is deleted. *Response: Partially accept. Figure 1-4 has been removed from the closure plan.*	Hold pending figure deletion.

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-14	Figure 1-4, pp. 1-17/1-18	Please note: the USDOE declared that post-closure actions will be considered part of long-term stewardship in the USDOE FY 2004 budget submitted to Congress in February 2003. The time line as shown to the right of *Major Central Plateau Activities* is therefore incorrect. Please insert post-closure actions parenthetically after Long-Term Stewardship. Please correct the box entitled *NEPA/SEPA/Processes* by changing "Significance determination" to "Threshold Determination" to reflect the requirement in WAC 197-11-310 and the process involved in WAC 197-11-330. Please add "NEPA ROD" in the same box to reflect completion of the NEPA cycle. Please reword "NEPA and SEPA EIS" to "NEPA EIS meeting SEPA requirements" to reflect the preparation of a NEPA EIS by the USDOE and the cooperation or adoption by Ecology. Please correct the box labeled *Integration Decision Documents/Processes* to add NEPA ROD. The USDOE completes the NEPA process by issuing an ROD that describes the alternative the agency selects after the Final EIS is published. In the box labeled Integration Steps, please revise "Demonstrate regulatory compliance – ensure satisfaction with RCRA/HSWA/RCW/MTCA (Initiative 97)" to reflect HFFACO Article IV, ¶ 17. Time line for *Component Closure Activities*: see comment on *Major Central Plateau Activities.* *Response: Bulleted text was removed per BBK-17.*	Closed per resolution of parking lot item #1
AH-11	Section 1.3.2, Figure 1-4	"Groundwater monitoring" as a "candidate integration element" must be removed from Figure 1-4. Groundwater monitoring represents WAC 173-303-610 and -645 performance standards applicable to each SST WMA. As such, groundwater monitoring is WMA-specific and should not be identified as a "candidate integration element". Revise the document to address this concern. AH *Response: Partially accept. Figure 1-4 has been removed from the closure plan.*	CLOSED
AH-12	Section 1.3.2, Figure 1-4	Add "Active WMA groundwater monitoring" and "postclosure groundwater monitoring" to the "SST System Closure" box on Figure 1-4. The Tier 1 document does not appear to acknowledge that WMA-specific groundwater monitoring is a performance standard (i.e., a regulatory requirement). AH *Response: Partially accept. Figure 1-4 has been removed from the closure plan.*	CLOSED
AH-13	Section 1.3.2, Figure 1-4	Revise the "SST System Closure" box on Figure 1-4 to state "System components to be addressed include:" rather than "System components to be closed include:". "Closure" of "groundwater" that is already contaminated from releases is not administratively or regulatorily correct. AH *Response: Partially accept. Figure 1-4 has been removed from the closure plan.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-14	Section 1.3.2, Figure 1-4	Delete the words "- integrated with other Central plateau GW monitoring" from the "SST System Postclosure State" box on Figure 1-4. Again, the Tier 1 document does not appear to acknowledge that WMA-specific groundwater monitoring is a performance standard (i.e., a regulatory requirement). Groundwater monitoring during the active life of the WMA and during post-closure is an action that should occur specific to the WMA. In other words, groundwater monitoring conducted during the active life of the WMA and during postclosure is not an activity that should be integrated. Clearly, groundwater monitoring is required to be conducted at the WMA "point of compliance" as defined by WAC 173-303-645(6). Postclosure groundwater monitoring is a WMA-specific activity, a performance standard, and a regulatory requirement. AH *Response: Partially accept. Figure 1-4 has been removed from the closure plan.*	CLOSED
AH-15	Section 1.3.2, Figure 1-4	Due to the Tier 1 document's lack of acknowledgement that WMA-specific groundwater monitoring is a performance standard (i.e., a regulatory requirement), revise the "Central Plateau Postclosure State" box on Figure 1-4 to identify that "WMA-specific" groundwater postclosure monitoring will be ongoing. Specifically, revise the wording regarding groundwater postclosure monitoring to read: "WMA-specific postclosure monitoring ongoing". AH *Response: Partially accept. Figure 1-4 has been removed from the closure plan.*	CLOSED
AH-16	Section 1.3.2, Figure 1-4	Revise the "Planning and Strategy Documents/Processes" box on Figure 1-4 (for the RCRA/HWMA line) as follows: "RCRA/HWMA requirements and process". Clearly, the RCRA/HWMA performance standards are an important element of planning and strategy documents and processes. AH *Response: Partially accept. Figure 1-4 has been removed from the closure plan.*	CLOSED
BBK-18	Figure 1-4	Delete Figure 1-4, see comment 18. *Response: Figure has been deleted.*	CLOSED Parking Lot #1 resolved (J von Reis)
BBK-19	Section 1.3.2	Ecology requests the deletion of this section, along with the figure it refers to. *Response: Section and figure has been deleted.*	CLOSED
DH-14	Section 1.3.3, Pages 1-19 through 1-21	Revise the section number for this section to Section 1.4 and adjust the subsequent sections to accommodate or move to section 6.0 as a subsection. Relative timeline information should be part of the required schedule information, not integration. DH *Response: Partially accept. Section number has been revised to 1.3.1.*	Closed Parking Lot #1 resolved (J von Reis)

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-20	Section 1.3.3, first paragraph	Please revise the text to read: "The SST system includes seven WMAs. Closure of the SST system requires closing the WMAs and conducting closure activities for individual system components within the WMAs. DOE will develop WMA closure action plans and component closure activity plans, ~~or alternate decision documentation such as corrective measures studies or CERCLA RODs referenced by the Site-Wide Permit~~, to describe how the components or groups of components will be disconnected, dismantled, decontaminated, removed, and/or stabilized." *Response: Partially accept. Inserted "(final and interim) upon approval through incorporation into" after CERCLA ROD.*	CLOSED
DS-1	Page 1-20 line 13	If the 2nd column represents the period during which WMA closure activities are completed; on Page 1-19, state the 1st column represents intervals during which closure activities occurs. Clarify; these two statements are not in agreement. *Response: Clarified third column description in Section 1.3.3.*	Closed
MJB-15	Sec. 1.3.3 Relative Timeline for WMA Closures, p. 1-20, ¶ 2	In sentence 2, the period during which WMA closures begin is said to occur when all of the SSTs have been retrieved, isolated and filled. The tank closure EIS, which evaluates clean closure versus landfill closure has not been issued for public comment; therefore, the USDOE is premature in assuming that WMA closures will begin after the SSTs are closed as landfills. The USDOE must complete the NEPA process then select the alternative to be implemented AFTER the analyses of impacts in the EIS are completed, the document has released for public comment, and a Record of Decision has been issued. Federal agencies may not make irretrievable and irreversible commitments of resources until the NEPA process is complete. Please add to the information in Figure 1-5 to show a typical schedule for closure of a WMA after clean closure of a tank. *Response: Added text to indicate that WMA closure occurs when SSTs, soil, and ancillary equipment component closures are completed in accordance with WAC 173-303-610(2) in fifth paragraph of Section 1.3.3 and added text regarding assumption that clean closure under WAC 173-303-640(8)(a) is not achieved in third paragraph of Section 1.3.3.*	CLOSED
AH-17	Section 1.3.3, Figure 1-5	On Figure 1-5, the word "strategies" is used repeatedly. Replace the word "strategies" with "schedules and processes". The word "strategies" should not be used unless strategies have been developed and/or approved by the agencies or stakeholders. *Response: Figure revised with suggested text.*	CLOSED Action List #12 (Freestone)
AH-18	Section 1.3.3, Figure 1-5	On Figure 1-5, revise the bullet under the "Groundwater Component Closure Activities" box to indicate that activities associated with characterizing the rate and extent of contamination migration may be integrated with regional contamination characterization efforts but that groundwater monitoring required by WAC 173-303-645 will be performed on a WMA-by-WMA basis. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4 (ORP/CH)

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-19	Section 1.3.3, Figure 1-5	On Figure 1-5, the first bullet under the "Groundwater Monitoring During Closure" box should include the WAC 173-303-645 citation. Also, it is recommended that the second bullet identify that monitoring requirements may change via the permit modification process of WAC 173-303-830. Revise the text to reflect these concerns. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4 (ORP/CH)
AH-20	Section 1.3.3, Figure 1-5	On Figure 1-5, revise the wording under the "Postclosure Groundwater Monitoring" box to read: "WMA-specific postclosure monitoring required by WAC 173-303-645 and -665 will be performed".	
AH-21	Section 1.3.3, Figure 1-5	On Figure 1-5, delete the following words under the "Postclosure Groundwater Monitoring" box: "integrated with Central Plateau regional groundwater monitoring". Replace the deleted wording be replaced with: "Where possible, information obtained from WMA-specific monitoring will be integrated with Central Plateau regional groundwater monitoring." *Response: Figure revised with suggested text.*	CLOSED Action List #12 (Freestone)
AH-22	Section 1.3.3, Figure 1-5	On Figure 1-5, Revise the title of the "Central Plateau Groundwater Monitoring" box to read: "Postclosure and Central Plateau Groundwater Monitoring". *Response: Figure revised with suggested text.*	CLOSED Action List #12 (Freestone)
AH-23	Section 1.3.3, Figure 1-5	On Figure 1-5, delet the bottom "Postclosure Care" and "Central Postclosure Care" boxes. Move all bullets occurring below these boxes up to the "Postclosure Groundwater Monitoring" and "Postclosure and Central Groundwater Monitoring" boxes. *Response: Figure revised with suggested text.*	CLOSED Action List #12 (Freestone)
BBK-21	Section 1.3.3, fifth paragraph	Please revise the text to read: "The second column represents the period during which WMA closure activities are completed. This period begins when all of the SSTs within a WMA have been retrieved, isolated, and filled, and the ancillary equipment and soils have been characterized and appropriately dispositioned...." *Response: Text revised as follows: "This period begins when closure activities on all SSTs, ancillary equipment, and soils in the WMA have been completed in accordance with WAC 173-303-610(2), and groundwater has..."*	CLOSED
DS-2	Page 1-21 line 3	Your statement that during this period other WMA closure action within the SST system are on going is not in agreement with previous statement, Be specific as to what period will be defined as "Closure actions complete" *Response: Clarified third column description in Section 1.3.3.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-15	Section 1.4, Page 1-21	Revise the entire section. The section does not accurately state the regulatory status of SST closure. Revise the section to include the fact that the primary regulatory driver for this RCRA/DW SST closure plan is WAC 173-303. Also indicate that the HFFACO requirements must also be met and that the HFFACO requires all waste must meet the RCRA closure plan performance standards regardless of the closure process or authority. The last paragraph implies that closure moves directly into landfill requirements without first demonstrating the ability to meet clean closure requirements. Revise the text to indicate that landfill closure can only occur after DOE demonstrates/documents the ability to achieve clean closure. Requirement: WAC 173-303, HFFACO *Response: Accept: Will 1) revise the section to include the fact that the primary regulatory driver for this RCRA/DW SST closure plan is WAC 173-303 and HFFACO, and 2) will revise text to "...cannot be clean closed until after first demonstrating an attempt to meet these standards and must be closed as landfills."*	Closed
MJB-16	Sec. 1.4.1, RCRA/HWMA Applicability, p. 1-22, ¶ 3	Sentence 1 states that the USDOE does not know if it will achieve the closure performance standards in WAC 173-303-610(2)(b), so closure plan contains options for clean closure and landfill closure in WAC 173-303. Please cite the appropriate regulatory references in WAC 173-303-640(8) and WAC 173-303-665(6) to closure and post-closure care. *Response: Added WAC 173-303-640(8) and WAC 173-303-665(6) cites to paragraph three of Section 1.4.1.*	Closed
DH-16	Section 1.4.1, Page 1-22	Lines 2-4. Revise the text to state that the SST (tank) system is subject to both WAC 173-303-610 and 640, not just 640 as the current text implies.	Closed
DH-17	Section 1.4.1, Page 1-22	Lines 18-28 Rad issue – hold -------------- *Response: Issue resolved by D. Heggen.*	CLOSED Action List #21 (DH)
BBK-22	Section 1.4, fourth paragraph	Please revise the text to read: "WAC 173-303-610 sets forth ~~primary~~ state requirements for closure and postclosure of dangerous waste TSD facilities such as the SST system. WAC 173-303-640 and 40 *Code of Federal Regulations (*CFR) 265.196 and 197 set forth ~~primary~~ state requirements for closure and postclosure care of tank systems ~~that cannot be clean closed and must be closed as~~ landfills, referencing standards contained in WAC 173-340....." *Response: Text revised.*	CLOSED
BBK-23	Section 1.4.1, fifth paragraph	Please revise the text to read: "DOE will attempt to remove or decontaminate all waste residues from contaminated SST system components, contaminated soils, and structures and equipment, evaluating removal and decontamination in accordance with WAC 173-303-610 and 640 requirements ~~the context of the *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-shell Tanks at the Hanford Site* (Closure Environmental Impact Statement [EIS]) now being prepared~~....." *Response: Text revised.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-24	Section 1.4.3	Have issues with DOE Order 435.1 been resolved? Should all but the first paragraph of this section be modified or deleted? *Response: Text in Section 1.4.3 modified.*	Closed - Parking Lot #2 resolved (J von Reis)
MJB-8	Sec. 1.4.4 National Environmental Policy Act and Washington State Environmental Policy Act Applicability, pp. 1-25/26	In ¶ 1, p. 1-26, the text states that the SEPA process is similar to NEPA. That is not factually accurate: the SEPA process differs from NEPA in that a threshold determination against a checklist is required, documents called Environmental Analyses that help determine whether a NEPA EIS is needed are not required by the State, the FONSI is not used (the document is a Determination of Non-Signifigance), there is a formal document published that announces the need for an EIS (Determination of Significance). The philosophy of the SEPA process is similar to that of NEPA: any action to be taken by a State agency (e.g., issuing a permit) must be evaluated for its potential environmental impacts before the agency takes action. Please clarify in text. *Response: Added text to better define SEPA process to second paragraph of Section 1.1.4.*	Closed
MJB-9	Sec. 1.4.4 National Environmental Policy Act and Washington State Environmental Policy Act Applicability, pp. 1-25/26	In ¶ 1, p. 1-26, the statement is made that the State may choose to co-author or adopt a NEPA EIS in lieu of preparing a SEPA EIS. Clarification: a state agency may adopt a NEPA environmental assessment to satisfy the requirements of a determination of non-significance or it may adopt a NEPA EIS if certain requirements in WAC 197-11-610(3) are met. The agency may choose to COOPERATE with a Federal agency, which may mean more than co-authoring a document (i.e., providing input to development of alternatives, etc.). Any NEPA document must be adopted in whole or part to satisfy SEPA (WAC 197-11-630 and WAC 197-11-965). *Response: Added text to better define NEPA EIS process to second paragraph of Section 1.1.4.*	Closed
DH-18	Section 2.0 and Section 2.1 – (all)	See previous Rev. 0 NOD comments (#82 and #83) requiring final status groundwater monitoring be described in the Rev 1. SST closure plan as effective with the issuance of this closure plan permit modification. Revise the entire section to reflect this concept. *Response: Comment will be resolved through development of permit conditions*	Parking Lot #4 (ORP/CH) Closed
JC-1	Page 2-2 Section 2.1.1 Lines 25-27	Groundwater is currently monitored under interim-status regulations, but final status (i.e., WAC 173-303-645) will apply when applying for a permit to close a Waste Management Area. Not addressed here in response to an NOD comment on Rev. 0 is the potential role that groundwater monitoring could play as part of LDMM during waste retrieval. *Response: Comment will be resolved through development of permit conditions*	Parking Lot #6 (ORP/CH) Closed
JC-2	Page 2-2 Section 2.0	Implementation of an effective and efficient LDMM system during waste retrieval for all tanks to which significant quantities of fluid will be added during waste retrieval (e.g., saltcake tanks) will be protective of groundwater and should be mentioned somewhere in this section. *Response: Comment will be resolved through development of permit conditions*	Parking Lot #6 (ORP/CH) Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
JC-3	Page 2-2 Section 2.1.1 Bullet 1	While background has been established for all SST WMAs, it was established under a groundwater flow regime that may be considerably different than the current flow system, especially with regard to direction. This section should include the requirement to revisit and revise the groundwater monitoring plan and network to accommodate changes in groundwater flow direction, changes in dispersivity and the required number of wells, etc. Please correct. *Response: Comment will be resolved through development of permit conditions*	Parking Lot #5 (ORP/CH) Closed
JC-4	Page 2-3 Table 2-1	As new and replacement wells are constructed and/or groundwater quality changes because of changing direction of groundwater flow, the list of site-specific parameters may need to be revised.	
JC-5	Page 2-4, Section 2.1.2	A mention of any relationship between post-closure groundwater monitoring and monitoring that will be implemented for Long Term Stewardship is perhaps worthy of mention here. *Response: Text inserted to address long-term stewardship as suggested.*	CLOSED
DH-19	Section 3.0, Page 3-1	Refer to previous Rev. 0 NOD comment #58. The text that DOE promised to supply relating to cleanup levels stated in WAC 173-303-610(2)(b) calculated according the WAC 173-340 (MTCA) is missing. Provide the missing text. *Response. Partially accept. This information is in Section 1.4.1 which was 1.3.1 as promised in the NOD reply. However elaboration of 610(2)(b) is contained in Section 3.4.1.*	Closed
BBK-25	Section 3.1, first paragraph	Please revise text to read: "Closure activities planned for the SST tank farms will be designed to minimize the maintenance required after closure of individual WMAs and the SST system. Closure activities ~~may~~ will include removing waste from tanks and ancillary equipment, minimizing the potential for spills and leaks, characterizing residuals and contaminated media, isolating and stabilizing any remaining wastes in tanks or ancillary equipment, evaluating and implementing closure options for environmental media, and constructing engineered surface barriers. DOE will focus primarily on the following to meet this general performance standard: • Waste removal ~~reduction~~ to reduce consequences of any maintenance issues..." *Response: Text revised as suggested.*	CLOSED
BBK-26	Section 3.1, fifth paragraph	As necessary, DOE ~~may~~ will install engineered surface barriers at WMAs and other locations to minimize water infiltration into remaining structures and equipment, soil, and groundwater. *Response: Text revised as suggested.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-17	Sec. 3.1, Minimize Need for Further Maintenance, p. 3-3, ¶ 3	The first sentence explains that the USDOE has not developed final barrier or marker designs at the Hanford Site; however, HFFACO Milestone M-45-55 requires that a Phase I RFI report for the S/SX, T/TY/TX, B/BY/BX be submitted by 02/28/04. Milestone M-45-55-T03 requires submission of a field investigation report for T/TX/TY by 01/31/2005. Per Milestone M-45-60, six months after the RFI report is approved by Ecology. See pp. 6-16/17 of RPP-13774, Rev. 1). From the text, Ecology cannot determine when the final barrier or marker designs will be completed in this closure plan. The WMA closures are said to be dependent upon barriers and markers, thus delay in the development will affect the permits for closure for the WMAs listed above. Please provide an integrated schedule for the integration of barrier and markers into the RFI/CMS activities for the three WMAs. *Response: Modified text in fourth and fifth sentences of paragraph five of Section 3.1 to clarify barrier design will be completed prior to end of closure activities.*	Closed
JC-6	Page 3-3 Section 3.1 Lines 24-28	Barriers should also be designed to minimize the potential for intrusion and destructive effects by burrowing animals (ground squirrels, gophers, etc.) that could reduce the potential for limiting infiltration. *Response: Text inserted to address barriers as suggested in Section 3.1 end of 6th paragraph.*	CLOSED
JC-7	Page 3-5 Lines 11-13	Page 3-5, Lines 11-13. Please add to this bullet the following: "....that will meet the standards of RCRA as an ARAR." *Response: Suggested text inserted.*	CLOSED
JC-8	Page 3-5 Line 15	Please add the following to this bullet: "....and periodic sampling of these wells for identified constituents as included in the post-closure monitoring plan." *Response: Suggested text inserted.*	CLOSED
MJB-18	Sec. 3.2.1.1, Meeting SST Retrieval Criteria, p. 3-6, ¶ 3	Sentence 1 states that the USDOE will submit an exception to EPA and Ecology. A bulleted list of information follows. Appendix H of the HFFACO Step 8 requires the USDOE to prepare a request for waiver to the appropriate regulatory agency. That waiver must be in the form of a petition that complies with WAC 173-303-910(6) Petitions to allow land disposal of a waste restricted under WAC 173-303-140 (Land Disposal Restrictions) if it is submitted to Ecology. Please add the regulatory reference. *Response: Added text to third paragraph of Section 3.2.1.1 to qualify that request is "Appendix H Attachment 2 request".*	Closed
BBK-27	Section 3.2.1.1, second set of bullets, fourth and fifth bullets	Please revise the text to read: • "The volume, chemical characteristics, and radiological characteristics of the ~~proposed~~ waste residual • Expected impacts to human health and the environment from leaving the ~~proposed~~ residual in place" *Response: Deleted suggested text.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-19	Sec. 3.2.1.2, Component Closure Activities for Tanks, p. 3-7	Paragraph 2 and others in this section state that tank stabilization will be completed through addition of cementitious grout. Ecology has not agreed that grout is an appropriate material to use to stabilize emptied tanks or to fill components left in the ground after closure. Unless/until the USDOE provides sufficient proof that the material being considered for stabilization will provide equivalent protection to that afforded by immobilized waste from the Waste Treatment plant, plans to remove components should be given preference to those that leave components in place. The USDOE should also consider mechanical and chemical techniques to remove wastes from ex-tank ancillary equipment to reduce the volume and toxicity of waste left in the equipment. As the effort to dissolve wastes plugging the transfer line from 241-U-107 to the 241-SY Tank Farm revealed, line blockages can be cleared. The standard *Response: Added "in accordance with Ecology-approved component closure activity plans" in second paragraph of Section 3.2.1.2. Also revised text by substituting "fill" for "grout" where appropriate.*	Closed
DH-20	Section 3.2.1.3 Page 3-7	Lines 30-35. Revise this portion of the paragraph as follows: **"Disposition of ex-tank ancillary equipment (such as pipelines, diversion boxes) will be described in an ancillary equipment component closure activity plan. Additionally, for closure actions, including SST retrieval, where ancillary equipment is connected/attached must describe with sufficient detail how anticipated ancillary equipment or tank retrieval/closure actions will not preclude future retrieval/closure actions for those components."** There is no agreement to move such a basic requirement into an unenforceable document outside of the closure plan such as the Implementation Plan. This is a key scheduling issue. Requirement WAC 173-303-610(3) *Response: See response to comment BBK-28.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-28	Section 3.2.1.3, second paragraph	Please revise the text to read: "There are uncertainties associated with the level of contamination contained in ancillary equipment and with potential difficulties in accessing buried equipment. DQOs will be developed to ensure appropriate characterization data are collected to support the ancillary equipment component closure activities. Disposition of in-tank ancillary equipment (such as in-tank measuring equipment and tank risers) will be described in the respective tank component closure activity plans. In-tank ancillary equipment will be dispositioned as debris during the tank closure activity. Disposition of ex-tank ancillary equipment (such as pipelines, diversion boxes) will be described in ~~either~~ an ancillary equipment component closure activity plan ~~or other alternate decision documentation such as a corrective measures study or ROD and referenced back to the SST system chapter of the Site-Wide Permit. Integration activities for remediating ex-tank ancillary equipment are expected to be developed through the *SST system Implementation Plan* pursuant to HFFACO Milestone M-45-06-T20~~." *Response: Partially accept. Inserted the following text "..ROD (final and interim) upon approval through incorporation into the SST system chapter of the Site-Wide Permit. Additionally, for closure actions, including SST retrieval, where ancillary equipment is connected/attached, DOE must describe with sufficient detail how anticipated ancillary equipment or tank retrieval/closure actions will not preclude future retrieval/closure actions."*	CLOSED
DH-21	Section 3.2.1.4, Pages 3-7 – 3-8	This section implies filling of SSTs with a grout-like immediately following tank retrieval. This is unacceptable. Eventually, after sufficient data is provided to address regulatory and stakeholder issues, grouting of tanks may be an acceptable option. However, to date, these issue are not resolved and most importantly, at this early stage of SST closure, DOE has not presented any evidence that tanks must be filled for structural engineering purposes. Furthermore, filling tanks at this stage of WMA characterization when overall risk/data uncertainty is extremely high would preclude future closure actions, if needed. No such action will be allowed until sufficient characterization occurs to reduce the high uncertainty that exists at this time. Revise the text to address/reflect these concerns. Requirement: WAC 173-303-610(3) *Response: Text revision*	Closed
BBK-29	Section 3.2.1.4, second paragraph	Please revise text to read: "Stabilization of any remaining below grade components following waste retrieval will be designed to immobilize any remaining ~~contain~~ wastes residue, minimize contaminant transport, and avoid long-term subsidence and settlement of the tank farm surface." *Response: Inserted suggested text.*	CLOSED

Comment Number	Position In Document	Comment/Response	Comment Closure Date
BBK-30	Section 3.2.1.5, fourth paragraph	Please revise the text to read: "Soil characterization and corrective measures activities for all WMAs will be integrated as appropriate with ancillary equipment and groundwater component closure activities and with the Ecology, EPA, and DOE Central Plateau regional closure strategies currently under development. ~~Integration will influence the implementation schedule as well as the technical and regulatory approach to completing the closure activities.~~ Coordination of these integration actions ~~is expected to~~ will be implemented ~~occur~~ through modification of the *SST System Implementation Plan* or component closure plans ~~pursuant to HFFACO Milestone M-45-06-T20~~." *Response: Revised text as suggested.*	CLOSED
DH-22	Section 3.2.1.6, Page 3-9	Section 3.2.1.6 does not identify that SST releases are currently being characterized via TPA Milestone M-45. Describe in detail the RCRA corrective action (Subpart S) process being followed via Milestone M-45. In addition, include the provision of Milestone M-45 status in Section 3.2.1.6. The status should identify what RCRA corrective action step each WMA is at in the Milestone M-45 process being followed. *Response: See response to comment AH-25.*	Closed
AH-24	Section 3.2.1.6	Section 3.2.1.6 has omitted the primary step of compliance monitoring to determine the impact to groundwater at the point of compliance during the active life of the unit and during the postclosure monitoring period. In other words, Section 3.2.1.6 has omitted WAC 173-303-645 groundwater monitoring performance standards. Revise the section to describe WAC 173-303-645 requirements. AH *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4 (ORP/CH)
AH-25	Section 3.2.1.6	Section 3.2.1.6 does not identify that SST releases are currently being characterized via TPA Milestone M-45. Describe in detail the RCRA corrective action (Subpart S) process being followed via Milestone M-45. In addition, include the provision of Milestone M-45 status in Section 3.2.1.6. The status should identify what RCRA corrective action step each WMA is at in the Milestone M-45 process being followed. AH *Response: Text revised*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-31	Section 3.2.1.7, third and fourth paragraphs	Please revise text to read: "~~Barrier design and installation of surface barriers over WMAs may be integrated with Central Plateau regional closure strategies. For example, barrier installation over a WMA may be delayed until closure efforts in a contiguous waste site (such as a DST farm) are complete. Additionally, barrier design criteria may need to be revised if a barrier cover encompasses multiple contiguous waste sites.~~ When an engineered surface barrier has been installed, the barrier and surrounding disturbed area will be revegetated to enhance evapotranspiration, limit erosion, and blend the area into the surrounding landscape of the Central Plateau. Performance monitoring will ensure the surface barrier is performing as designed. Monitoring will include visual inspection and ~~may~~ will be supplemented with groundwater sampling. DOE will also employ institutional controls and markers to minimize the potential for intrusion by humans." *Response: Revised text as suggested.*	CLOSED
DH-23	Section 3.2.2 Page 3-10, and throughout the document.	Lines 22-26. This section does not provide the true picture of leak detection and monitoring and mitigation (LDMM) for the SST system. The status of the DOE baseline LDMM as a stand alone system has been found to be unacceptable, especially for tank waste removal operations using liquid retrieval methods. Refer to the June 2, 2003 letter to DOE regarding resolution of outstanding RCR comments for tank S-102 and S-112 Functions and Requirements documents. This letter details Ecology concerns over the lack of baseline leak detection validation. It requires the use of electrical resistivity LDMM which is the only leak detection system validated at Hanford. Refer to the following DOE documents for additional comparison of the DOE LDMM baseline system to the electrical resistivity methods: PNNL-13818 (March 2002), RPP-14606 (March 2003), RPP-15449 (March 2003). Unless live testing during retrievals show that the electrical resistivity LDMM methods to be ineffective, Ecology requires a minimum of this level of LDMM to be used as the LDMM baseline for all retrieval/closure actions involving liquid retrieval methods. For closure purposes, the most accurate measurement of leak loss is required for the following reasons: 1) to document the volume of any leak for risk assessment calculations, 2) to document the amount of waste leaked to the vadose zone after all closure actions are complete, and 3) to respond to a release of waste to the environment. Revise the text to accommodate the above concerns and concepts. Requirement: WAC 173-303-640(7) *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #6

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-20	Sec. 3.2.2, Treatment Storage, and Disposal of Retrieved Waste, p. 3-11	Figure 3-1 shows Retrieved SST waste TRU and LLW traveling to supplemental TRU and LLW waste processing. Please correct the figure to show that SST liquid wastes will be considered TRU mixed waste; LLW will only include waste from secondary waste streams (contaminated soil, PPE, etc). Ecology will not agree that liquid tank wastes previously designated at HLW may be reclassified as LLW. The same figure shows HLW/LLW/LAW from the SSTs going to the DSTs. The SSTs do not contain LLW. Only HLW waste is stored in the SSTs. Some fraction of that waste can be considered LAW but none of it is considered LLW. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #11
MJB-21	Sec. 3.3, Return Land to Appearance of Surrounding Land Areas, ¶ 4, p. 3-12.	A statement is made that given previous activity on the Central Plateau, the most appropriate future uses might be industrial or no permitted uses, that is treating the area as an exclusion zone. While the USDOE may conjecture what the future state of the Tank Farms areas might be, the final decisions are yet to be made, as is indicated in ¶ 1 on p. 3-13. Please delete the speculative statement on p. 3-12.	Action Item # 42 (MJB)
BBK-32	Section 3.3.1, second paragraph	Please revise text to read: "~~Possible a~~Actions associated with restoration activities may include: • Design and implement practicable restoration measures consistent with restoration goals and estimates of future land use ..." *Response: Text revised as suggested.*	CLOSED
BBK-33	Section 3.4	Please revise the text to read: "In addition to standards stated in terms of general functionality, protection, and restoration, the SST closure action must comply with specific criteria for waste removal and ~~or~~ decontamination, or conversely, to meet closure and postclosure requirements consistent with ~~landfill standards (WAC 173-303-665([6]).~~ WAC 173-303-610(2)(b) ~~contains~~ a standards applicable to closure of all dangerous waste facilities,~~-~~ WAC 173-303-640(8) ~~contains a~~ standards ~~specifically~~ applicable to closure of tank systems~~.~~, and landfill standards (WAC 173-303-665([6])." *Reponse: Text revised as suggested.*	CLOSED
BBK-34	Section 3.3.1, third paragraph	Please revise text to read: "DOE will perform waste removal or decontamination activities in accordance with all applicable regulations. DOE will assess the alternative to clean up soil and groundwater associated with the SST system pursuant to WAC 173-303-610(2)(b)(i). Such assessment will be documented ~~through a corrective action RFI/CMS or~~ as part of a component closure activity plan. Should this assessment conclude that removal or decontamination to levels calculated according to MTCA Method B is not practicable, in accordance with WAC 173-303-640(8)(b), the performance of closure and postclosure care in accordance with WAC 173-303-665(6) requirements that apply to landfills will be required.	
JC-9	Page 4-1 Lines 1 and 2	A risk assessment is required for closure of units as a landfill AFTER an adequate demonstration/analysis proves that clean closure is not possible. This statement needs to be added to this paragraph. Furthermore, since most agree that clean closure is unlikely, a technically credible risk assessment should be performed to evaluate the clean closure option. If, as suspected, clean closure is not feasible, then that risk assessment should be included in the Tier 1 Closure Plan as applicable to all tanks. (JC)	

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-24	Section 5.0 Pages 5-1 through 5-3	The overall SST characterization strategy is lacking. A description of the known status of each WMA and associated related uncertainty is missing. A description of known data needs in each WMA is also missing. This section relies almost exclusively on the DQO process as the ultimate guide to direct characterization. That is incorrect. Sufficient goals and objectives must be provided in the closure plan to direct the DQO process in order to provide data to satisfy closure requirements. Provide the missing information as well as a description of a logical stepped characterization approach for each WMA. Provide the estimated acceptable uncertainty targeted for final WMA characterization. Remove "DQO" from the headings of most sections. The sections should describe characterization needs with the DQO process as a tool to achieve sufficient data to support these needs. DH Condition to modify the permit at a specified date. DOE may choose various methods to develop the permit mod – possibly the implementation plan; however, it will be subject to Ecology approval and public notice requirements through a class 2 or 3 modification. Requirement: WAC 173-303-610(3), WAC 173-303-830(4) *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #10 (DH) Action List #23 (J von Reis)
DH-25	Section 5.0 Pages 5-1 through 5-3	Missing from this section is a description of waste characterization to provide data to prevent harm to workers. Waste must be properly characterized and the data utilized to sufficiently understand potential air emission hazards in order to allow DOE to take appropriate measures such as engineering controls to prevent worker exposure to toxic air emissions. Air Issue – hold	Hold
DS-3	Section 5.0	The Waste Analysis Plan has not been identified in the document. Requirement: 173-303-300	Action Item #38,39

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-26	Section 6.0, General	Paragraph 1. Ecology is not aware of an agreement that the implementation plan is another mechanism for the timing/scheduling of SST closure activities. The implementation plan may have some use as a planning tool; however, the exact use for the plan under development. The HFFACO is the previous agreed-to mechanism for establishing schedules for SST closure actions including retrievals. Ecology is aware of plans by DOE to conduct closure actions (retrievals) on SSTs in the near future outside of an approved schedule (i.e., C-200 series SSTs) in the HFFACO. If that is the case, DOE must include these actions in the appropriate sections of this closure plan. Schedules for all closure actions are required as part of a closure plan; however the HFFACO M-45 closure milestones can be incorporated by reference into the SST closure plan. There is no need for yet another process to document closure activities/schedules. All closure actions must be scheduled/approved through the closure plan and/or the HFFACO incorporated by reference. Revise the text to include the above requirements. Requirement: WAC 173-303-610(3) *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #10 (DH)
DH-27	Section 6.0	Revise the section to reduce the text discussing the M-45-06-T20A "Implementaton Plan" down to one subsection basically describing the plan as a potential planning tool. Requirement: WAC 173-303-610(3) *Response: Reduced discussion of implementation plan in Section 6.0.*	Closed
DH-28	Section 6.0, Page 6-2	Lines 4-7. Although the HFFACO establishes a high-level schedule for overall SST closure actions, it also includes specific closure actions such as retrieval schedules and requirements for SSTs such as Retrieval Functions and Requirements document milestones found in the attached Table 6-1. Revise the text to clearly indicate that the HFFACO is an agreed-to mechanism for scheduling closure actions and that these actions, including retrievals, will be incorporated by reference in the SST closure plan permit and will be subject to SST closure plan requirements. Requirement: WAC 173-303-610(3)	Hold
DH-29	Section 8.0, General	Missing is the contingent post closure plan or a schedule to supply the plan. Provide either the plan or a schedule to provide the plan in the near future. **TIMING CONDITION?** Requirement: WAC 173-303-640(8)(C)(ii) *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #10 (DH)
JC-18	Page 8-1 Line 4	Given the conditions of the Central Plateau with a thick vadose zone and deep water table in the unconfined aquifer, vadose zone monitoring during the post-closure period should be an optional consideration.	

Comment Number	Position in Document	Comment/Response	Comment Closure Date
JC-19	Page 8-2 Lines 2-4	Page 8-2, Lines 2-4. The current groundwater monitoring plan for each WMA is for compliance with requirements for monitoring of a TSD facility. As part of LDMM during waste retrieval operations to assess any potential impacts of waste retrieval to groundwater, consideration should be given to supplemental groundwater monitoring; i.e., a change in the constituents monitored and the frequency of monitoring. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #6
DH-30	Framework, Addendum 2, HWMA Compliance Matrix	The HWMA Compliance Matrix of Addendum 2 has omitted all groundwater regulatory cites of WAC 173-303-645. All applicable cites must be added. Specifically, applicable standards (i.e., requirements) associated with WAC 173-303-645(1), -645(2), -645(3), -645(4), -645(5), 645(6), -645(7), -645(8), -645(9), -645(10), and -645(11) must be included in the matrix. Also list all the general operating requirements + Air (or omnibus for air) Alternatively, DELETE this matrix if not needed HOLD FOR Internal Decision If deleted – we must cross walk a corrected matrix compared to the closure plan text to be requirements in the matrix are also covered in the text. Jean Vanni has a corrected version of the matrix. Idaho DEQ said this matrix has been used for Part B RCRA permits at INEEL to address contingency requirements.	Action List #13 (DH)
AH-26	Framework, Addendum 2, HWMA Compliance Matrix	The HWMA Compliance Matrix of Addendum 2 has omitted all groundwater regulatory cites of WAC 173-303-645. All applicable cites must be added. Specifically, applicable standards (i.e., requirements) associated with WAC 173-303-645(1), -645(2), -645(3), -645(4), -645(5), 645(6), -645(7), -645(8), -645(9), -645(10), and -645(11) must be included in the matrix. **ECOLOGY AND DOE CONSIDERING DELETING THIS TABLE ???? REGULATORS IN IDAHO REQUIRED THIS FOR THEIR SITE — I plan to discuss this with Idaho regulators to try to understand why they required it???** AH/DH	Action List #13 (DH)
MJB-24	Addendum 2 HWMA Compliance Matrix, p. Addendum 2-11	WAC 197-11-100(1) The approach to SEPA compliance listed in the matrix, to submit an environmental checklist for any proposed system closure, does not provide sufficient analyses of the cumulative, long-term impacts of component/waste management area/tank farm closures. The *Tank Closure Environmental Impact Statement* is presumed to contain sufficient analyses of the impacts of closing all of the components, WMAs, and tank farms. The USDOE Office of River Protection assumes incorrectly that Ecology has determined that each proposed closure action is singular. Ecology deems the individual closures as related actions (see WAC 197-11-060(3)(b). To prepare environmental checklists for each closure action that do not address the cumulative impacts of the closures is prohibited by WAC 197-11-060(5)(d)(iii). *Response: Addendum was deleted.*	Closed pending resolution of Action #13

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-25	HWMA Compliance Matrix, p. Addendum 2-11	Please add the following references: WAC 197-11-060(4) Impacts, WAC 197-11-060(5) Phased review (d), WAC 197-11-070 Limitations on actions during the SEPA process (1) through (4). *Response: Addendum was deleted.*	Closed pending resolution of Action #13
DH-31	Framework	**General Requirements – hold for additional NOD(s)** ???????????? *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #9 (Ecology)
		Appendix C WMA C Closure Action Plan	
JC-20	General Comment	A strategy for characterization and closure of all pipelines within and between SST farms, including the development of closure performance standards for all pipelines needs to be developed so that all pipelines, when closed through whatever process and whatever schedule, will conform to the same performance standards. *Response: Text revised in Section 1.3, 3.1, 3.2, and 3.4 of Framework Closure Plan.*	CLOSED 12/10/03 Parking Lot #8 CLOSED 12/12/03 Action List #17 (ORP/CH)
JC-21	General Comment	While it is assumed that SST WMAs will be closed as landfills, an evaluation of the clean closure alternative is required. A Tier 1 Risk Assessment that addresses worker safety as well as environmental threats should be conducted, with the resultant conclusion applicable to all tank farms and WMAs. Such an activity would also streamline the process so that this decision does not have to be made for each and every tank farm and component thereof. *Response: Revised text in Section 1.3.3 of Framework Closure Plan and Section C1.0 of WMA Closure Action Plan sufficiently addresses concern of commentor.*	Closed
JC-22	General Comment	If landfill closure is selected, decommissioning of all wells that may be buried by the barrier must be included in the closure activities for this (and other) WMAs. *Response: Inserted text in Section 3.1 of Freamework Closure Plan citing WAC 173-360-460.*	Closed
AH-27	Section C1.0	Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan, it is recommended that WAC 173-303-645 requirements be cited in Section C1.0. Insert the following sentence in the third paragraph between the first and second sentences: **"Due to unremediated releases from the WMA C and agreements made via the *Hanford Federal Facility Agreement and Consent Order* (HFFACO), the groundwater monitoring requirements of WAC 173-303-645 are also applicable."** AH *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4 (ORP/CH)

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-35	Section C1.0, first paragraph	Provide a reference to a list of WMA C components which are covered by this portion of the closure plan. *Response: Inserted suggested text in Section C.1.*	CLOSED
MJB-C1	Sec. C1.0, ¶ 1, p. C1-1, Sec. C2.0, ¶ 1. p. C2-1	Both locations state that WMA C is generally coincident with fence line of the 241-C Tank Farm. Aside from obvious references to the groundwater that moves beneath the farm, it is not apparent what other solid waste management units or other facilities and equipment are outside of the C Farm that would be included in the WMA. Please specify what part of WMA is not coincident with the C Farm. Please explain why the USDOE proposes to permit that non-coincident area with the WMA C. *Response: Modified text in Sections C1.0 and C2.2 to clarify boundary of WMAs and where closure actions for components outside those boundaries will be discussed.*	Closed
DH-32	Section C1.0 Page C1-1	Lines 14-15. Explain the statement: "This document in its final form, will be submitted as the closure action plan for that purpose." Explain which document is being referenced. Ecology assumes the referenced document is the WMA-C portion (Addendum C1) of the SST closure plan. This statement contradicts the purpose of the existing Addendum C1 of the SST closure plan. If the purpose of this "document" is other than as a closure action plan, please state the purpose. Requirement WAC 173-303-610(3) and 640(8) *Response: Deleted sentence.*	Closed
MJB-C2	Sec. C1.0, ¶ 2	Text states that closure of the WMA C will include disposition of all components including any corrective measures required for soil or groundwater. Please explain what corrective measures will be taken to disposition soil and groundwater. *Response: Added text to indicate that corrective measures will be selected to meet performance objectives.*	Closed
DH-33	Section C1.0, Page C1-1	Line 16. Insert the word "clean" between "with" and "closure". Requirement: WAC 173-303-640(8) *Response: Added text.*	Closed
DH-34	Section C-1.0, Page C1-1	Line 21. Insert the following text after "...commitment...": "...and after it has been demonstrated by DOE to not be practicable to achieve clean closure for either soil or tank/ancillary equipment or both." Requirement: WAC 173-303-340(8) *Response: Added text.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-36	Section C1.1, first bullet	Please revise the text to read: "DOE submits this closure action plan to support the following: • Closure in accordance with WAC 173-303-610 TSD closure and post-closure requirements • The concurrent closure activity for the tank 241-C-106 (C-106)..." *Response: Added suggested text.*	CLOSED
BBK-37	Section C1.1, first paragraph	Please revise the text to read: "DOE expects that information gaps will be filled by successive revisions of this closure action plan as component closure activities generate data and reduce the uncertainties. DOE will not propose closure of WMA C until all associated components have been addressed pursuant to component closure activity plans ~~or alternative documentation (such as corrective measures, *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) Action Memoranda or Records of Decision [ROD]),~~ approved through modifications to the Site-Wide Permit."	
AH-28	Section C1.1	Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan, it is recommended that the HFFACO agreement to monitoring groundwater in relation to SSTs be identified as a bullet in Section C1.1. Insert the following bullet in Section C1.1 after the third bullet: **"HFFACO Milestone M-24-00, which specifies groundwater monitoring will occur in relation to the SSTs."** AH *Response: Added suggested text.*	CLOSED
DH-35	Section C1.2	Groundwater monitoring authorities and Rad issue **HOLD FOR INTERNAL REVIEW** *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4 (ORP/CH) Action List #21 (DH)
AH-29	Section C1.2	Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan, it is recommended that WAC 173-303-645 requirements be cited in Section C1.2. Specifically, identify that groundwater monitoring requirements in the second paragraph so that the text reads as: **"The HFFACO establishes that WMA C and the balance of the SST system will be closed in accordance with WAC 173-303-610, WAC 173-303-645, and the HFFACO Milestone M-45 series."** AH *Response: Added "WAC-173-303-645" to text.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-38	Section C1.2, third paragraph	The HFFACO establishes that WMA C and the balance of the SST system will be closed in accordance with WAC 173-303-610 and the HFFACO Milestone M-45 series. Closure will be carried out at the WMA level. Thus, the requirements for certification of closure, and-for potentially postclosure care, a contingent for landfill closure, will apply to WMA C and ultimately will be addressed in this closure action plan...." *Response: Revised text as suggested.*	CLOSED
BBK-39	Section C1.2, fourth paragraph	Please revise the text to read: ".....(as defined by the *Atomic Energy Act of 1954* [AEA]) has been incorporated into the Site-Wide Permit, it is not incorporated for the purpose of regulating such components under the authority of this the Site-Wide Ppermit and the HWMA. To the extent that *Resource Conservation and Recovery Act of 1976* (RCRA)/HWMA requirements are inconsistent with requirements under the AEA...." *Response: Revised text as suggested.*	CLOSED
BBK-40	Section C1.3	Please revise the text to read: "....DOE has developed a tiered structure of documentation to integrate the various component closure activity plans, closure action plans, and into the Site-Wide Permit, as shown in Figure C1-1...." *Response: Added suggested text.*	CLOSED
JC-23	Page C1-3 Section C1.3.2	As this is a RCRA TSD and includes contaminated groundwater, here or somewhere the satisfaction of RCRA requirements for closure need to be spelled out, considering that the groundwater beneath WMA C will be closed as part of the 200-PO-1 groundwater operable unit. *Response: Revised text in C4.2.3, C4.2.4, and C4.2.6 sufficiently address commentor's issue.*	Closed
MJB-C3	Sec. C1.3.2, p. C1-3	In Sentence 1, the text states that component closure activity plans will be submitted. In Sentence 2, contradictory information states that component closure activity plans or equivalent decision documents will be developed consistent with the WMA strategy for closure. Please clarify whether the component closure activity plans will be replaced by "equivalent decision documents" for certain components and what those components will be. *Response: Text added for BBK-40 resolves commentor's issue.*	Closed
BBK-41	Section C1.3.2	Please revise the text to read: "DOE intends to submit component closure activity plans (tier 3) for the various components of WMA C, such as individual or groups of tanks, ancillary equipment, soil, and groundwater. The component closure activity plans, or equivalent decision documents, will be developed to be consistent with the overall WMA strategy for closure. Each approved component closure activity plan will become an attachment to this WMA C Closure Action Plan." *Response: Partially accept. Added the following text to end of paragraph "If equivalent documents are used they will be approved through incorporation into the Site-Wide Permit ".*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-36	SectionC1.3.2, Page C1-3	Line 15. Revise the text to indicate that if DOE intends to submit closure activity plans group tanks, the tank histories/waste knowledge, condition, structure of the tanks must be adequate to allow the tanks to be treated in a similar fashion. Requirement: WAC 173-303-610	Closed – Comment Withdrawn
AH-30	Section C1.3, Figure C1-1	The titles of the Tier 3 documents are not legible. Include an identification, by document title, in Section C1.3 of each document that is designed to be used to support closure of WMA C. The significance of this may be considered in relation to groundwater monitoring. The Hanford Site has many mechanisms for reporting groundwater monitoring information. For completeness, the Tier 2 closure plan must identify all sources (by title or description) where groundwater information may be obtained and which are intended to be used to satisfy *Washington Administrative Code* (WAC). For example, it is assumed that several sources of information would include: quarterly groundwater reports for WMA C, annual groundwater reports for WMA C, vadose zone characterization reports for WMA C or any WMA C tank, the Hanford Environmental Information System (HEIS) database, etc.	Hold
AH-31	Section C1.3.3	The last sentence of Section C1.3.3 indicates that postclosure requirements will be incorporated into Part VI should landfill postclosure requirements be required for WMA C. The text implies that postclosure care and/or monitoring will not be conducted for SST system components that have been closed until the entire WMA is closed. The Tier 2 document must clearly identify that until a closure decision is made for the entire WMA C, the closed component will be managed and monitored as an "active portion" as defined by WAC 173-303-040. This is especially relevant as the WMA closure decision may not be made for years after SST components have been closed. The Tier 2 document must include a detailed description of how the SST component will be managed and monitored after the SST component has been closed and before the WMA closure decision is made. Revise the text to reflect these concerns. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4 (ORP/CH)
JC-24	Page C2-3 Figure C2-2	The following should be added to this figure: 1) the date that the direction of groundwater was determined, 2) the assumed leaking tanks as identified in Hanlon, and 3) the identification and location of all Unplanned Releases, including the areas affected by these leaks. *Response: 1) will add date to groundwater flow direction arrow on Figure C2-2., 2) will shade Hanlon-designated leaker and footnote to Figure C3-1 (for UPR locations) with associated text information on Figure C3-1, and 3) UPR locations in Figure C5-1 sufficient.* *Inserted text in Section C2.1 to direct reader to figure in Section C5.0.*	CLOSED 12/12/03 Action List #45
BR-13	Figure C2-2, p. C2-3	Some sites that were referred to in the History of WMA C section should be added to this figure: 202A building, 244AR vault, and 244A lift station. If these locations are outside the map area then add arrows pointing in their relative directions. *Response: Figure revised to reflect suggested text.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-38	Section C2.0, general	Although some information was provided regarding the status of certain components, missing is a description of the status of each transfer line listed. Include a schedule to provide the missing details such as line material/construction, location map, general history of use, interconnecting components, reason for being removed from service (i.e., plugging, line leakage). Also if a line leaked, provide information on waste type, volume, associated UPR number, etc. Requirement: WAC 173-303-610, 640	Action List #31 (DH)
AH-32	Section C2.0, Page C2-6, Paragraph 3	The third paragraph defines interim stabilized as meaning the tank "now contains less than 189,250 L (50,000 gal) of drainable interstitial liquid and less than 18,925 L (5,000 gal) of supernatant liquid". The word "now" implies a measurement made in time. The description of the interim stabilized state should include an identification that over time, liquid drains out of the solid waste. While it is recognized that the Tier 2 document include a date of the interim stabilized state designation (HNF-EP-1082 2003), the Tier 2 document should include a description of how the drainable liquid will be measured on a periodic basis to ensure that the interim stabilized designation is still applicable. Also, the Tier 2 document should include a description of actions to be taken in the event that the interim stabilized liquid volume criteria is exceeded and the tank is no longer considered interim stabilized. Revise the document to reflect these concerns. *Response: Added text to Section C2.0 regarding quarterly volume measurements.*	Closed
MJB-C4	Sec. C2.1, pp. C2-8 & 9	A bulleted description of each of the 14 unplanned release (UPR) sites is included on these pages; however, they do not appear as components on Table C2-2. Earlier descriptions of the WMA C closure (see p. C1-1) state that disposition of all components including corrective measures required for soil contaminated with dangerous waste or dangerous waste constituents will be included. Ecology must assume that the unplanned release sites where dangerous waste was released have become components by these statements. Please add the dangerous waste UPR sites to Table C2-2. *Response: Added sentence to sixth paragraph of C2.1 specifying that UPRs associated with the soil component and will be addressed during investigation and cleanup.*	Closed
DH-40	Section C2.2, Page C2-9, Paragraph 1	In Section C2.2, page C2-9, the first paragraph identifies that the component list (which constitutes Table C2-2) "represents units listed on the RCRA Part A, Form 3 permit application". The RCRA Part A, Form 3 permit application has undergone numerous revisions. Include a revision number associated with the RCRA Part A permit. *Response: Added Part A revision number to text.*	Closed
DH-41	Section C2.2, Page C2-9	Lines 29-36. Provide additional text referencing Section C4.2 and related subsections. Section C4.2 provides further detail regarding the scope of WMA C closure actions. Also revise the text to indicate this section describes a very general picture (overview) of WMA C closure actions. Response: Changed section C2.2 title and added suggested text to end of paragraph. *Response: Revised text as suggested.*	CLOSED 12/10/03

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-42	Section C2.2, Page C2-10	Lines 1-2. Either provide the regulatory designation of the other components, or a schedule to provide designations. *Response: Sentence deleted.*	Closed
DH-43	Table C2-2, Page C2-10	Revise the table to include the current status of each component, (i.e., estimated waste remaining in each component - liquid s. solid). Include information regarding the type and thickness of material used to construct lines/tanks. Also indicate if a tank or line has plugged or leaked in the past. A schedule to provide this information may be used.	Action List #31 (DH)
JC-25	Page C2-9 Last 2 lines	Explain and justify why the diversion boxes are RCRA waste piles. Diversion boxes fit the definition of Ancillary Equipment in WAC 173-303-040 and will be treated as such by Ecology. *Response: Text was deleted per earlier comment from Section C2.2.*	Closed
AH-33	Section C3.0, Paragraph 1	Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan, the first sentence of the first paragraph of Section C3.0 should identify that groundwater monitoring requirements are applicable to WMA C. Include the following text: **"In accordance with closure requirements outlined in WAC 173-303-610(3)(a)(vi) and the HFFACO, this section describes groundwater monitoring requirements and activities associated with WMA C."** *Response: Revised text as suggested.*	Closed
AH-34	Section C3.0, Bullet 5	The fifth bullet in Section C3.0 indicates that only "recent" groundwater sampling results are described and/or discussed in the Tier 2 document. As the groundwater monitoring network only consists of seven wells and the sampling time frame does not span decades, the description and discussion should not be limited to "recent" groundwater sampling results. Delete the word "recent" from the fifth bullet. *Response: "recent" deleted from fifth bullet*	CLOSED
JC-26	Page C3-1 Reference to Figure C2-2	The sentence states that, "As shown on Figure C2-2, seven RCRA groundwater monitoring wells are located outside the WMA C fenceline." Fig. C2-2 shows only five groundwater monitoring wells. *Response: Changed text to "nine" and will revise Figure to show new wells.*	Closed
AH-35	Section C3.1, Page C3-2	Section C3.1, page C3-2, states: "Changes in the monitoring program status will be documented in modifications to the WMA C RCRA groundwater monitoring plan (PNNL-13024, PNNL-13024 ICN-1)." The text should include a description of a process by which changes will first be approved by Ecology prior to implementation. The description of the process should also include a description of how the closure plan will be modified administratively. In other words, the closure plan should include reference to WAC 173-303-830 with an indication that the permit modification process as codified by WAC 173-303-830 will be followed for making changes in the monitoring program and/or monitoring network. Revise the text to include the above stated recommendations. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #5 (ORP/CH)

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-36	Section C3.1, Page C3-2	Section C3.1, page C3-2, states: "Prior to closure of WMA C, a postclosure groundwater monitoring plan will be developed." As indicated previously, the Tier 2 document should identify that the time after SST component closure and before WMA C closure, the closed SST component is considered "active portion" as defined by WAC 173-303-040. As the time between SST component closure and WMA C closure may be significant, the Tier 2 or Tier 3 document should include a detailed description of how the closed SST component will be managed and monitored until the closure decision for the WMA C is made. Revise the text to include these recommendations. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4 (ORP/CH)
AH-37	Section C3.1, Page C3-2	Section C3.1, page C3-2, states: "Prior to closure of WMA C, a postclosure groundwater monitoring plan will be developed." The text should identify that the plan developed will be approved by Ecology and the SST component closure plan will be modified via the WAC 173-303-830 process. Provide additional text to clearly indicate by permit (closure plan) modification, the postclosure groundwater monitoring plan will be incorporated into the closure permit. *Response: Inserted the following text at the end of the paragraph "The plan must be approved by Ecology and modified through the WAC 173-303-830 process."*	Closed
AH-38	Section C3.1, Page C3-2	Section C3.1, page C3-2, states: "Postclosure groundwater monitoring will be integrated with the Central Plateau regional groundwater monitoring system." As commented on in my October 8 memorandum, certain postclosure groundwater monitoring activities are required by WAC 173-303-645 to be conducted on a WMA-specific-by-WMA-specific basis. Such monitoring represents fundamental RCRA groundwater monitoring requirements to determine a unit's impact on groundwater quality at the regulatory-defined point of compliance. Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan, include a citation of WAC 173-303-645 requirements in Section C3.1. *Response: Inserted " in compliance with WAC 173-303-645" in fourth paragraph, second sentence.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-39	Section C3.2, Page C3-2	Section C3.2, page C3-2, states: "Geologic and hydrologic data obtained from these wells are adequate for inferring generalized stratigraphy and groundwater conditions below WMA C..." The statement could be interpreted to imply that Ecology has made a compliance determination in relation to the WMA C. This is not the case. During 2000, Ecology performed a Comprehensive Groundwater Monitoring Evaluation (CME) of the T and TX-TY Tank Farm Groundwater Monitoring Networks. Ecology issued a 34 page report of the CME dated March 1, 2001 entitled "Comprehensive Groundwater Monitoring Evaluation Report T and TX-TY Tank Farm Groundwater Monitoring Networks March 1, 2001". The CME report included findings and conclusions as well as recommendations. Since then, there have been no other CMEs performed at the Hanford Site. Due to the possible incorrect interpretation of the quoted statement, the statement should be re-written. Revise the text as follows: **"Geologic and hydrologic data have been obtained from these wells from which generalized stratigraphy and groundwater conditions below WMA C may be inferred. However, Ecology has not performed a RCRA Comprehensive Groundwater Monitoring Evaluation (CME) of the WMA C and therefore, has made no compliance determination regarding the adequacy of the existing groundwater monitoring system to satisfy WAC 173-303-645 requirements. However, it may be concluded that the *existing WMA C groundwater monitoring network does not provide* component-specific monitoring information that would allow an identification of potential distribution and movement of contaminants directly below the individual components of WMA facilities."** *Response: Changed "adequate" to "used" in first paragraph of Section C3.2 to remove inference that an Ecology compliance determination has been made.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-40	Section C3.2	During year 2000, Ecology performed a Comprehensive Groundwater Monitoring Evaluation (CME) of the T and TX-TY Tank Farm Groundwater Monitoring Networks. Ecology issued a 34 page report of the CME dated March 1, 2001 entitled "Comprehensive Groundwater Monitoring Evaluation Report T and TX-TY Tank Farm Groundwater Monitoring Networks March 1, 2001". The CME report included findings and conclusions as well as recommendations. Due to the significance of the deficiencies associated with the T and TX-TY WMAs, the Tier 2 document should identify that those deficiencies associated with the T and TX-TY WMAs that are similar to the WMA C will be addressed by the approved closure plan. This statement should be placed in Section C3.2. Revise the text as follows: **"It is acknowledged that a RCRA CME of the T and TX-TY WMAs was performed by Ecology. It is also acknowledged that certain groundwater monitoring network and groundwater monitoring program deficiencies were noted in the resulting report that are also applicable to the WMA C groundwater monitoring network and groundwater monitoring program. Specifically, the following deficiencies noted in the T and TX-TY tank farm CME report are also applicable to the WMA C groundwater monitoring network and program: inadequate groundwater monitoring well spatial coverage at the point of compliance and inappropriate collection of filtered samples (without demonstration of representative metal concentration measurement). These deficiencies will be addressed by this closure plan."** *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #5 (ORP/CH)
AH-41	Section C3.2, Last Sentence	The last sentence of the Section C3.2 paragraph states: "Elevation values contained in Section C3.2.1 are based on the North American vertical datum of 1988." Due to the significant difficulties associated with determining groundwater flow direction in the vicinity of the WMA C, either delete the sentence or include a statement that references where in the closure plan the reader may better understand the difficulties associated with obtaining a groundwater flow direction due to the flatness of the hydraulic gradient (i.e., Section C3.2.2). *Response: No change required. Discussed with commenter the purpose of using the NAVD88 datum in closure action plan.*	Closed
AH-42	Section C3.2, Page C3-3	Section C3.2, page C3-3, it is indicated that the stratigraphic data of Table C3-1 "should only be used as estimates until refined through possible future characterization activities". The closure plan should identify if there are plans for future characterization activities. Furthermore, if the future characterization activities are to be applied to WMA C to satisfy groundwater monitoring requirements of WAC 173-303-645, the text should also indicate the future characterization activities will occur after Ecology's approval and will be reflected in either or both a modified closure plan or/and modified closure plan permit conditions. Revise text per recommendation. *Response: No change required. Referred commenter to Section C3.5.5 for existing text identifying future WMA C characterization activities.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-43	Section C3.2.2, Page C3-5, Paragraph 1	The first paragraph of Section C3.2.2, page C3-5, provides depth-to-groundwater measurements collected for only one date (June 25, 2002). Depth-to-groundwater measurements should be provided for a range of time. Since the five WMA C groundwater monitoring wells were installed, the Tier 2 document should include a discussion of depth-to-groundwater measurements . Providing only one measurement does not adequately describe the hydraulic gradient in the vicinity of the WMA C. Section C3.2.2 should include sufficient number of depth-to-groundwater measurements for the reader to understand if the depth-to-groundwater is static. Furthermore, if the depth-to-groundwater is increasing, information should be provided to indicate the "life" of the existing groundwater monitoring wells. In other words, if the groundwater table is receding, information should be provided which describes that condition. Also, if the groundwater table is receding, linear regression calculations and future approximations should be provided for each groundwater monitoring well. Provide additional text to accommodate the above recommendations. *Response: Inserted suggested text.*	Closed
AH-44	Section C3.2.2, Page C3-5, Paragraph 5	The fifth paragraph of Section C3.2.2, page C3-5, describes the difficulty in determining groundwater flow direction due to the nearly flat hydraulic gradient below WMA C. The sixth paragraph of Section C3.2.2, page C3-5, *indicates the groundwater flow direction is expected to continue to change.* Groundwater flow direction and monitoring to determine groundwater quality impacts are fundamental RCRA WAC 173-303-645 requirements. The section should include a detailed description of how groundwater flow directions in the vicinity of the WMA C will be determined. In addition, the section should indicate that future groundwater flow direction determinations not described in this closure plan will occur after Ecology's approval and will be reflected in either or both a modified closure plan or/and modified closure plan permit conditions. Revise the text to address the above concerns. *Response: Groundwater monitoring issues will be resolved through the drafting of permit conditions.*	Parking Lot #5 (ORP/CH) CLOSED 12/12/03 Action List #15 (AH&JC)
AH-45	Section C3.2.2, Page C3-5, Paragraph 7	The seventh paragraph of Section C3.2.2, page C3-5, indicates that groundwater flow rates beneath WMA C were derived. Closure plans and permits are considered "stand alone" documents. This is to say that the information provided in the document is complete and does not require other documents to be reviewed to determine what is being provided. As various hydraulic conductivities were used from various published values, the derivation, including all values used, should be included in this Tier 2 document. Provide this missing information. *Response: Groundwater monitoring issues will be resolved through the drafting of permit conditions.*	Parking Lot #5 (ORP/CH) CLOSED 12/12/03 Action List #15 (AH&JC)
AH-46	Section C3.2.3, Page C3-6, Last Paragraph	The last paragraph of Section C3.2.3, page C3-6, indicates that clastic dikes were observed in C farm during construction. Identify if any more information (i.e., mapping, observations, etc.) is available regarding clastic dikes in the vicinity of WMA C or 200 East Area. Response: Added text to paragraph six of Section C3.3 indicating that the effects of clastic dikes on contaminant transport are not established.	CLOSED 12/10/03 Action List #16 (Freestone)

Comment Number	Position in Document	Comment/Response	Comment Closure Date
JC-27	Page C3-7 Paragraph 2	The effect of leaking water (and other) lines and the location of UPRs should be mentioned here. *Response: In Section C3.3 added text to indicate leaking water and other water sources accelerate transport.*	Closed
JC-28	Page C3-7 Paragraph 3 Last sentence	There is "...no direct evidence of contaminant migration along a clastic dike in WMA C." However, there is also no direct evidence that clastic dikes have not affected contaminant fate and transport. Provide a basis for this statement or delete. *Response: Revised text in referenced sentence.*	Closed
AH-47	Section C3.3, Page C3-7, Last Sentence	The last sentence of the first paragraph on page C3-7, Section C3.3, should identify the scenario as a conceptual model. Provide the following additional text: **"Therefore, via this generalized conceptualization (that has not been validated in the vicinity of WMA C), potential impacts to the groundwater from contaminant sources would likely occur near the source."** *Response: Added "is an overview that" to to first paragraph of Section C3.3. New text implies that conceptual model discussed in Closure Action Plan is intended to be a general overview – not a refined conceptual model that has undergone validation.*	Closed
AH-48	Section C3.3, Page C3-7	The first sentence of the last paragraph in Section C3.3, page C3-7, references Section C3.5.5 as discussing the planned characterization activities for WMA C. The correct section to reference is: Section C3.4.3. *Response: Revised text as suggested.*	Closed
JC-29	Page C3-9 Section C3.4.2	This section provides little information about contaminant distribution with depth in WMA C, including the fact that Co-60 has shown at least 12 ft. of downward movement in borehole 30-06-10 in a period of some 8 years at depths well below the bottom of the C-106 tank. *Response: Text inserted in Section C3.4.2.*	CLOSED 12/12/03 Action List #46
AH-49	Section C3.4.3, Page C3-10	This section should include a detailed description of the additional vadose zone characterization that is planned for FY 2004. Similarly, the same section should include a detailed description of how the vadose zone will be characterized during the drilling and installation of the new groundwater monitoring wells. It is noted that Section C3.3.3 does not include a description of how additional vadose zone characterization outside the WMA C fenceline will be conducted as implied by the last sentence in Section C3.4.3. Provide additional text to address the above concerns. *Response: Inserted additional text in Section C3.4.3.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-50	Section C3.4.3, Page C3-10	This section should also include a description of how vadose zone characterization will be approved by Ecology prior to implementation. Furthermore, the description of the process should identify how the closure plan will be modified administratively. In other words, the closure plan should include a reference to WAC 173-303-830 with an indication that the permit modification process as codified by WAC 173-303-830 will be followed for making changes in the RCRA corrective action characterization activities in the vicinity of WMA C. Provide additional text to address these concerns. *Response: Added "information obtained subsequent to preparation of this closure action plan will be documented in a RFI report pursuant to HFFACO M-45-55." to second paragraph of Section C3.4.3.*	CLOSED
JC-30	Page C3-10 Section 3.4.3	Fails to mention the work plan addendum for characterization of the soils and groundwater associated with WMA C as is currently being planned and implemented. *Response: Added reference to Addendum in Section C3.4.*	Closed
AH-51	Section C3-5, Page C3-10	This section should explain that the minimum interim status requirements for a groundwater monitoring network are one upgradient and three downgradient groundwater monitoring wells. The section should also identify that, to date, Ecology has not performed a RCRA CME for the WMA C to determine if the WMA C is compliant with interim status groundwater monitoring requirements. The significance of this acknowledgement is related to 1) the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan, and 2) the deficiencies associated with the T and TX-TY WMA's groundwater monitoring networks and programs noted during the RCRA CME associated with those WMAs. As identified previously, certain groundwater monitoring network and program deficiencies associated with the T and TX-TY WMAs are also applicable to the WMA C (i.e., inadequate groundwater monitoring well spatial coverage at the point of compliance and inappropriate collection of filtered samples (without demonstration of representative metal concentration measurement)). Provide additional text to address the above concerns. *Response: Groundwater monitoring issues will be resolved through the drafting of permit conditions.*	PLOT 4 CLOSED 12/12/03 Action Item #15
AH-52	Section C3.5, Page C3-10	This section should identify and describe the Ecology letter regarding "C Single-Shell Tank (SST) Farm Waste Management Area (WMA) Resource Conservation and Recovery Act Groundwater Monitoring" dated October 11, 2000 addressed to M. Thompson (USDOE) from D. Goswami (Ecology) and M. Brown (Ecology) in which Ecology acknowledged technetium-99 contamination increases in WMA C groundwater monitoring wells. Section C3.5 should also identify that due to the increased technetium-99 contamination increases in WMA C groundwater monitoring wells, Ecology requested USDOE to conduct quarterly monitoring. Provide additional text to address the above stated concerns. *Response: Ecology/ORP developed text for insertion into Section 2.3 of C-106 Closure Activity Plan.*	CLOSED 12/12/03 ACTION ITEM #33

Comment Number	Position in Document	Comment/Response	Comment Closure Date
JC-31	Page C3-10 Section C3.5.1	New RCRA groundwater monitoring wells have been installed at WMA C, but are not mentioned here. *Response: Revised table C3-2 and added text to footnote.*	CLOSED 12/12/03 Action List #47
AH-53	Section C3.5.1, Page C3-10, Paragraph 1	The first paragraph of Section C3.5.1, page C3-10, indicates that additional wells will be installed to provide upgradient and downgradient coverage of WMA C. Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan, specify the RCRA requirement (i.e., WAC 173-303-645(8)(a)). *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4
AH-54	Section C3.5.1, Page C3-10, Paragraph 1	The third sentence of the first paragraph of Section C3.5.1, page C3-10, states: "In order to comply with RCRA requirements, additional wells will be installed to provide upgradient and downgradient coverage of WMA C." The sentence could be interpreted to mean that the existing WMA C groundwater monitoring network is out of compliance. The paragraph should identify that Ecology has not performed a RCRA Comprehensive Groundwater Monitoring Evaluation (CME) of the WMA C and therefore, has made no compliance determination regarding the adequacy of the existing groundwater monitoring system to satisfy WAC 173-303-645 requirements. The paragraph should also identify that it may be concluded that the inadequate groundwater monitoring well spatial coverage at the WMA C point of compliance does not currently satisfy WAC 173-303-645(8)(a) (i.e., the current groundwater monitoring network is inadequate in that it does not allow a determination of WMA C's impact on groundwater quality at the WMA C point of compliance). Revise the text to address the above concerns. *Response: Modified text in Section 3.5.1 to acknowledge new well placement to improve upgradient and downgradient coverage.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-55	Section C3.5.1, Page C3-10, Paragraph 1	The third sentence of the first paragraph of Section C3.5.1, page C3-10, states: "In order to comply with RCRA requirements, additional wells will be installed to provide upgradient and downgradient coverage of WMA C." The sentence could be interpreted to mean that the existing WMA C groundwater monitoring network is out of compliance. Approximately two years ago and as part of Milestone M-24 negotiations, Ecology provided USDOE a table which identified the number of wells that would be appropriate to install at the WMA C point of compliance to satisfy WAC 173-303-654(8)(a). This table represented a compilation of Hanford Site well needs. The well needs were based on conservative well spacings due to a lack of field-confirmed site-specific modeling input parameters. To further explain, Ecology issued a letter regarding "Monitoring Efficiency Model (MEMO) as Applied to Single-Shell Tank (SST) Farm Waste Management Areas (WMAs)" dated October 13, 2000 addressed to M. Thompson (USDOE) from D. Goswami (Ecology). The letter explained Ecology concerns with the MEMO model's application. The letter also described comparison of MEMO model well spacings and groundwater contaminant observations at two locations. The letter concluded: "Until such time that MEMO output can be validated by the comparison of field-confirmed site-specific input parameters (i.e., transverse dispersion coefficients, longitudinal dispersion coefficients, source concentrations, seepage velocities, etc.) and groundwater contaminant observations, Ecology will promote usage of conservative input parameters and/or the reliance upon closer well spacings." Section C3.5.1 should include 1) an identification of Ecology's October 13, 2000 letter, 2) a discussion of the MEMO model, 3) an acknowledgement of the number of wells that Ecology considered needed to satisfy WAC 173-303-645(8), and 4) any field-confirmed WMA C-specific MEMO model input parameters obtained during the last one and a half years. Revise the text to address these concerns. *Response: Revised text in Section C3.5.1*	CLOSED 12/10/03 Action List #34 (Freestone)
AH-56	Section C3.5.1, Page C3-10, Paragraph 1	The third sentence of the first paragraph of Section C3.5.1, page C3-10, states: "In order to comply with RCRA requirements, additional wells will be installed to provide upgradient and downgradient coverage of WMA C." The sentence could be interpreted to mean that the existing WMA C groundwater monitoring network is out of compliance. If field-confirmed WMA C-specific MEMO model input parameters are not available, Section C3.5.1 should include a detailed description of the process that will be followed to provide a technical basis for the groundwater monitoring well spatial coverage at the WMA C point of compliance. In addition, if an inadequate technical basis exists to justify the proposed spatial coverage at the WMA C point of compliance (i.e., field-confirmed WMA C-specific MEMO model input parameters are not available), Section C3.5.1 should also include a description of how changes will be made to the groundwater monitoring network in the future. Specifically, Section C3.5.1 should identify that the closure plan modification process as codified by WAC 173-303-830 will be followed. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #5

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-57	Section C3.5.1, Page C3-10, Paragraph 1	The first paragraph of Section C3.5.1, page C3-10, indicates that details of the existing groundwater monitoring network are discussed in another document. Details regarding the groundwater monitoring network and program are required to be discussed in the closure plan (see WAC 173-303-610(3)(a)(vi)). In other words, the closure plan is intended to be a "stand alone" document and must include a detailed description of activities necessary to ensure that all partial and final closures satisfy the closure performance standards including groundwater monitoring. Provide additional text to address these concerns. *Response: Groundwater monitoring issues will be resolved through the drafting of permit conditions.*	CLOSED 12/12/03 Action Item #15
AH-58	Section C3.5.2, Page C3-11	Section C3.5.2, page C3-11, indicates there is a WMA C groundwater sampling and analysis plan. Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan and the requirement of WAC 173-303-610(3)(a)(vi), the details of the groundwater sampling program should be included in this closure document. The elements of the sampling and analysis plan should, at a minimum, include: procedures for groundwater sampling, sample documentation and preservation, shipment, chain-of-custody requirements, quality assurance/quality control procedures, etc. In addition, and due to the T and TX-TY WMA CME findings and recommendations, the sampling and analysis plan should include an identification that both filtered and non-filtered groundwater samples will be analyzed until such time as USDOE demonstrates the appropriateness of analyzing only filtered groundwater samples. Provide additional text to address the above concerns. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4
AH-59	Section C3.5.2, Page C3-11	Section C3.5.2, page C3-11, does not describe how reporting of statistically significant evidence of contamination. Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan and the lack of detail regarding groundwater monitoring provided in this closure plan, Section C3.5.2 should specify that the reporting requirements of WAC 173-303-645(9)(g) will be followed. Furthermore, Section C3.5.2 should include a description of how WAC 173-303-645(9)(g) reporting requirements will be satisfied. Provide additional text to address the above concerns. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-60	Section C3.5.2, Page C3-11	Section C3.5.2, page C3-11, does not provide detailed description of the groundwater detection monitoring program that will be followed at WMA C. Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan and the lack of detail regarding groundwater monitoring provided in this closure plan, Section C3.5.2 should include a detailed description of the groundwater detection monitoring program that will be followed at WMA C. At a minimum, the description should include the following: identification of constituents and/or parameters that will be monitored, monitoring frequency of each constituent and/or parameter, identification of the statistical method to be used to evaluate the groundwater monitoring data, justification of the proposed statistical method, a description of the statistical evaluation methodology, background data for each constituent and/or parameter, statistical mean calculations for each constituent and/or parameter, etc. Provide additional text to address the above stated requirements. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4
AH-61	Section C3.5.2, Page C3-11	Section C3.5.2, page C3-11, does not cite WAC 173-303-645(8)(h) as a groundwater monitoring requirement that must be satisfied. In addition to including a detailed description of the statistical methodology that will be followed, include the WAC 173-303-645(8)(h) cite. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4
AH-62	Section C3.5.2, Page C3-12	Section C3.5.3, page C3-12, states: "For information purposes, the following radionuclide information pursuant to AEA authority is summarized." The closure plan does not recognize Washington State's authority or obligation to impose radionuclide constituent and/or parameter groundwater monitoring for the purposes of detecting, monitoring, and/or characterizing impacts from the SSTs to the groundwaters of Washington State. Delete the statement.	CLOSED Independen t follow-up by Ecology
JC-32	Page C3-11 Section C3.5.3	Trend plots showing concentration/activity over time should be included for principal contaminants. Data for just 2001 makes this section incomplete. *Response: Inserted text and trend plot figures in Section C3.5.3.*	CLOSED 12/12/03 Action List #48
JC-33	Page C3-11 Last bullet	What is the suspected source of the NO3, SO4, Ca and Cl? Because HNO3 was extensively used in chemical processing, an anthropogenic source is indicated. *Response: Added text to Section C3.5.3 to indicate sources of contamination are not defined.*	Closed
JC-34	Page C3-11 Table C3-11	The date of the upgradient/downgradient determination should be indicated, as groundwater flow direction has changed with time. *Response: Added reference to source document and date to Table C3-2.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-63	Section C3.5.4, Page C3-12	Section C3.5.4, page C3-12, describes groundwater monitoring well inspection and maintenance. The section should identify where this information will be maintained and how Ecology may access the documentation of well inspection and maintenance. Provide additional text to address this concept. *Response: Added and revised text in Section C3.5.4.*	CLOSED Action Item #36
AH-64	Section C3.5.4, Page C3-12	Section C3.5.4, page C3-12, describes groundwater monitoring well inspection and maintenance. Revise this section to include inspection and maintenance dates for each WMA C well as well as a description of actions taken. *Response: Added and revised text in Section C3.5.4.*	CLOSED Action Item #36
AH-65	Section C3.5.5, Page C3-12	Section C3.5.5, page C3-12, should identify that prior to installing any groundwater monitoring wells intended to satisfy WAC 173-303-645 groundwater monitoring requirements at the WMA C point of compliance, Ecology approval will be obtained. In addition, prior to installing any groundwater monitoring well intended to satisfy WAC 173-303-645 requirements at the WMA C point of compliance, the closure plan modification process of WAC 173-303-830 will be followed. Section C3.5.5 should include a description of the closure plan modification process. The description should identify the various classes of modifications and should specify that the WAC 173-303-830 closure and/or groundwater monitoring network/program modification process and criteria will be followed. Provide additional text to address these requirements. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #5
AH-66	Section C3.5.2, Page C3-11	The last sentence of the paragraph in Section C3.5.2, page C3-11, states: "Additional groundwater monitoring wells will provide supplementary data for characterizing groundwater flow direction, stratigraphy, vadose zone properties, and groundwater chemistry in the vicinity of WMA C." It can also be stated: "Additional groundwater monitoring wells will be installed to satisfy WAC 173-303-645 requirements for determining groundwater quality at the WMA C point of compliance (i.e., detecting releases and impacts to groundwater)". Clearly, the existing WMA C groundwater monitoring network is deficient. The text should be re-written to promote compliance rather than to imply that additional groundwater monitoring wells will provide supplementary data. Revise the text as described above. *Response: Text revisions were made to C3.5.5.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
AH-67	Section C3.5.2, Page C3-11	Section C3.5.2, page C3-11, appears to describe that corrections of the deficiencies associated with the WMA C groundwater monitoring network will occur via a data quality objective process. In my October 8 memorandum regarding the Tier 1 document, numerous deficiencies were noted regarding the Tier 1 document's lack of acknowledgement that WMA-specific groundwater protection standards are specified by WAC 173-303-645. Section C3.5.2 should include a statement that groundwater monitoring requirements of WAC 173-303-645 will be satisfied as part of SST component and SST system closure actions. Furthermore, Section C3.5.2 should identify that during the active life of the WMA C and during postclosure, groundwater monitoring will occur at the WMA C point of compliance (as defined by WAC 173-303-645(6)). Provide additional text to address the above concerns. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4
AH-68	Section C4.0, Page C4-1	Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan, the second paragraph of Section C4.0, page C4-1, should include a reference to groundwater protection standards of WAC 173-303-645(3). Recommended text is: **"Additionally, the section lists the component closure activities that will contribute to meeting the closure performance standards of WAC 173-303-610(2), -640(8), and HFFACO Milestone M-45 and the groundwater protection standards of WAC 173-303-645(3)."** Revise the text to reflect the above recommendations. *Response: Partially accept. Revised text to include "and -645(3)".*	CLOSED
BBK-42	Section C4.0	Please revise the text to read: "Component closure activity plans~~, or alternate decision documentation such as corrective measures studies or CERCLA RODs, referenced by the Site-Wide Permit,~~ will be developed to describe how the components or groups of components will be characterized, disconnected, dismantled, decontaminated, removed, and/or stabilized." *Response: Deleted "referenced by" and inserted "upon approval through incorporation into…".*	CLOSED
DS-4	page C4-1 line 17	This time line depicts "related sequence and anticipated duration of activities", the WAC requests at a minimum the total time required to close…The figure does not have a unit of time associated with it. Other ongoing closure activities are not identified. Requirement: 173-303-610(3)(vii) *Response: Added text referencing M-45 Milestone to Section 1.3.3 of Framework Closure Plan and in Section C4.1 of WMA C Closure Action Plan.*	Closed
BBK-43	Section C4.1, second bullet	Please revise the text to read: "Column Two: The second column represents the period during which all WMA C closure activities are completed. This period begins when all of the SSTs within a WMA have been retrieved, isolated, and filled, and the ancillary equipment and soils have been characterized and appropriately dispositioned….." *Response: Added suggested text.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-44	Figure C4-1	It seems like it should be possible to put some dates on this, even if it is decades. There are milestones that drive this work, maybe they could provide some data points. Please add any chronological parameters available to the figure. *Response: Added relevant RFI/CMS M-45 milestone dates associated with WMA C to figure.*	CLOSED Action Item #6 (J von Reis)
AH-69	Section C4.1, Figure C4-1	The first bullet directly under the "Postclosure Groundwater Monitoring" box in Figure C4-1 should read as follows: "RCRA postclosure monitoring at the WMA C point of compliance". A second bullet should be added under the "Postclosure Groundwater Monitoring" box which might read as follows: **"RCRA groundwater corrective action requirements integrated with Central Plateau regional groundwater monitoring as appropriate".** Revise the text to reflect these recommendations. *Response: Figure text revised in accordance with recommendations.*	CLOSED 12/10/03 Action Item #37
JC-35	Page C4-2 Figure C4-1	While groundwater beneath WMA C will be closed under CERCLA as part of the closure of the 200-PO-1 groundwater operable unit, it should be stated that such closure must satisfy the RCRA requirements for corrective action and closure. *Response: Text changes already made to the Figure are sufficient to address comment concerns.*	Closed
AH-70	Section C4.1, Figure C4-1	The second bullet directly under the "Groundwater Monitoring During Closure" box in Figure C4-1 should read as follows: **"Monitoring program and/or network may change during closure process".** Revise the figure as described above. *Response: Text changes were made to the Figure.*	CLOSED 12/10/03 Action Item #37
DS-8	Attachment C 1.2.1.4	Is the contingent post-closure plan complete? Figure C4 Relative Timeline of Major Activities for Closure of WMA C does not include the activities for contingent post—closure plan activities. Requirement: 173-303-640 (8)(ii) *Response: Added text to refer to postclosure plan in Section C4.1.*	Closed
AH-71	General	A general comment throughout the Tier 2 document is that the groundwater monitoring during closure is not clearly described as being WMA C-specific and at the point of compliance. For example, the second paragraph of Section C4.2.3 states: "Soil characterization and corrective measures activities will be integrated as appropriate with ancillary equipment and groundwater closure activities and with the Ecology, EPA, and DOE Central Plateau regional closure strategies currently under development." The Tier 2 document should be written to clearly describe WMA C-specific groundwater monitoring at the point of compliance to satisfy groundwater protection standards of WAC 173-303-645(3) and monitoring requirements of WAC 173-303-645. Revise the text to address these concerns. *Response: Added –645 citation to C4.2.3.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-44	Section C4.2.1, Pages C4-3 to C4-4	Although the HFFACO milestones/schedules listed in the Framework portion of the closure plan include some WMA C closure actions, DOE plans to conduct several other WMA C closure actions (C-200 series tanks) in the near future. Although Ecology reviewed a C-200 Series Functions and Requirements document and provided formal comments regarding the proposed actions, these proposed actions are missing from this closure plan. All proposed closure actions, including tank retrievals, must at least be summarized and included in this closure plan. These actions will be incorporated by reference into the closure plan. DOE proposes to conduct the C-200 retrieval closure actions outside of the established HFFACO approval process without even a reference to the plans or schedule in the closure plan. Revise Section C4.0 to include the C-200 series retrieval closure actions as well as the future C-104 retrieval closure action. Requirement WAC 173-303-610(3) *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #10 (DH)
DS-5	Page C4-3 Section 4.2.1 line23	What are DQO summary reports? Are they part of the DQO process? And who in Ecology approves them. *Response: Corrected text with appropriate DQO document title.*	Closed
DS-6	Page C4 Sec. 4.2	Since 173-303-610 requires a description of each unit, and they are not currently included, will these be provided as attachments to the closure plan or permit? If so, will the addition of these figures be permit mods? *Response: No text change required. Provided clarification of "unit" and referred to component tables, also found supporting text in Section 1.2.1.*	Closed
JC-36	Page C4-3 Section 4.2.1 Paragraph 3	Some indication as to the means for verifying that retrieval volume criteria have been met should be included; i.e., what technologies are being considered and when they may be chosen/implemented. Eyeball qualitative estimates are NOT acceptable. *Response:*	On Hold per JWB
BBK-45	Section C4.2.1, fourth paragraph	Please revise the text to read: "If the residual waste in individual tanks meets the retrieval criteria and risk metrics related to the residual waste are accepted, DOE will modify the closure activity plan and the Site-Wide permit if necessary, and then proceed with implementing the approved component closure activity plan......" *Response: Revised text as suggested.*	CLOSED
JC-37	Page C4-4 Lines 6-13	The schedule for placement of grout should be provided. As this is an irreversible action, grout should not be added before the WMA is ready for closure because it could preclude any additional retrieval/action in the subject tank. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12

Comment Number	Position in Document	Comment/Response	Comment Closure Date
JC-38	Page C4-4 Line 10	Cementitious grout may be free-flowing when added, but not after it sets. This can not be added before the WMA is ready for closure (see comment above). *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12
BBK-46	Section C4.2.1, last paragraph	The text states that "Physical and administrative isolation of the tanks will occur before and after the tank retrieval and tank stabilization activities. Physical isolation refers to filling (such as by grouting) and/or capping of pipelines, drains, ducting or other openings into the tank structure to prevent..." Provide additional explanation (possibly a list) describing which physical and which administrative procedures will be taken before, and which after the tank retrieval and stabilization.	Action Item #7 (J von Reis)
DS-7	Sec 4.2.2	There has been little or no language to describe the steps needed to remove ancillary equipment. This has not been addressed in the WMA. Requirement: 173-303-610(3)(v) *Response: No text change. Showed supporting existing text in Sections 3.2.1.3 and C4.2.2.2*	Closed
BBK-47	Section C4.2.2, second paragraph	Please revise the text to read: ".....the respective tank component closure activity plans. In-tank equipment will be dispositioned as in-tank debris during the tank closure activity. Disposition of ex-tank ancillary equipment (such as pipelines, diversion boxes, and cascade lines) will be described in either an ancillary equipment component closure activity plan, or tank component closure activity plan~~, or other alternate decision documentation such as a corrective measures study or ROD and referenced back to the SST system chapter of the Site-Wide Permit~~. Integration activities for remediating...." *Response: Added text to indicate approval through incorporation into the site-wide permit.*	Closed
BBK-48	Section C4.2.2, last paragraph	Please revise the text to read: "Ancillary equipment closure activities will be integrated as appropriate with soil and groundwater component closure activities and with the Ecology, EPA, and DOE Central Plateau regional closure strategies currently under development. ~~Integration will influence the implementation schedule as well as the technical and regulatory approach to completing the closure activities.~~ Coordination of these integration actions is expected to occur through modification of the *SST System Implementation Plan* ~~pursuant to HFFACO Milestone M-45-06-T20~~." *Response: Text changes made per request.*	Closed
BBK-49	Section C4.2.3, first paragraph	Please revise the text to read: "The two primary steps in the WMA C soil component closure activities are 1) characterizing the nature, extent, and mobility of the contamination in the soil column, and 2) performing necessary ~~corrective measures~~ closure in accordance with WAC 173-303-610....." *Response: Added requested text.*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-50	Section C4.2.3, second paragraph	Please revise the text to read: "Soil characterization and corrective measures activities will be integrated as appropriate with ancillary equipment and groundwater component closure activities and with the Ecology, EPA, and DOE Central Plateau regional closure strategies currently under development. ~~Integration will influence the implementation schedule as well as the technical and regulatory approach to completing the closure activities.~~ Coordination of these integration actions is expected to occur through modification of the *SST System Implementation Plan* ~~pursuant to HFFACO Milestone M-45-06-T20~~." *Response: Made changes similar to requested text.*	Closed
AH-72	Section C4.2.3	The text of Section C4.2.3 refers to "regional closure strategies currently under development". WAC 173-303-610(3)(a)(vi) requires the closure plan include a detailed description of activities necessary during closure including groundwater monitoring. As such, the Tier 2 document should include the detailed description of regional closure strategies if those strategies include WMA C groundwater monitoring activities. Therefore, Section C4.2.3 should identify that after groundwater regional strategies are finalized, the WMA C closure plan will be modified in accordance with WAC 173-303-830 to incorporate and/or change WMA C groundwater monitoring network and/or program description. Revise the text to address the above concerns. *Response: Text added in 4.2.3.*	CLOSED
AH-73	Section C4.2.4	Section C4.2.4 has omitted the fundamental step in groundwater component closure activities of groundwater monitoring to satisfy groundwater protection standards of WAC 173-303-645(3) and groundwater monitoring requirements of WAC 173-303-645. The first sentence of the first paragraph of Section C4.2.4 should identify three primary steps in groundwater component closure activities. Recommended wording is: **"The three primary steps in groundwater component closure activities are: 1) groundwater monitoring to satisfy groundwater protection standards of WAC 173-303-645(3), 2) characterizing the nature and extent of contamination, and 3) performing necessary corrective measures."** Revise the text to include the recommended language. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4
BBK-51	Section C4.2.4, second paragraph	Please delete the second paragraph starting with "In the event…." *Response: Text deleted*	CLOSED Parking Lot #3 (J von Reis)
AH-74	Section C4.2.4, Pages C4-5, C4-6	Revise Section C4.2.4, pages C4-5 and C4-6, to identify groundwater monitoring to satisfy groundwater protection standards of WAC 173-303-645(3) as a fundamental step in groundwater component closure activities. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4
AH-75	Section C4.2.4, Pages C4-5, C4-6	Revise Section C4.2.4, pages C4-5 and C4-6, to identify that WMA C-specific groundwater monitoring will occur at the WMA C point of compliance. *Response: Inserted text into Section C4.2.6.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-C6	Sec.C4.2.4, p. C4-6, ¶ 2; Sec. C4.2.6,. ¶ 2, p. C4-7	The text on p. C4-6 states that the groundwater remediation may be performed per a CERCLA ROD developed for operable unit 200-PO-1. The text on p. C4-7 states that a post-closure monitoring plan will be developed as part of future modifications of the postclosure care plan. Ecology holds the requirement in WAC 173-303-665(b)(5)(b)(iv) to be an ARAR for the operable unit CERCLA cleanup, i.e., monitoring and maintaining the groundwater monitoring system. Please indicate the USDOE's intent in text. *Response: Added WAC 173-303-665(6)(b)(iv) cite in sentence one of paragraph two of C4.2.6.*	Closed
JC-39	Page C4-6 Lines 4-6	While corrective actions may be accomplished under a CERCLA ROD, satisfaction of RCRA Corrective Action requirements must be met and this should be so stated here. *Response: Revised text from previous comment disposition sufficient for comment resolution.*	Closed
BBK-52	Section C4.2.5, last paragraph	The text states that "The System Assessment Capability (SAC) is a computational tool for use in preparing the Hanford site-wide composite analysis of long-term impacts to groundwater. The WMA C risk assessment will be integrated with the SAC by preparing a constituent breakthrough curve for constituents at the water table underlying the WMA. This data set will be inserted into the SAC computations to represent the WMA as a point source in the composite analysis, as available. This will allow the localized fate and transport analysis performed at the WMA level to be directly integrated into the large-scale analysis performed by the SAC." Please include an explanation that the output from the SAC will not make any of the cleanup-levels for WMA C any less stringent than the regulatory requirements. *Response: Added text to Section C4.2.5.*	CLOSED
AH-76	Section C4.2.6, Page C4-6	Section C4.2.6, page C4-6, references another document for details of the groundwater monitoring plan. Due to the consistent lack of acknowledgement of applicability of groundwater performance standards of WAC 173-303-645 in Tier 1 of the SST closure plan and the WAC 173-303-610(3)(a)(vi) requirement that the closure plan include a detailed description of activities necessary during closure including groundwater monitoring, the Tier 2 document must contain a detailed description of the groundwater monitoring program that will be conducted during the time that WMA C component closure activities are underway and until WMA C closure is achieved. Revise the text. AH *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4
AH-77	Section C4.2.6, Pages C4-6, C4-7	Section C4.2.6, pages C4-6 and C4-7, should identify that groundwater monitoring in relation to the WMA C will be conducted to satisfy groundwater protection standards of WAC 173-303-645(3). Revise the text. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-C7	Sec. C4.2.6, p. C4-11	The WMA C text for WAC 173-303-665(6) must be corrected to match the Dangerous Waste Regulations (e.g., (a) "At closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill"...should be "At final closure..."). Please review and revise quoted text as needed. *Response: Revised text in Section 4.3 as suggested.*	Closed
AH-78	Section C4.2.7, Page C4-7	An additional bullet should be added to Section C4.2.7, page C4-7, which identifies that groundwater protection standards will be satisfied. Recommended wording for the bullet is: **"Groundwater monitoring at the WMA C point of compliance as necessary to comply with groundwater protection standards."** Revise the text to include the recommended language. AH *Response: Added requested text in C4.2.7.*	CLOSED
BBK-53	Section C4.2.7, second paragraph	Please revise the text to read: "Should removal or decontamination of dangerous waste constituents not be achievable at WMA C, the proposed *contingent final remedy for WMA C is closure in accordance with WAC 173-*303-665 with the installation of an engineered surface barrier." *Response: Added requested text in C4.2.7.*	CLOSED
BBK-54	Section C4.2.7, third paragraph	Please revise the text to read: "performance standards for barriers under the requirements of WAC 173-303-665 are discussed in Section C4.3. Surface barrier designs developed for application to waste sites located within the Hanford Site 200 Areas will meet or exceed RCRA design criteria, as well as incorporate established long-term performance and maintenance objectives and specified design criteria. ~~These objectives and criteria are based on an evaluation of CERCLA applicable or relevant and appropriate requirements (ARARs) and engineering criteria.~~ A site-specific evaluation will be done to ensure that a surface barrier design candidate is appropriate for specific WMA C characteristics and will be ultimately incorporated into the Site-Wide Permit." *Response: Revised text in Section C4.2.7.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
BBK-6	Section C4.2.7, fourth, fifth, and sixth paragraphs	Please revise text to read: "ARARs and technical guidance pertaining to surface barrier design for various RCRA treatment, storage, and disposal (TSD) scenarios at the Hanford Site are currently defined in *Focused Feasibility Study of Engineered Barriers for Waste Management Units in 200 Areas* (DOE/RL-93-33). Based on current knowledge of waste sources associated with WMA C, it is anticipated that the minimum design criteria required for the waste site would be the modified RCRA Subtitle C Barrier, as defined in this report. However, any final barrier design will be incorporated into this permit prior to installation. Additional factors that may be considered in barrier design are aspects of risk and performance assessment modeling. Contingent actions for barrier design and installation of the surface barrier over WMA C would be integrated with Central Plateau regional closure strategies. ~~For example, barrier installation over a WMA may be delayed until closure efforts in a contiguous waste site (such as a DST farm) are complete.~~ Additionally, barrier design criteria may need to be ~~redesigned~~ *modified if the barrier cover encompasses multiple contiguous waste sites.* When the construction of the WMA C engineered surface barrier is complete, the barrier and surrounding disturbed area would be revegetated to further enhance evapotranspiration, limit erosion, and blend the site area into the surrounding landscape of the Central Plateau. ~~Some level of p~~Performance monitoring will~~ould~~ be implemented to ensure the surface barrier is performing as designed. Monitoring the continued integrity of the surface barrier would be accomplished through visual inspection and ~~may~~ will be supplemented with groundwater sampling. The long-term effectiveness of the surface barriers in the Central Plateau depends on maintaining...." *Response: Revised text in Section C4.2.7.*	CLOSED
AH-79	Section C4.2.8, Page C4-8	Section C4.2.8, page C4-8, should include a statement regarding groundwater protection standards. Recommended language is: **"These activities would also satisfy groundwater protection standards."** Revise the text to include the recommended language. AH *Response: Recommended text added to Section C4.2.8*	CLOSED
AH-80	Section C4.3	A major deficiency of the Tier 2 document is that Section C4.3 omits the category of groundwater protection standard as a standard with which compliance must be determined. The section must identify the groundwater protection standards of WAC 173-303-645(3) and must include applicable corresponding actions that USDOE will undertake to meet the groundwater protection standards. Revise the text to address this deficiency. AH *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #4

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-45	Section C6.0, Pages C6-1 to C6-2	See comment for Section C4.2.1. Provide schedule information for the C-200 series tank retrieval closure actions. Additionally, include a date to provide schedule updates for the remaining known WMA C closure activities. The HFFACO M-45 implementation plan could be used as a mechanism to generate schedule updates for any WMA to be added to the SST closure plan through permit modifications upon approval of the implementation plan every two years. Requirement WAC 173-303-610(3) *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #10 (DH)
DH-46	WMA C	**Hold for NOD on missing General Requirements** **Many will be in the Framework section---------** Jeanne Wallace/ Bob Wilson	HOLD
DH-47	Section C8.0	**Postclosure Care Issue - Hold** Alisa, Jeanne Wallace, Brenda BK	HOLD
JC-40	Page C8-1 Section C8.1.1	Integration with the Central Plateau regional groundwater monitoring system is acceptable, PROVIDED that the proposed groundwater monitoring system meets the needs for RCRA closure with waste left in place. *Response: Added "RCRA-compliant" to first sentence of Section C8.1.1.*	Closed
JC-41	Page C8-1 Section C8.1	Assuming that WMA C will be closed as a landfill, some provisions must be included for monitoring the performance of any barrier that is erected at the site. *Response: Added text to Section C8.1.2 to indicate subsurface monitoring systems will be part of barrier monitoring.*	Closed
		SST CLOSURE ACTION PLAN SEPA CHECKLIST July 2003	
MJB-S1	Item A.10, p. 4 of 30	The text states that the USDOE must approve the reclassification of the residual waste as waste incidental to reprocessing that can be managed as low level waste. This statement does not reflect recent Court decisions that High Level Waste may not be reclassified by the USDOE. Please explain the USDOE's current plans to designate the waste left in the C-106 tank.	
MJB-S2	Item A.11, p. 5 of 30	¶ 4 states that nominally 114,000-L batches of 0.9 to 1.0 molar acid will be introduced directly into 241-C-106 then allowed to react with the residual waste for 1 – 7 days. The USDOE estimates that up to 210,000 gallons of acid will be required to dissolve 9,000 gal of sludge. Ecology requests that the USDOE address the addition of that large volume of acid to the Double Shell Tanks, including reactions with waste already stored in the tanks that might be released as a result of chemical interactions.	
MJB-S3	Item A.11, p. 5&6 of 30	¶ 7 on p. 5 and ¶ 1 on p. 6 indicate that the grout to be added during Phase I will be free flowing and of sufficient volume to cover the residual waste at the bottom of the tank and form a grout layer. Ecology noted that the grout performance objectives for Phase I require the material to cover the waste but not to mix with the waste. From the performance objectives, it appears that the grout will not combine with the waste to create a new waste form. Please confirm.	

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-S4	Item A.11, p. 7, ¶ 3	The text states that the HEPA filtration system will be used to control toxic or radioactive air emissions from the 241-C-106 tanks. Please explain how the HEPA filtration system will provide best available control technology (T-BACT) for air toxics.	
MJB-S5	Item A.11, p. 7, ¶ 4	Text states that contaminated equipment removed from the tank would be disposed as solid waste, and that fill equipment may be cleaned using water, which will then be disposed. Please provide more definite information about the destination of the equipment contaminated by tank waste; that is, whether it will be handled under the debris rule or considered as listed waste.	
MJB-S6	Item A.11, p. 7, ¶ 6	The text describes isolation measures planned but does not address nozzles and pipes that are present at the bottom and on the sides of the tank. Please explain what measures will be taken to seal those tank penetrations (i.e., grout flows will plug the risers and fill the lines). Also, please explain what measures will be taken to avoid intrusion via the engineered air handling system.	
MJB-S7	Item B.3.d	The text states that all pressurized raw and potable water lines feeding the 241-C tank farm were tested in July 2002; Ecology wishes to know if any water line leaks have occurred during the recent retrieval of waste from Tank C-106, with estimates of volumes lost, locations, and any corrective measures taken. In addition, Ecology wishes to know if line tests were conducted in July and any results that differed from July 2003.	
MJB-S8	Item B.4.b	The area around the 241-C tank farm is said to be "disturbed extensively". Please describe any herbicide application programs, soil stabilization efforts, or other activities conducted to control the growth of vegetation in that area.	
MJB-S9	Page 29 of 30	Please add DOE /EA-1462, Rev. 0, *Environmental Assessment for the Accelerated Tank Closure Demonstration Project*, to the References	
MJB-S10	Page 28 of 30	Mr. Schepens' signature is lacking in part C. Please provide a Ecology a signed copy of the checklist.	
Attachment C-1 Single-Shell Tank 241-C-106 Component Closure Activity Plan			
DH-48	Section 1.0, Page C-1-1-1	Line 11. Replace "...are in accordance..." with the following: "...will comply with..." *Response: Accept*	Closed
DH-49	Section 1.0 Page C-1-1-1	Line 14. Insert "action" between "...closure..." and "...will..." *Response: Accept*	Closed
BBK-57	Section 1.0, last paragraph	Please revise the text to read: "*SST System Closure Plan*. Each component closure activity plan will constitute a modification of the *SST System Closure Plan* and require a modification to the Site-Wide Permit. ~~Closure activities may also be integrated into the *SST System Closure Plan* as part of decisions made under corrective actions for past practices (Part IV of the Site-Wide Permit) or a *Comprehensive Environmental Response, Compensation, and Liability Act* record of decision.~~" *Response: Revised text in Section 1.0*	Closed
DH-50	Section 1.1, Page C-1-1-1	Line 28. Include the following additional text at the end of the sentence: "...as well as Section 6 of the HFFACO action plan." *Response: Accept*	Closed

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-51	Section 1.1.1, Page C-1-1-1	Lines 30-36. Despite previous acknowledgement by DOE, this closure action plan neglected to include descriptions of closure actions for interconnected/adjacent components. This concept has been brought to the attention of DOE during numerous meetings with DOE and contractors. Without this detail, it is impossible to determine whether or not the C-106 closure action will adversely affect future closure actions for adjacent/interconnected components including soil. Conversely, DOE must also document how adjacent/interconnected component actions (and timing of those actions) would affect C-106 retrieval/closure actions. Revise the entire paragraph and section to include detailed descriptions of proposed closure actions for components interconnected or adjacent to C-106. Requirement: WAC 173-303-610(3) *Response: Partially accept. This section is a simple scope statement, however, a general sentence at line 32 was inserted. "A description of isolation activities for adjacent/interconnected components, including evaluations to determine impacts on future closure actions is included in Section 5.3."* *This old sentence was deleted: "The cascade line between C-106 and C-105 will be addressed in the component closure activity plan for C-105."* *Also, more detail was inserted into Section 5.3.*	CLOSED 12/10/03 Action List #25 (J von Reis)
DH-52	Section 1.1.1, Page C-1-1-2	Lines 1-5. Including descriptions of SST retrieval/closure actions in this closure plan is not just for informational purposes. Strike the entire paragraph and replace with the following: "Retrieval of SST waste constitutes a key SST System closure action. All retrieval actions will be approved through the HFFACO and scheduled, in advance, through HFFACO M-45 Milestones. Since retrieval actions are significant closure actions, detailed summaries of those actions will be included in the SST closure plan." Additional text is needed to describe the process for including the retrieval action summaries in the SST closure plan. Revise the text as indicated above. Requirement: WAC 173-303-610(3) *Response: Accept. The following paragraph was added: "Retrieval of SST waste constitutes a key SST System closure action. The C-106 retrieval actions will be approved through the HFFACO and scheduled, in advance, through HFFACO M-45 Milestones. Since retrieval actions are significant closure actions, detailed summaries of those actions are included in Section 2.4.3."*	Closed
DH-53	Section 1.1.1, Page C-1-1-2	Lines 8-10. (See comment on Page C-1-1-2, Lines 30-36) Missing is a description of how actions for adjacent/attached components/soil will be coordinated with the C-106 retrieval/closure action(s). Requirement: WAC 173-303-610(3) *Response: Accept. See response to DH-51*	CLOSED 12/10/03 Action List #25 (J von Reis)

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-Y1	Sec. 1.1.1, ¶ 2, p. C-1-1-2.	Bullet 1 states that C-106 will be retrieved to the extent technically possible per HFFACO MM-45-00. Please add "and Appendix H" after M-45-00. *Response: No text revision required. Explained that Appendix H is part of HFFACO M-45 milestone.*	Closed
JC-42	Page C-1-1-2 Lines 10-17	What is the schedule and the technical and regulatory justification for the proposed addition of the various fill media for this tank? Requirement: Provide schedule as well as technical and regulatory justification for these proposed actions. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12
DH-54	Section 1.1.1, Page C-1-1-2, and throughout the document	Lines 11-17. An acceptable justification has not been provided as to why a final closure action such as filling a tank with grout is needed so early in the closure process is missing. WMA-C has not been adequately characterized to allow a final grout filling of C-106 at this time. Ecology will not issue a closure action plan for a final closure action prior to proper characterization of either the component or the WMA in which it resides. Until it is documented that the tank retrieval results in a clean tank with no leaks, and DOE can document how adjacent/interconnected component closure actions relate to C-106 and that C-106 actions will not impact other closure actions, filling C-106 with grout will not be allowed. Furthermore, proposing such an action prior to completion or the SEPA process (EIS) and prior to a formal public comment period or prior to is not acceptable. Filling any tank with grout at this early stage of closure would eliminate the ability to remove additional residual waste, preclude further tank characterization, and eliminate other possible remediation options. Additionally, HFFACO Milestone M-45-05M-T01 does not require results of the C-106 retrieval including waste analysis until 2/27/04. Proposing a final closure action for public review prior to regulatory review of analytical data is not logical. A final component closure action that does not meet clean closure standards should not be allowed prior to sufficient characterization of WMA C. At this stage of characterization, uncertainty associated with current information and risk estimates is extremely high. Capping of tank openings would be an acceptable example an acceptable near-term closure action for WMA-C. Revise Attachment C-1 to delete filling of C-106 with grout as the closure action proposed at this time. Provide alternate closure actions that would not preclude future characterization or waste removal. WAC 173-303-610(3) *Response: Comment will be resolved through development of permit conditions*	Parking Lot #12 CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-55	Section 1.1.1, Page 1-1-2, and throughout the document	Lines 18-26. The Characterization of C-106 as described in the C-106 DQO was limited by the number of available risers (one) and the lack of developed technology with the ability to reach locations inside the tank beyond just below the one riser. Additional tank characterization may be required in the future, depending on the results of the retrieval closure actions currently underway. WAC 173-303-610(3) *Proposed revision In Ecology Review 12/4; Sent to Deborah Singleton per Dick Heggen's request 12/11 for her review by 12/12.*	Action List #27 (LM)
DH-56	Section 1.2.1, Page C-1-1-3, Lines 33-36 and Page C-1-1-4, Lines 1-4	Strike all text beginning with "The actions..." The statements are unacceptable and incorrectly describe proper closure process. The actions proposed (filling with grout) are actually final closure actions that would only be allowed to occur after meeting performance standards as well as other criteria and considerations stated in the previous comments on Attachment C-1, Section 1.1.1. Requirement: WAC 173-303-610(3) *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12
BBK-58	Section 1.2.1, third paragraph	The text states "The three general closure performance standards defined in WAC 173-303-610(2)(i) are described in Sections 1.2.1.1 through 1.2.1.3. Removal or decontamination standards defined in WAC 173-303-610(2)(b) and WAC 173-303-640(8) are described in Section 1.2.1.4. Compliance with requirements will be documented in waste retrieval and closure demonstration project reports." Please add text explaining that these reports will be incorporated into the Site-Wide permit prior to subsequent actions being taken. *Response: Revised text in Section 1.2.1. The last sentence in the last paragraph was revised to read: "Compliance with requirements will be documented in waste retrieval and closure demonstration project reports, and will be incorporated into the Site-Wide Permit as needed."*	CLOSED 12/10/03 Action #8
MJB-Y3	Sec. 1.2.1.2 ¶ 1, p. C-1-1-4	Sentence 4 states that tank isolation may include administrative actions. Please describe what administrative activities will be performed, at what frequencies, and by whom. Please elaborate as to the protection of public health and the environment that the measures will afford. *Response: Revised and inserted text in Section 1.2.1.2.*	CLOSED
JC-43	Page C-1-1-4, Line 21	: "....at least three grout fill layers will be added." Requirement: Provide schedule as well as technical and regulatory justification for the addition of grout fill layers. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-57	Section 1.2.1.1, Page C-1-1-4	Lines 18-23. There are likely other less permanent actions following retrieval, missing from this closure action plan, that could minimize the need for further maintenance such as capping lines, risers, covering the tank, and providing run-on controls. Assuming that proper run-on controls are in place why would Enraf or temperature probes be needed in a fully retrieved/stabilized tank? Also using a final closure action as the only example is not acceptable at this time. Revise the section to include other non-final closure actions as examples. Requirement: WAC 173-303-610(3) *Response: Revised Section 1.2.1.1 to include requested actions.*	Closed
BBK-59	Section 1.2.1.1	Please revise the text to read: "Component closure activities planned for C-106 are designed to minimize the maintenance required after the actions are complete. Waste will be retrieved from C-106 to meet HFFACO retrieval goals, the tank will be isolated from the system and at least three grout fill layers will be added. Please add text to explain if ANY inspections or maintenance will be necessary after the addition of grout. *Response: The last sentence in the section was replaced with: "If the tank is filled as part of closure demonstration field activities, DOE will conduct annual visual inspections of the tank farm surface in the tank vicinity. If the tank is not filled as part of closure demonstration field activities, DOE will conduct annual visual inspections of the tank farm surface in the tank vicinity and will continue to operate any existing liquid detection or monitoring device, i.e., Enraf™."*	CLOSED Action Item #8 (J von Reis)
BBK-60	Section 1.2.1.2	Please revise the text to read: "C-106 will be retrieved to the extent technically possible in accordance with criteria set forth in Milestone M-45 and Appendix H of the HFFACO. Component closure activities, as described in Section 5.0, will include stabilizing any remaining wastes, complete filling of the tank for structural integrity and intrusion prevention, and isolating C-106 from the SST system and the environment. Tank isolation activities may will include administrative actions and cutting or removing and sealing off all pipes or other connectors between C-106 and the balance of the SST system. All of these activities will serve to control the postclosure escape of remaining dangerous waste constituents. At a later point in the overall closure of the SST system, DOE will undertake final closure of WMA C. ~~As part of WMA C closure actions, DOE will close ancillary equipment, may place a permanent barrier over WMA C if removal or decontamination of waste constituents is not practicably achievable, and may undertake other closure and postclosure actions for contaminated soil and groundwater as necessary to comply with the final status closure plan permit conditions and satisfy the associated closure performance standards. These actions will be assessed with regard to long-term protection of human health and the environment through a comprehensive risk assessment of the tank, WMA, and SST system.~~" *Response: Accept. Deleted text.*	CLOSED

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-58	Section 1.2.1.2, Page C-1-1-5	Lines 1-3. Missing in the risk assessment statements is a requirement to compare individual actions to cumulative risk which includes WMA-C together with other adjacent or nearby non-tank risk sources that potentially add to the cumulative risk numbers. Requirement: WAC 173-303-610 *Response: Accept. The following sentence was added: "Individual actions will be assessed for their impact on long-term cumulative risk (i.e., WMA C together with other adjacent or nearby non-tank risk sources)."*	Closed
MJB-Y2	Sec. 1.2.1.2 ¶ 1, p. C-1-1-4	Sentence 3 states that the USDOE will close ancillary equipment. Please specify what measures will be used to close the equipment. *Response: Explained that ancillary equipment closure outside scope of the C-106 closure activity plan as mentioned elsewhere in document. No text changes required.*	Closed
MJB-Y3	Sec. 1.2.1.2 ¶ 1, p. C-1-1-4	Sentence 4 states that tank isolation may include administrative actions. Please describe what administrative activities will be performed, at what frequencies, and by whom. Please elaborate as to the protection of public health and the environment that the measures will afford. *Response: The description of tank isolation activities in Section 5.3 was expanded. (See DH-70)*	CLOSED Action List #25
BBK-61	Section 1.2.1.3	Please add text indicating what will happen above C-106 post tank closure and prior to closure of WMA C. *Response: Revised Section 1.2.1.3.*	CLOSED
MJB-Y4	Sec. 1.2.1.4, ¶ 3, p. C-1-1-5	Sentence 2 states that because the entire waste management area will not be closed with C-106, a contingent post-closure plan is not included for the tank. Please *Response: Inserted reference to Section C8.1 in Section 1.2.1.4.*	Closed
DH-59	Section 1.2.1.4, Page C-1-1-5	Lines 22-25. Clarify this paragraph by indicating that DOE must document the ability to clean close tanks, ancillary equipment and soils within WMA-C. Requirement: WAC 173-303-640(8) *Response: Revised text*	Closed
DH-60	Section 1.2.1.4, Page C-1-1-5	Lines 36-39. The text clearly indicates that evaluation of closure options has not been conducted relative to the final closure action proposed in this plan. This is further reason to not allow the closure action to proceed as proposed. Requirement. WAC 173-303-610(3) and 640(8). *Response: Scheduling issues associated with this comment will be resolved through the drafting of permit conditions.*	CLOSED 12/12/03 Action List #28 (DH)
DH-61	Section 2.1.2, Page C-1-2-1	Line 30. Provide additional information detailing the status of the remaining conduit as a potential pathway for contaminant release or intrusion. Requirement. WAC 173-303-610(3) *Response: Additional information on tank isolation was added to Section 5.3.*	CLOSED 12/10/03 Action List #25

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-62	Section 2.1.2, Pages C-1-2-4 and C-1-2-5	Figure 2-3 and associated text. Previous NOD #227 required a "scaled diagram indicating line numbers as well as the physical status of lines (and connections), attached pits, drains, risers, pumps, etc." Figures 2-3, 5-2, and associated text partially satisfies the original NOD. Provide additional text to comply with the original NOD. Requirement WAC 173-303-610(3) *Response: No changes in Section 2.1.2 - as agreed; Additional information on tank isolation was added to Section 5.3.*	Closed
JC-44	Page C-1-2-6, Lines 7, 8	What is the basis for declaring C-106 a sound tank? Without some type of integrity testing, the basis for declaring this tank sound is not justified. **Requirement:** Provide regulatory and technical basis for the declaration of C-106 as a sound tank. *Response: A new Section 2.3 "Tank Integrity" was inserted.*	CLOSED 12/12/03 Action List #49
DH-63	Section 2.2, Page C-1-2-6	Lines 7-9. DOE speculates that C-106 is a sound tank. DOE has not performed integrity assessments on any of the 149 SSTs to support the statement that "C-106 is a sound tank..." Also, characterization external to the tank has not been performed to support the claim that leakage to the soil would have been from lines, etc, but not the tank. Revise the paragraph as follows: "**Although an integrity assessment, or soil/ancillary equipment characterization has not been performed relative to C-106, existing information does not indicate waste releases to the vadose zone from C-106. During the previous C-106 retrieval effort, groundwater monitoring indicated a dilution effect on Tc-99 groundwater contamination during the period of C-106 retrieval operations. To date an exact cause has not been established.**" *Response: Ecology/ORP developed text for insertion into the new Section 2.3.*	CLOSED 12/12/03 Action List #29 (JWB/LM)
DH-64	Section 2.3, Page C-1-2-6	Lines 16-19. This paragraph indicates that about 5,000 gallons of sludge remained in C-106 following retrieval. This does not match the 9,000 gallons of sludge described in Section 2.4.1. Revise the document to either explain the discrepancy or correct the data. *Response: Sentence was revised. "Measurements at this time indicated approximately 97% of the sludge, 707 kL (187 kgal) of the estimated 727 kL (192 kgal), in C-106 was sluiced to double-shell tank (DST) AY-102."*	Closed
DH-65	Sections 2.4.1, 2.4.2, 2.4.3, Pages C-1-2-7 to C-1-2-9	Lines 7-14. The description of 1) waste volume, 2) waste analysis, and 3) HFFACO retrieval criteria is inadequate and premature. To support a (proposed) final component closure action, data/review/analysis for all these categories must be presented in the closure plan, not just an esoteric discussion of how to gather the information. Therefore, until the above-described information is presented in this closure plan, the proposed action cannot be considered. Additionally, WMA-C has not been characterized to allow a comparison of the proposed action against overall WMA-C (cumulative) risk which further precludes a consideration of any final closure action not meeting clean-closure requirements or overall WMA-C risk at this time. The proposed closure action is to be placed on hold at this time. DH *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-Y5	Sec. 2.4.3, ¶ 5, pp. C-1-2-8&-9	Paragraph 5 states that oxalic acid was used in tanks at the Savannah River Site and in Russian radioactive waste tanks. Please explain why that information relates to the use of the acid in Hanford tanks; i.e. similar contaminants, similar tank construction or use, similar results, etc. *Response: Deleted sentence corresponding to comment.*	Closed
DH-66	Section 2.4.3, Page C-1-2-8	Lines 29-36. Missing is a description of the C-106 retrieval process including the process involved in selecting oxalic acid as the initial retrieval technology. Retrieval is a major closure action and must be fully summarized in the component closure plan. Provide additional text to address this deficiency. Requirement WAC 173-303-610(3) *Response: Additional text was added to this Section as a result of this and other NODs. The results of oxalic acid retrieval will be documented in the Waste Retrieval and Closure Demonstration Project Report required by TPA Milestone M-45-05H.*	Closed
DS-9		What information do you have available to dispel the concern that the addition of oxalic acid presents a criticality concern because certain elements are less soluble than others? Where criticality evaluations performed? According to a memorandum (5/16/97) from DNFSB; partitioning of fissile materials presents a criticality concern when using an acid cleaning process. Post-cleaning residual sludge from the study tank had twice the concentration of Pu as those taken prior to treatment. *Response: No text change required. Comment concerns are addressed in RPP-16537. Electronic copy of document given to commenter.*	Closed
JC-45	Page C-1-2-9, Lines 3-13	Oxalic acid effects on the sludge are briefly mentioned. However, as a solvent for iron oxides, oxalic acid has the potential to cause serious problems with the integrity of a 60 year old, corroded carbon steel liner. The effects of oxalic acid on the liner in C-106 are not discussed. The potential effects of oxalic acid and the volume of neutralized waste to be added to AN-106 are also not discussed Requirement: Provide the technical and regulatory justification for use of oxalic acid and its potential effects on the carbon steel liner of C-106 . Also discuss the potential effects of the addition of waste to AN-106 in terms of waste acceptance criteria and volume/space limitations. *Response: Text added to Section 2.4.3*	CLOSED 12/12/03 Action List #50
MJB-Y6	Sec. 2.4.3, ¶ 8, pp. C-1-2-9	The text indicates that the existing sluicer will be used to rinse off the inside of the tank. Please provide sluicing volumes and confirm that the rinsate will *be pumped from the tank to DST 241-AN-106.* *Response: Revisions were agreed to and made*	CLOSED *Action List #43*

Comment Number	Position in Document	Comment/Response	Comment Closure Date
JC-46	Pages C-1-2-9 - C-1-2-12, LDMM System	The proposed LDMM system is ineffective and unacceptable. Drywell logging is unlikely to detect a leak in a timely manner. Furthermore, no details are provided on the proposed schedule for logging, the depths to be logged, the tools to be used, logging rates to be employed and the frequency of logging. Nor is there any indication of the response to any detected leak. In addition, there has been at least 12 feet of vertical movement of Co-60 in drywell 30-06-10 since 1993 at depths well below the bottom of the C-106 tank. How will you distinguish this ongoing movement of unspecified cause from any possible leak during waste retrieval in C-106? The sensitivity of leak detection in the range of 4,000 to 12,000 gals using drywell logging is neither technically defended nor acceptable. Use of the ENRAF system has severe limitations, notably its location and inability to measure during operation of pumps. Mass balance monitoring of the waste retrieval in C-106 in 1999 was highly uncertain and could not determine whether a leak of less than 6,600 gals had occurred because of measurement uncertainty. Mass balance is too fraught with error to be acceptable. No mention is made of HRR which is proposed for the adjoining C-103 tank and could be used for C-106. In short, the proposed LDMM system does not pass the laugh test. Requirement: Propose an LDMM system that is functional and effective, including methods, data to be measured, data interpretation, frequency of data interpretation to demonstrate timely LDMM, and responses to any detected leaks. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #6
DH-67	Section 2.4.4, Pages C-1-2-9 to C-1-2-13	The described baseline LDMM is unacceptable. Reference Ecology letter to James Rasmussen dated June 2, 2003 summarizing Ecology concerns over the DOE baseline LDMM. Using the DOE baseline LDMM, it will not be possible to adequately document the volume or location of potential tank leaks. Essentially, almost all SST retrievals will use methods that render tank mass balance calculations almost useless (+/- 70,000 gallons or more). Ex-tank dry well LDMM may be able to detect leaks if leaks occur near a dry well; however, DOE predicts up to a seven year time frame to detect leaks not located near a dry well. Additionally the DOE estimate of 18,000 gallons for a center tank leak is based on old transport models (Isaacson – 1980's) and Ecology questions the validity of the 18,000 gallon estimate. Describe how DOE will adequately characterize the area surrounding an SST to provide confident data to use in assessing risk and compliance with closure goals/requirements. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #6
MJB-Y7	Sec. 2.4.4.1, ¶ 3, p. C-1-2-11	The text indicates that the timeframe required for leaks to migrate, detection of small volumes, and low percentage of soil limits use of the dry wells. Confirmation of leaks is said to be possible; however, it is not clear how the USDOE will determine that capability is needed. Please explain when use of the dry wells will begin and for how long monitoring will continue after the transfers end. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #6

Comment Number	Position in Document	Comment/Response	Comment Closure Date
MJB-Y8	Sec. 2.4.4.3, ¶ 4, p. C-1-2-12	The text indicates that the sir flow through C-106 will dissolve some of the acid, which would then be transported through the filters. It is not clear what impact that acid will have on the filter materials or their metal frames. Please provide information about the potential for releases of oxalic acid to the environment. Also, please address the potential for reactions between the waste in DST AN-103 and the sodium oxalate formed when the oxalic acid is neutralized in the DST. Please provide information about the potential for emissions from AN-103 that could result those reactions. *Response: Section revised as agreed*	CLOSED Action List #44
JC-47	Page C-1-3-5, Table 3-2	This table indicates that tanks C-103 and C-109 are leakers. Neither tank is listed in Hanlon as an "assumed leaker". Table 3.1 (RPP 16608, Rev. 0) indicates that some of the assumed leakers in Hanlon may not have leaked, but that C-105 (not listed as an assumed leaker in Hanlon) has leaked. Furthermore, the declaration is made in this closure plan that tank C-106 is sound. This conflicting information indicates that the basis for determining the integrity of tanks is highly suspect and must be resolved. This conflicting information certainly underscores the importance and significance of an effective LDMM system (see comment 5 above). Requirement: Provide a technical and regulatory basis for the declaration of tanks as sound; i.e., having integrity. *Response: Updated table and inserted text in Section 3.3.2 and new Section 2.3 (Tank Integrity Summary).*	Action List #51 CLOSED 12/12/03
JC-48	Page C-1-3-6 Line 19	The statement is made that WMA C is not currently under assessment status. What is presumably intended is that WMA C is not currently in interim-status groundwater quality assessment monitoring under 40 CFR 265, Subpart F. True? Please clarify. Requirement: Clarify the meaning of this phrase. *Response: Added RFI/CMS workplan reference and deleted "assessment status". Assessment status no longer drives the RFI/CMS process.*	Closed
JC-49	Page C-1-4-1, Line 25	The statement is made that grout fill will be placed in the tank. What is the technical and regulatory justification for this action? When is it proposed to occur? Is this not an irreversible action that would not be acceptable until final tank closure? Requirement: Provide answers to the questions stated above; i.e., the technical and regulatory justification along with a schedule for grout fill placement in the tank. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12
DD-103	p. C-1-4-2, para 1	Please clarify that this risk assessment for C-106 is focused on long-term impacts to groundwater and does not evaluate soil nor air pathways, as might be required in an intruder scenario or with short-term risks, respectively.	

Comment Number	Position in Document	Comment/Response	Comment Closure Date
JC-50	Page C-1-4-5 Lines 5-8	See comment JC-49 regarding the addition of grout fill to an SST before final closure. If this is an unacceptable action, then it can not be used as a base assumption for risk assessments. **Requirement:** Provide technical and regulatory justification along with schedule for grout placement in a tank. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12
DH-69	Section 5.2 All, Pages C-1-5-3 to C-1-5-7	Revise the entire section. The proposed actions lack sufficient basis, are premature, and are counterproductive at this time. Additionally, until a complete description of closure actions related to ancillary equipment attached to C-106 is presented, neither interim nor final closure actions will be considered. Delete the description of the grout proposal. Provide a description of related ancillary equipment actions as well as alternative interim closure actions to replace the proposed final grout closure action. Requirement. WAC 173-303-610(3) *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12
JC-54	Page C-1-5-5, Line 23	A stated purpose of the Phase 1 cementitious grout filling is to provide structural stability and compressive strength as a foundation for later addition (at some unspecified time) of Phase II and III grout layers. Later in the section, "gel time" is one of the sought parameters for the Phase 1 grout. All these comments indicate that the Phase I grout will harden and "gel", thereby making it non-retrievable and that constitutes an unacceptable irreversible action. **Requirement:** Provide the technical and regulatory justification for the addition of cementitious grout and the physical and chemical properties of each layer, including the role it will play in the satisfaction of the technical objectives for cementitious grout. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12
JC-55	Page C-1-5-5-5 through Page C-1-5-7, Sections 5.2.1 and 5.2.2	DOE is expecting Ecology of the addition of cementitious grout to the tanks without providing a technical and regulatory justification and schedule for this material. Furthermore, the design parameters for the various phases of grout have as yet to be determined. No approval will be forthcoming for the addition of cementitious grout until this required, but missing information is provided. **Requirement:** Provide technical and regulatory justification as well as schedule for the addition of cementitious grout to tanks in various phases and provide the specific design properties of these various grout layers to Ecology. This will be required prior to any approval of this action. *Response: Comment will be resolved through development of permit conditions*	CLOSED Parking Lot #12

Comment Number	Position in Document	Comment/Response	Comment Closure Date
DH-70	Section 5.3 All, Page C-1-5-8	Revise the entire section. Isolation of C106 from ancillary equipment cannot occur without first analyzing the impact of isolation on both the tank and ancillary equipment. For instance, the tank may be needed to flush line waste into prior to retrieval. The last sentence (Lines 28-29) is not acceptable. DOE must provide additional text summarizing the interrelated actions for tank(s) and ancillary equipment. A condition listing a schedule to provide this information may be necessary. Response: Revised text in Section 5.3.	CLOSED 12/10/03 Action List #25
DH-71	Section 5.4 LDR	**LDR cannot be addressed until waste is adequately characterized. Issue – hold for internal discussion** **Bartus**	HOLD
DH-72	Section 5.6	**General Requirements Issue – HOLD This section should be expanded to include general requirements not covered elsewhere in the permit, including a specific level of detail for C-106. Hold for final NODs** Jeanne Wallace/Bob Wilson/ R. Heggen	HOLD
DH-73	Section 5.8	**Schedule Issue – HOLD Not if the final action will not occur at this time.** **Perhaps a revised schedule for other less final actions. Additional NOD or condition** DH	HOLD
JC-56	Page C-1-5-14, Table 5-2	**This table indicates that a certified SST system closure plan was submitted to Ecology on 12/29/2002. In fact, Ecology has as yet to receive a "certified SST system closure plan", so this milestone was technically not met.** Requirement: Provide an SST system closure plan to Ecology that is certified to be true, accurate and complete, or submit a schedule as to when such a document will be submitted to Ecology. No approval will be forthcoming without receipt of a closure plan that is certified to be "true, accurate, and complete" in accordance with WAC 173-303-610. *Response: Clarified to commentor that the table reflects milestone language. Added footnote to Table 5-2 that "Certification obtained for RPP-13774 Rev.0"*	Closed
DH-74	Section 6.0	**Care after C-106 + Post Closure —Issues – Hold for additional NODs or conditions** Jeanne Wallace/R. Heggen	HOLD

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Document Number(s)/Title(s) RPP-13774, *Single-Shell Tank System Closure Plan*	Program/Project/Building Number	Reviewer	Organization/Group	Location/Phone

Item	Page #	Comment (s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/ problem indicated.)	Hold Point	Disposition (Provide justification if NOT accepted.)	Status
BR-1.	General Comment	This large multi-tiered document has no index. An index would be extremely helpful. If it is not possible to provide an index then much more cross-referencing to other sections of the document is needed. ***Response: The latter is preferable. Indices at this point would be time-prohibitive and aren't typically provided in closure plans. Better cross-referencing to other sections can be provided where specified.***		Accepted response (10/31/03)	No Action Required
BR-10.	Tier 1, Section 4.4.2, p. 4-14, Lines 16	Direct exposure requires further explanation. It includes ingestion and inhalation, for rads and nonrads. Add additional pathways for direct exposure. ***Response, The impacts from accidents only examined the highest probable accident, in this case, ventilation accident, which is based on an air release pathway and not direct exposure or ingestion pathway.***		Accept response however, the air permit for the tank farms will be examined for non-rads.	Action, check air-permit for non-rads, and include them if possible
BR-11.	Tier 1, Section 4.5, p. 4-16, Line 8	Replace WAC 173-303-7490(4)(b) with WAC 173-340-7490(4)(b). ***Accept, will change to the correct WAC number***		Accepted response (10/31/03)	Action, replace WAC Number
BR-12.	Tier 1, Section 4.5, p. 4-16, Line 14-15	Add to this section the frequency of biological surveys, and whether they will happen before or after closure activities. ***Response, an ecological risk assessment will be done prior to system SST closure. Biological surveys conducted now would be misleading, because tank farm operations is managed in a manner to eliminate to the extent possible intrusion of plants, animals, and insects into the Waste Management Areas***		Conditional acceptance	Action, add text stating a need to determine when a biological survey needs to completed
BR-2.	Tier 1, Section 1.3, p. 1-14, Lines 10-13	More details are needed regarding soil remediation. Applicable regulations include WAC 173-340 and potentially CERCLA; these should be mentioned. Also, the land disposal facility for the soil should be given (ERDF?). ***Response: This information is contained in other sections. Section 1.3 was intended to be a general overview of integration opportunities. See Sections 1.1.3, 1.3.1, and***		Deferred Ecology needed to speak to Brenda (10/31/03)	

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		3.4.1 as examples. *For the latter comment, the following could be added to the end of Section 3.2.2: Contaminated soil may be generated during WMA closure actions. The disposal site for soil will likely be the Low-Level Burial Grounds mixed waste trenches unless soil remediation is done under CERCLA. If CERCLA is the statutory authority for soil remediation, then ERDF may be used. However, soil remediation is expected to occur as part of RCRA corrective action or TSD closure, thus the LLBG would be the appropriate disposal unit. One exception could be soil remediation outside of the WMAs which may be remediated through the CERCLA process and referenced in the Site-Wide Permit.*			
BR-3.	Tier 1, Section 4.3, p. 4-4 line 28 – p. 4-5 line 2	While it is good that this risk assessment addresses groundwater contamination, there should be some mention of the extent to which it addresses direct contact exposure. *Response, an enhanced RCRA Subtitle C will be placed over the site. This barrier has a design life of 500 years and is designed to prevent bio-intrusion and human intrusion (DOE/RL-93-033)*		Accepted response, provided additional detail on the barrier is given (10/31/03)	Action, provide additional text and references to the barrier, included solid description of barrier in modeling section
BR-4.	Tier 1, Section 4.3, p. 4-5 line 2	Explain in this section why evaluation of intruder risks is being deferred to future closure analyses. The information should be given in this document. *Response, an enhanced RCRA Subtitle C will be placed over the site. This barrier has a design life of 500 years and is designed to prevent bio-intrusion and human intrusion (DOE/RL-93-033)*		Accepted response, provided additional detail on the barrier is given (10/31/03)	Action, provide additional text and references to the barrier, included solid description of barrier in modeling section
BR-5.	Tier 1, Section 4.3.1, p. 4-5, Line 19	Strike "and the environment" from this line. The risk assessment just addresses human health risks. No consideration is given to ecological receptors. *Response, during the December 13, 2002 seminar on risk assessments, it was agreed that ecological risk assessment will be done at system SST closure, the wording here reflects that intent. An ecological risk shall be completed before final closure of the WMA.*		Accepted response, provided additional detail on ecological risk (10/31/03)	Action, include information on when ecological risk will be done and why ER is deferred until WMA Closure
BR-6.	Tier 1, Figure 4-1, p. 4-7	Add an arrow to show leaching of contaminated surface soil. Leaching often begins at the surface, so it applies to both surface and subsurface soils. Perhaps "surface soil" is also considered "subsurface soil" with respect to leaching (??). This is confusing to the reader; please clarify. *Accept, will add an arrow to the figure*		Accepted response (10/31/03)	Action, include an arrow on figure

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BR-7.	Tier 1, Section 4.3.2, p. 4-8, Lines 15-19	Add here the number of COPCs that will be evaluated based on the DQO. *Accept, however for a number of chemicals listed in the DQO, IRIS has not published either reference dose nor slope factors. Therefore quantifying the risk from those chemicals may not be possible.*		Modify response (10/31/03)	Action, response will be modified to indicate a hierarchy of risk was examined, not just IRIS
BR-8.	Tier 1, Section 4.3.2, p. 4-9, Lines 1-8	Add in this section a bullet: No exceedence of WAC 173-340 standards for direct contact. *Accept, will add the bullet*		Accepted response (10/31/03)	Action, add bullet to text
BR-9.	Tier 1, Section 4.4.2, p. 4-14, Lines 4-6	Provide the basis and criteria for estimating accident frequencies. *Response, Accident frequencies are based on published documents, FSARs, DSA and other safety hazard analysis documents*		Accepted response (10/31/03)	Action, add sentence stating this
DD-1	Tier 1, p. 4-1, para 2	Although mention is made of protecting the environment, little detail is provided. Please specify that an ecological risk assessment (ERA) will be performed as part of the SST closure process. An ERA is specified in DOE/RL-99-36 (USDOE, 2000), as well as for the Tank Farm Feasibility Study and Tank Farm Closure Risk Assessment in RPP-14284, Rev. 0 (Mann et al, 2003). *Response, as agreed to in the December 13, 2002 workshop on risk assessments, an ecological risk assessment will be completed as part of the Tank Farm Feasibility Study, and WMA Closure. Presently, the tank farms are managed in a manner intended to eliminate, to the extent possible, the intrusion of plants and wildlife into the facilities. Furthermore, Ecological Impacts will be much more impacted by the engineered features (for example, surface barriers, fill materials) and until these engineered features are better known.*		Accepted Response (11/04/03)	Action, rewrite paragraph acknowledging Ecological Risk Assessment, when it is due, and why it is being delayed
DD-10	Tier 1, p. 4-6, #2	This list of receptor scenarios should also include terrestrial and aquatic ecological receptors. *Response, terrestrial and aquatic ecological receptors will be evaluated during the ecological risk assessment at WMA Closure.* EDE for radionuclides and ILCR and III for nonradionuclides should all be assessed for all receptors. Decisions should be based on all three of these metrics (not just EDE). *Response, all metrics (Dose, ILCR, and III) are evaluated.*		Accepted Response (11/04/03) Accepted Response (11/04/03)	Action, include statement about ERA Action, modify text accordingly. Please note that there are DOE Orders that require us to evaluate Dose for these

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					receptors, but there are not regulations for us to evaluate ILCR and HI for Intruder and All pathways farmer.
DD-11	Tier 1 p. 4-8, #2	Please see my comments for HNF-SD-WM-TI-707, Rev. 2 (Rittmann, 2003). *__Response, please see attached responses__*		Accepted Response (11/04/03)	No action, document has been revised to Rev. 3 which addressed Ecology's comments. Rev 3 is a draft and needs to be reviewed.
DD-12	Tier 1, p. 4-8, #3	Provide the basis for including only Tc-99, I-129, Cr+6, nitrate, and nitrite. At a minimum, cite the "previous fate and transport simulation efforts at Hanford." What about assessing other COPCs. For example, the RPE for tank C-104 (RPP-7804, Rev. 0) lists C-14, Se-79, U-233/234/235/236/238, and total U, in addition to those COPCs mentioned here. *__Response, will provide additional references for these CoC's. In the final risk assessment other CoCs will be addressed. Additionally, a table will be prepared that shows the CoCs that are the major contributors to the cumulative metric.__*		Accepted Response (11/04/03)	Action, provide additional references and table.
DD-13	Tier 1, p. 4-9, #4	Define "C4 concentration." This appears redundant with the next bullet (i.e., 4 mrem/y EDE for beta/photon emitters in drinking water). *__Response, there are two ways of calculating dose, one is target organ dose, while the other is EDE. The C4 concentrations are derived from the target organ dose. See section 5.2.2 of Appendix C for a complete discussion of dose calculation.__* Why not also include BDAC standards (USDOE, 2002) for ecological receptors in soil, sediment, and water, based on 1 rad/d (for aquatic animals and terrestrial plants) and 0.1 rad/d (for riparian and terrestrial animals)? *__Response, the appropriate standards for ecological risk will be included at WMA closure__* Why not also include a dose limit to an RME individual (e.g., 15 mrem/y from WDOH [1997])? *__Response, this list was not intended to be an all inclusive list. The performace objectives listed here were derived from RPP-14283 and that should have been__*		Accepted Response (11/04/03) Accepted Response (11/04/03) Accepted Response (11/04/03)	No Action Required No action required Rewrite section and

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		referenced. RPP-14283 provide a detailed discussion of WDoH guidance document			provide the correct reference
DD-14	Tier 1, p. 4-10, para 4	The bulleted "closure management alternatives" (i.e., retrieval efficacy/residual volume, tank fill effects, final cover efficacy) comprise independent variables influencing risk, rather than "alternatives" per se. Alternatives specify particular values within variable distributions. *????*		Accepted Response (11/04/03)	Action, rename section to variables instead of alternatives.
DD-15	Tier 1, p. 4-12, para 1	It appears that short-term risk assessment considers only radionuclides. Please address nonradionuclide risk too. Response, The short-term worker exposure analysis will address nonradionuclides by examining the Air Permits for non-radionuclides.		Accepted Response (11/04/03)	Action, examine NOC air permit for non-radionuclides and update section with non-radionuclides
DD-16	Tier 1, p. 4-14, step 4	Are only inhalation and direct exposure (i.e., external radiation exposure) evaluated for mixed waste accidents? What about ingestion? Response, ingestion of material under these scenarios would be neglible compared to inhalation. The ingestion mechanism would only account for some fraction of the inhaled quantities which would deposit in the mouth and esophagus.		Accepted Response (11/04/03)	Action, state that this is a bounding calculation
DD-17	Tier 1, p. 4-14, step 5	Why are "involved workers" apparently excluded here? Response, omitted by accident will be included		Accepted Response (11/04/03)	Action, change text to include involved workers
DD-18	Tier 1, p. 4-15, step 7	Why are "involved workers" apparently excluded here? Response, omitted by accident will be included		Accepted Response (11/04/03)	Action, change text to include involved workers
DD-19	Tier 1, p. 4-15, step 8	Please list the ICRP (1991) dose-to-risk conversion factors for low and high doses. Response, For involved and noninvolved worker, ICRP 1991 dose to risk conversion factors are: 4.0 E-04 LCF/rem for low doses under 20 rem 8.0 E-04 LCF/rem for high doses over 20 rem For general public ICRP 1991 dose to risk conversion factors are: 5.0 E-04 LCF/rem for low doses under 20 rem 1.0 E-03 LCF/rem for high doses over 20 rem		Accepted Response (11/04/03)	Action, include dose to risk conversion factor

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DD-2	Tier 1, p. 4-1, para 4	*Section 4.0 discusses* short-term and long-term risks, radionuclides, nonradionuclides, human health, and the environment. Please clearly state that 1) short and long-term risks from radionuclides and nonradionuclides will be evaluated in humans, and 2) long-term risks from radionuclides and nonradionuclides will be evaluated in terrestrial and aquatic ecological receptors. ***Accept, but noting that ecological risks will be evaluated at Tank Farm Closure***		Accepted Response (11/04/03)	Action, rewrite paragraph acknowledging Ecological Risk Assessment with these statements
DD-20	Tier 1, p. 4-16, para 2	The WAC citation should be "WAC 173-340-7490(4)(b)." In addition to contaminated soil, note that ecological receptors may be impacted by contaminated groundwater (e.g., riverbank springs, irrigation scenarios) ***Response, the correct citation will be given***		Accepted Response (11/04/03)	Action, Provide correct citation
DD-21	Tier 1, p. 4-16, para 6	Re an ERA, a food chain evaluation should be performed, independent of the amount of bioaccumulation that may be predicted. Exposure to COPCs via the foodchain has become fairly routine in ERA, especially for upper trophic level receptors (e.g., birds, mammals, fish). ***Response, will add food chain evaluation to paragraph***		Accepted Response (11/04/03)	Action, add food chain evaluation to paragraph
DD-22	Tier 1, p. 4-16, para 7	A conceptual model should be developed for ERA which includes all source terms, exposure pathways, and terrestrial and aquatic receptors. Likewise, a range of spatial and temporal scales should be evaluated. ***Response, as agreed to in the December 13, 2002 workshop on risk assessments, an ecological risk assessment will be completed as part of the Tank Farm Feasibility Study, and WMA Closure. Presently, the tank farms are managed in a manner intended to eliminate, to the extent possible, the intrusion of plants and wildlife into the facilities. Furthermore, Ecological impacts will be much more impacted by the engineered features (for example, surface barriers, fill materials) until these engineered features are better known.***		Accepted Response (11/04/03)	Action, add when a conceptual model for the ERA will be developed
DD-23	Tier 1, p. 4-17, para 1	Note that the specified data packages (i.e., RPP-14283, HNF-SD-WM-TI-707) focus on human health risk and largely ignore ecological risk to terrestrial and aquatic receptors. A parallel effort with data package development should be aimed at ecological risk. ***Response, appropriate data packages will be developed for the ecological risk at during WMA closure.***		Accepted Response (11/04/03)	Action, add text to note that similar data packages, if necessary, shall be developed for the ERA
DD-24	Tier 1,	Please provide more detail on the independent merit review board. Will their review		Accepted Response (11/04/03)	No Action necessary

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	p. 4-17, para 5	comments be incorporated into the SST closure risk assessment methodology? ***Response, the requirements for the independent merit review board are still developed. However, details of the review board are often discussed during the technical exchange on risk assessment that occurs every other week. Ecology is invited to those meetings.***			
DD-25	Tier 1, p. 4-18, para 1	In addition to data on residual tank waste, please list data requirements for other source terms, as well (e.g., retrieval leaks, past leaks, ancillary equipment residuals, intentional discharges, etc.). ***Accept, will add additional data requirements for other source terms***		Accepted Response (11/04/03)	Action, will provide additional data requirements for other source terms
DD-3	Tier 1, p. 4-2, para 2	Please provide a citation for the System Assessment Capability. Please see my comments for RPP-14284, Rev. 0 (Mann et al, 2003). ***Accept, please see attached responses, and will include reference to System Assessment Capability***		Accepted Response (11/04/03)	No action, document has been revised to Rev. 1 which addressed Ecology's comments. Rev 1 is a draft and needs to be reviewed.
DD-4	Tier 1, p. 4-2, para 3	Please specify "multiple performance criteria." ***Accept, risk metrics will be spelled out***		Accepted Response (11/04/03)	Action, define multiple performance criteria in terms of Risk Metrics
DD-5	Tier 1, p. 4-4, para 3	Risk assessment objectives (Section 4.2.2) should include ecological risk. ***Accept, will add ecological risk***		Accepted Response (11/04/03)	Action add Ecological Risk to numbered list
DD-6	Tier 1, p. 4-5, para 4	Please see my comments for RPP-14283, Rev. 0 (Mann et al, 2003). ***Accept, please see attached responses***		Accepted Response (11/04/03)	No action, document has been revised to Rev. 1 which addressed Ecology's comments. Rev 1 is a draft and needs to be reviewed.
DD-7	Tier 1, p. 4-5, para 5	Please specify source terms (i.e., COPCs, their inventory, and concentrations). ***Response, CoCs and Inventories are given in Tier 2 Addendum C1 and in RPP-15317***		Accepted Response (11/04/03)	Action, provide reference for inventories and CoCs
DD-8	Tier 1, p. 4-6, para 2	The conceptual exposure model (Figure 4-1) should include terrestrial and aquatic ecological receptors, in addition to various human receptors (consistent with Figure 4-3		Accepted Response (11/04/03)	Action, include a statement that says an ecological risk

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		in DOE/RL-99-36, Rev. 1). *Response, ORP has committed to doing an ecological risk assessment before closure of a WMA, a conceptual model figure will be developed for the ecological risk and will be added to the closure plan at that time.* Is "Trespasser" (Figure 4-1) the same as "Intruder?" *Response, trespasser is the same as intruder and the figure will be modified*			conceptual model will be developed at the time an ERA is done. Action, change figure
DD-9	Tier 1, p. 4-6, #1	The institutional control period is described as 150 yrs (not 50 yrs) in the Tri Party response letter (7/11/02) to HAB Consensus Advice #132. *Accept, the text will be changed to reflect this.*		Accepted Response (11/04/03)	Action, revise text to 150 years
JC-1	Tier 1, Page 4-1 Lines 1 and 2	A risk assessment is required for closure of units as a landfill AFTER an adequate demonstration/analysis proves that clean closure is not possible. This statement needs to be added to this paragraph. Furthermore, since most agree that clean closure is unlikely, a technically credible risk assessment should be performed to evaluate the clean closure option. If, as suspected, clean closure is not feasible, then that risk assessment should be included in the Tier 1 Closure Plan as applicable to all tanks. (JC) *Response, the risk assessment for the Clean Closure option is being conducted as part of the Tank Farm EIS*		Accepted Response 11/20/03	Action Item: Include a pointer to the EIS specifically stating that the Clean Closure Risk Assessment is being provided by the Tank Farm Closure EIS
JC-2	Tier 1, Page 4-4 Line 1	For the risk assessment at the closure of a WMA, ACTUAL volumes of retrieval leaks will be needed, NOT hypothetical estimates. An effective LDMM system will provide this data. (JC) *Response, this risk assessment was completed before retrieval began therefore the use of hypothetical retrieval leaks is appropriate, since no data on retrieval leak volumes are available. Furthermore, I believe that the LDMM system will be deployed on future retrievals and leak volumes calculated by the LDMM can be used to update risk assessments, but until actual volumes are available, a hypothetical leak will be used for the risk assessment. The LDMM is scheduled to be deployed for the retrievals at Tanks S-103, C-105, and C-103*		Accepted Response 11/20/03	Action Item: Remove "hypothetical" in front of retrieval leak. Add text that actual data will be used to examine retrieval leaks when that data becomes available.
JC-3	Tier 1, Page 4-4 Line 3	For the risk assessment at the closure of a WMA, ALL liquid waste disposal sites both within and adjacent to the existing boundary of the WMA that will be covered by a barrier will constitute a new source term. Definitive inventories will be needed not just for the SSTs and facilities within the current perimeter fence of a WMA, but also for adjoining cribs, trenches, specific retention trenches, tile fields, reverse wells, French drains so that a credible risk assessment of this new composite source term can be		Accepted Response 11/20/03	Action Item: Add explanation about SAC analysis to page 4-1 to address concerns from nearby facilities

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		performed. (JC) *Response, the System Assessment Capability is performing a composite risk analysis that will address this question. This will be reference along with the expected publication of the document.*			
JC-4	Tier 1, Page 4-6 Line 2	See comment for Page 4-4, Line 1. (JC) *Response, the risk assessment for the Clean Closure option is being conducted as part of the Tank Farm EIS*		Accepted Response 11/20/03	Action Item: See action item for comment 4-1 line 1
JC-5	Tier 1, Page 4-6 Lines 18-22	The emphasis here is on human receptors at various locations as depicted in Figure 4-1. Ecosystem risk is not mentioned here, but is in Section 4.5. A note that ecosystem risk is addressed later in the section would be appropriate to indicate that this element has not been ignored. (JC) *Response, will include a note in this section addressing the ecological risk*		Accepted Response 11/20/03	Action Item: Provide table about levels of risk assessment and it is included and evaluated at each level
JC-6	Tier 1, Page 4-8 Lines 20-24	Unless and until proven otherwise, uranium should be included in this list. (JC) *Response, uranium will be added to this list, please note the risk assessment provided for WMA C did include uranium.*		Accepted Response 11/20/03	Action Item: Add uranium to this discussion
JC-7	Tier 1, Page 4-12 Figure 4-2	This figure nicely depicts the process of reduction of uncertainty. How will uncertainty be quantitatively addressed to demonstrate the success of this process in a way that can be easily understood by stakeholders? Please address. (JC) *Response, the initial risk assessment biased the input parameters so that the results would be on the low side. For example, the hydraulic conductivity used in the modeling was 50 m/d, a higher hydraulic conductivity would shorten the travel time, but reduce the peak values because of more water flowing through the system. It was believed that a hydraulic conductivity of 50 m/d was on the low side. Therefore, when a RCRA monitoring well was installed just outside the WMA C Fenceline, it was requested that the monitoring well go all the way to the basalt, and that unconfined aquifer be tested. This was done in September, the drilling indicated the formation was open framework gravels down to the basalt, and aquifer tests indicate the hydraulic conductivity was between 1,000 and 6,000 m/d. We are doing the same with tank waste samples. In our model, we assume that Tc-99 in the sludge is 100% soluble with water, testing from PNNL laboratory indicates that in may only be 25% soluble. So, uncertainty is reduced by having a data collection program in conjunction with the risk assessment and applying the new data to the model.*		Accepted Response 11/20/03	Action Item: Refer to the uncertainty section in WMA Closure Plan
JC-8	Tier 1,	Emphasis on conceptual model development is focused on fate and transport through the		Accept Response	Action Item: Provide

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	Pages 4-4 to 4-12	vadose zone. What is the approach to be used for groundwater transport to the potential receptors? Please specify. (JC) ***<u>Response, the model incorporates groundwater transport to the fenceline. At that point, it is assumed the water will be withdrawn from the aquifer at that location. For points downstream of the fenceline, a streamtube analytic solution is used. Additionally, results from the vadose zone model are being transmitted to PNNL for use in the SAC model.</u>***		(11/20/03)	add
JC-9	Tier 1, Pages 4-4 to 4-12	As the models/codes are likely to be similar for all computations, some discussion of the modeling approaches and codes should be addressed. Please specify. (JC) ***<u>Response, a modeling data package with this information was created and will be referenced.</u>***		Accepted Response 11/20/03	Action Item: Refer to modeling data package to describe model setup.
MB-1	Tier 1, Sec. 4.3.2, Define the Conceptual Exposure Model, p.4-8	In item 3, a number of contaminants of concern having long half-lives are listed. Absent is uranium; the State of Washington is concerned that no effort is made to include this toxic in those constituents with long-term impact. ***Response, Uranium will be added to this list, additionally in Addendum C1, a table will be prepared showing the contaminants of concern that are the top contributors to the risk metric***		Accepted Response 11/20/03	Action Item: add uranium to list of COPCs
MB-2	Tier 1, Sec. 4.4.2 Radiological Risk from Accidents Involving Mixed Wastes, p. 4-13	This section indicates that radiological risk will be expessed as the number of latent cancer fatalities (LCF) resulting from accidents. In sec. 4.3.2, a parameter is listed that bounds the lifetime cancer risk (LCR) at 1E-5. It is not clear why radiological risk is confined only to LCF. Radiological risk clearly encompasses non-fatal cancers; explanation must be added to explain the choice of LCF alone. That explanation must address the bases that the USDOE used to choose LCF as representative of all cancer risk. ***Response, The latent cancer fatality is consistent with the methodology approval by Ecology in AX RPE and TWRS EIS and provides a means for comparison with these other documents including S-112 F & R, S-102 F & R and C-104 F & R. This methodology is consistent with the International Commission of Radiological Protection (ICRP) recommendations for calculating dose to risk. This methodology does not represent all cancer risk. The methodology for the long-term groundwater and soils risk in Section 4.3.2 is different than the LCF risk. This risk represents exposures to current worker and general public should the most bounding accident***		Accepted Response 11/20/03	Action Item: Add non-radionuclides to short term risk

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		occur during closure activities only.			
BR-28.	General note based on Tier 2, Sec. C5.1.2, Figure 5-3	Figure 5-3 shows exceedence of the I-129 MCL at the fenceline for the base case at about 2050 or 2100. This is the only COC that is projected to actually exceed an MCL. All others appear to remain well below their MCL. *It* appears that I-129 is a relatively significant problem and should always be discussed in tank risk documents along with Tc-99. ***Response, there is not an MCL for I-129, what is reported as an MCL is actually a MCL derived concentration relating dose from beta emitters to a 4 mrem in a year dose using target organ.***		Accepted response (10/31/03)	No action required
BR-13.	Tier 2, Figure C2-2, p. C3	Some sites that were referred to in the History of WMA C section should be added to this figure: 202A building, 244AR vault, and 244A lift station. If these locations are outside the map area then add arrows pointing in their relative directions. ***Response, All three of the sites are to the south of WMA C. The map can be updated to show arrows labeled with the sites. (Note: I could not find reference to the 244A lift station in my version of the WMA C draft)***		Accepted response (10/31/03)	Action, include an arrow on figure
BR-14.	Tier 2, Section C2, p. C8, lines 11-13	Provide more information about UN-200-E-27: type of release (liquid, solid), depth of contamination ("surface" could go down to 15 ft). ***Response, The UN-200-E-27 release was airborne particulate contamination, and the impact is limited to the ground surface.***		Accepted response (10/31/03)	Action, add sentence
BR-15.	Tier 2, Section C2, p. C8, lines 14-16	Provide the thickness of clean soil that was used to cover UN-200-E68. This is important to evaluating compliance with WAC 173-340. ***Response, The WMA C text was taken from a document (PNNL-13024) that miss-quotes the source document – the WIDS report states "the affected areas (for UN-200-E-68) were either decontaminated to background radiation levels or covered for later decontamination", with no indication that it was covered with clean soil. The source of the wind-borne contamination was determined to be the 241-C-151 diversion box, which was opened, flushed, and sprayed with Turco Fabri-Film to physically fix contamination to the structure surface. This text can be added to the WMA C UPR discussion.***		Accepted response (10/31/03)	Action, add discussion
BR-16.	Tier 2, Section C2, p. C8,	Provide the distance to the south of WMA C that UN-200-E72 is located. Also give its aerial extent, how the contamination is "fixed" in place, the source of the contamination, and its depth.		Accepted response (10/31/03)	Action, add discussion

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	lines 17-21	***Response. The site is located near the 216-C-8 crib. The surface contamination was fixed in place with Turco Fabri-Film. The source of the contamination was determined to be from the burial of previously undocumented contamination material. The area was surrounded with a chain and posted as a Surface Contamination Area, however, the site is no longer marked or posted. No information regarding the buried material was given in the WIDS report, it is assumed that the contamination extends to the depth of the buried material, but the aerial extent and depth are not known.***			
BR-17.	Tier 2, Section C2, p. C8, lines 22-24	Give the direction for UN-200-E81 relative to 244 CR vault – is it N, S, E, or W? Also give the depth of the gravel cover. This is important to evaluating compliance with WAC 173-340. ***Response, the unplanned release is to NE of the 244 CR vault, near the 241-CR-151 diversion box. The cover was comprised of 0.5 m (18 inches) of backfill and clean gravel.***		Accepted response (10/31/03)	Action, add discussion
BR-18.	Tier 2, Section C2, p. C8, lines 25-29	The location of UN-200-E82 is not clear. Is it between tanks C-104 and C-101? What is the depth of the gravel cover at this site? This is important to evaluating compliance with WAC 173-340. ***Response, the release occurred at the 241-C-152 diversion box and flowed to the northeast, downgrade, until it pooled into an area, measuring approximately 0.46 m^2 (5 ft^2), outside the WMA C fence, according to the WIDS report. The reference used for the text was erroneous, it will be updated to state that the source was determined to be the feed line running between tank C-105 and the 221-B building, and the underground waste line leak was discovered near the 241-C-152 diversion box. The depth of the clean gravel applied in 1969 was not provided in the WIDS report, however, it states that additional decontamination of the area was done in 1985.***		Accepted response (10/31/03)	Action, add discussion
BR-19.	Tier 2, Section C2, p. C8, lines 25-29	Where is UN-200-E-86? The previous revision of this document had a very useful figure showing the location of the UPRs and UN's relative to the tanks. With this figure deleted the descriptions of the locations for the sites require greater detail. Alternatively, add the UPRs and UN's to Figure C2-2. ***Response. The WIDS report states that the release occurred near the southwest corner of WMA C, outside the fence. The site is an area measuring approximately 6 by 6 m (20 by 20 ft), with concrete AC-540 marker posts at each corner. The surface has been covered with "Shotcrete". It is posted with "Underground Radioactive Material" signs.***		Accepted response (10/31/03)	Action, add discussion

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BR-20.	Tier 2, Section C2, p. C9, lines 3-6	Please add how UN-200-E99 was decontaminated. *Response. The release site was not decontaminated (the reference used was erroneous); radiological surveys completed inside the posted Surface Contamination Area (in support of herbicide applications in 1981) found no detectable contamination, and the Surface Contamination postings were removed on March 5, 1981 and the area was released from radiation zone status, based on the radiation survey results. The reference used for the WMA C text states the release site as west of the 244-CR vault; the WMA C text will be corrected to say the release was a posted area located south of 7th street, directly south of the 244-CR vault, per the WIDS report.*		Accepted response (10/31/03)	Action, add discussion
BR-21.	Tier 2, Section C5.0, General	There are many instances in which concentrations or doses, generally obtained via modeling, are reported to greater than 2 significant figures. This gives the reader the illusion that the estimates are quite good. Given the high level of uncertainty in the BBI, processes modeled and other inputs, there is little justification for exceeding 2 significant figures on any of the estimated concentrations or doses. *Accept, numbers will be displayed with only 2 significant digits.*		Accepted response (10/31/03)	Action, only report to 2 significant digits
BR-22.	Tier 2, Section C5, p. C5-1, lines 21-23	This statement should be rephrased to indicate that the dose is only a radiological dose. Also, the pathway of exposure should be given in this statement. *Accept, statement will be re-worded.*		Accepted response (10/31/03)	Action, re-word statement and add pathway to exposure
BR-23.	Tier 2, Section C5.1.2, p. C5-10, lines 4-5	Please rephrase this sentence: ~~Estimated past leaks from C105 and ancillary equipment have released 13.26 Ci of technecium-99~~, to read Past leaks from C105 and ancillary equipment have released an estimated 13 Ci of technecium-99. *Accept, sentence will be changed to suggested text.*		Accepted response (10/31/03)	Action, re-word statement and add pathway to exposure
BR-24.	Tier 2, Section C5.1.2, p. C5-10, lines 16-18	Please replace the expression "selected phase removal" with a more detailed explanation of this process. Also, please provide the reader with a reference for the HTWOS projected residuals. *Accept, the inventory and terminology is described in addendum C1. A better reference to the appropriate sections will be provided.*		Accepted response (10/31/03)	Action, will provide reference to the appropriate sections in addendum C1
BR-25.	Tier 2, Section C5.1.2, Tables C5-3,	Grouting of pipelines is not guaranteed. Therefore, a case with ungrouted pipelines should be added for all COCs. *Response, ancillary equipment must be removed, isolated, and/or stabilized. Because*		Accepted response (10/31/03)	No action required

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	C5-4, C5-5	*of these requirements, it is expected the pipelines either removed or grouted, that is also the working assumption for the EIS.*			
BR-26.	Tier 2, Section C5.1.2, Lines 2-6	Chromium is given as the primary hazard index driver. However, given that uranium is also of concern from a hazard perspective (in addition to being a cancer risk) there should be a statement here about its role as a hazard, and it should be ranked relative to nitrate, nitrite and chromium. The ranking of the hazardous chemicals would be useful in this section. *Accept, will provide additional text on other contaminants*		Conditional acceptance (10/31/03)	Action, a ranking of contaminants per metric will be added, the table will include both HSRAM industrial and residential, a discussion of choice of scenarios will also be provided
BR-27.	Tier 2, Section C5.1.2, General	This section should include some discussion about grout failure in tanks via cracking and grout separation from tank walls. *Accept, additional text will be provided describing the advection case. The advection case would be similar to grout failure or grout separation from tank walls*		Accepted response (10/31/03)	Action, a discussion of the advection case will be provided. The advection case would be similar to grout failure
BR-29.	Tier 2, Section C5.1.2, Table C5-5	The value given for the residuals in 244-CR vault and catch tank release by diffusion is given as 0.0000, while other values are reported at levels as low as E-06. Is this a typo? Please put actual values in for this release even if they are low. *Accept, will provide the correct values*		Accepted response (10/31/03)	Action will provide correct values
BR-30.	Tier 2, Section C5.1.4 p. C5-17	Sensitivities to infiltration rates and diffusion rates out of the grout should also be examined. *Response, sensitivity to diffusion rates is provide in the addendum, for infiltration rates, we used conservative values. A table will be prepared giving major model parameter assumptions and the relative impact they have.*		Accepted response (10/31/03)	Action re-do uncertainty section
BR-31.	Tier 2, Section C5.1.4, Table C5-6, p. C5-19	The last row discusses Kd and indicates that as Kd increases from 0.0 to 0.01 the peak concentrations decrease by 5% at the fenceline. Is this true for uranium? A Kd of 0.6 mL/g was used for U, which means that concentrations modeled are 3 times lower than they would be if a Kd of 0 was used. Some evidence suggests that sorption Kd values for U should be 0 for Hanford subsurface materials (BHI-01667). Please address how conservative the approach is for uranium. *Response, more recent studies, (Serne, 2003) suggest that uranium has a K_d of 0.2 to 4.0 mL/g. With the lower K_d being appropriate at high and low pH values.*		Accepted response (10/31/03)	No action required

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BR-32.	Tier 2, Section C5.2, p. C5-20, lines 29-30	Provide a sentence that describes the basis for choosing the scenarios that are discussed in this section. *Accept, the basis for choosing these scenarios will provided.*		Accepted response (10/31/03)	Action, provide basis for choosing risk scenarios
BR-33.	Tier 2, Section C5.2, p. C5-21, line 2	Please provide the revision of the document cited. *Accept, revision 3 of HNF-SD-WM-TI-707 was used.*		Accepted response (10/31/03)	Action, will provide the correct revision
BR-34.	Tier 2, Section C5.2.3, p. C5-27, Table C5-9	The table gives risk values for Cr(VI) as if it is a carcinogen. Are the values in this table for Cr (VI) cancer risk values, or hazard index values? If they are hazard index values please indicate this. *Response, These are ILCR number for Cr(VI). ILCR comes from inhalation during showering and dust inhalation from using groundwater for irrigation*		Accepted response (10/31/03)	Action, will provide stating the Cr(VI) ILCR is from inhalation from showering and dust inhalation from using groundwater for irrigation
BR-35.	Tier 2, Section C5.2.3, p. C5-27, Table C5-9	Notice that past leaks and unplanned releases result in risk exceeding 1E0-5 in the river in the year 2355 for the HSRAM residential scenario. Risks in groundwater at the fenceline and in the exclusion zone are higher than this at earlier dates. This is problematic, and remedial actions should be addressed in the closure plan. It would be helpful to the reader if a reference to the section of the closure plan that discusses remedial actions could be given on p. C5-26. Also, there seems to be an interchanging of the terms "exclusion zone" and "core zone". It would be best to chose one of these and use it consistently throughout. *Response, we have provided Columbia River water as undiluted. In reality, there would be a dilution factor applied for Columbia River surface water. We will use "core zone" boundary nomenclature*		Accepted response (10/31/03)	Action, exclusion zone boundary will be changed to core zone boundary throughout the document. Will provide additional language stating the calculations are biased toward the higher numbers
BR-36.	Tier 2, Section C5.2.3, p. C5-27, Table C5-9	What is Columbia River groundwater? Is this the springs along the river? If so, why are concentrations in the river the same, or in some cases higher, than those in the groundwater? Wouldn't dilution influence the concentrations in the river? *Response, Columbia River groundwater would be groundwater just before it enters the Columbia River. No dilution should occur in this water.*		Accepted response (10/31/03)	Action, explain the difference between surface water and groundwater, provide example of dilution.
BR-37.	Tier 2, Section C5.3.2, p.C5-31	This section only addresses exposure to rads. Please address exposure to non-rads such as gases like ammonia and H_2S. *Response, The short-term worker exposure analysis will address nonradionuclides*		Accepted response (10/31/03)	Action, check air permit for inventory and if possible include non-rads

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		(i.e., chemicals) on new data from the waste retrieval of tank C-106			
BR-38.	Tier 2, Section C5.4.1, p.C5-31, line 27	The document appears to have no Figure C5-9. Is the statement supposed to refer to Figure C5-8? *Accept, yes wrong figure caption, will be corrected*		Accepted response (10/31/03)	Action, change figure caption
BR-39.	Tier 2, Section C5.4.1, p.C5-32, line 17-18	The discussion makes it sound as though groundwater flow is along rows in tank farms, rather than down gradient. Please clarify. *Response, at the present time the groundwater flow direction is to the Southwest due to the influence of B-Pond. Predicted long term flow direction is to the southeast, which is roughly parallel to the line of tanks. Assuming this flow direction is also the most conservative since it represents the shortest distance to the WMA C fenceline*		Accepted response (10/31/03)	Action, provide additional text for groundwater flow directions
BR-40.	Tier 2, Section C5.4.1, p.C5-32, line 22-23	Please justify ignoring gas-phase transport of iodine. This also refers to Addendum C, p. C1-19, line 8. *Response, Monitoring of iodine-129 in groundwater indicates the transfer of iodine-129 from groundwater to air would be a minor. It is expected that air-transport of I-129 would be negligible. Additionally, although the numerical code to run air transport is available, they are computationally intensive and can take weeks to run one simulation. This maybe investigated in greater detail in the future.*		Accepted response (10/31/03)	No Action Required
BR-41.	Tier 2, Addend. C, Section 2.0, p. C1-9, Lines 33-38	Please define "downstream" (is this down gradient?) and "near the site" (quantitatively if possible). *Accept, downstream is downgradient, text will be modified. Near the site is within the core zone boundary*		Accepted response (10/31/03)	Action, change downstream to downgradient and define near the site
BR-42.	Tier 2, Addend. C, Section 3.1, Figure 3, p. C1-13	Please replace the expression "breakthrough curve" with "contaminant concentrations through time"; please mention that the "routing" will be done electronically. *Response, breakthough curves are the standard nomenclature when discussing contaminant transport.*		Accepted response (10/31/03)	Action, provide definition of breakthrough curve
BR-43.	Tier 2, Addend. C, Section 3.3.1, p. C1-17, Table 3 and General	There is proposed use of an enhanced RCRA C barrier. It is important to reference documents or sections of the closure plan that describe the characteristics of the barrier. In other parts of Hanford RCRA C barriers are expected to fail rapidly due to the cracks that can form in an arid climate, so the enhancements are important if the lifetime is to be 500 y, and the reader should know where to find these. *Accept, a description of the barrier and its performance will be added along with the*		Accepted response (10/31/03)	Action, provide adequate description of modified RCRA Subtitle C barrier and appropriate references

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		appropriate references for the barrier.			
BR-44.	Tier 2, Addend. C, Section 3.3.1, p. C1-18, Line 11	Define "unit source inventory" or reference the section of the closure plan where it has been explained. ***Accept, unit inventory is discussed in Sections 4.1 and 4.2 of Addendum C1. All numerical models were simulated with an inventory of 1 Ci. The model results for each source term (past leak, retrieval leak, tank residuals, or ancillary equipment residuals) can then be multiplied by the actual inventory expected for the source term. This allows us to scale the results to the appropriate inventory. Inventory for the tanks are constantly changing.***		Accepted response (10/31/03)	Action, reference appropriate section in Addendum C1
BR-45.	Tier 2, Addend. C, Section 3.3.2, p. C1-19, line 28-30	It is difficult to tell where the streamtubes begin and how contamination from the vadose zone connects with streamtubes – a figure would be very helpful. ***Accept, a 2-Dimensional cross-sectional model is used to model each within the vadose zone to the fenceline, however from the fenceline to the river a streamtube model is used. A figure will be provided***		Accepted response (10/31/03)	Action, add figure showing streamtubes and text describing streamtubes
BR-46.	Tier 2, Addend. C, Section 3.5.1, Table 5, p. C1-24	Give the size of 216-C-8 french drain leak. Also, summarize briefly from RPP-15327 for UPR-200-C136. ***Accept, the amount of effluent discharged to the 216-C-8 french drain is 10,000 L (2,640 gal)***		Accepted response (10/31/03)	Action, include number of gallons discharged to 216-C-8 french drain to table
BR-47.	Tier 2, Addend. C, Section 3.5.2, p. C1-34, lines 1-4	Explain more in the text about the dropping of C-14, cyanide and Se-79 from the list, and the addition of Cr (VI). Is the empirical groundwater information pertinent to the tank farm areas? What processes attenuate C-14, cyanide and Se-79, and which have introduced Cr (VI)? ***Accept, the CoCs presented in this risk assessment are ones that driven the dose, ILCR, and Hazard Index for previous risk and performance assessment and have made it through the vadose zone through the vadose zone to the groundwater from the monitoring program. Risk assessments are iterative in nature, additional CoCs are being examined and a chart or table will be provided that shows the cumulative radiological dose, hazard index, and ILCR and the CoCs that a major contributors to the metric***		Accepted response (10/31/03)	Action, a ranking of contaminants per metric will be added, the table will include both HSRAM industrial and residential

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BR-48.	Tier 2, Addend. C, Section 4.0, p. C1-35 Bullets 6&7 in shaded box	These bullets are a bit misleading. Macropore flow can mobilize even contaminants with high Kds. Since we must resort to models in lieu of data it should be up front that not all processes of significance are understand accounted for. Please insert a bullet about model assumptions. ***Response. The vadose zone flow and contaminant transport modeling is based on continuum assumption. Potential discrete, preferential pathways such as clastic dikes and poorly sealed well casings are not included. Analysis for the S/SX field investigation report has shown that clastic dike effects on long-term risk under low recharge conditions are negligible.***		Accepted response (10/31/03)	No action required
BR-49.	Tier 2, Addend. C, Section 4.0, p. C1-36, lines 4-11	This section is unclear. Please define "Minimal changes in groundwater impacts" and "groundwater impacts were reduced" relative to a reference point. ***Accept, paragraph will be re-written. Minimal changes in impacts refer to the different release rates (the peak concentration for a release that took place over 1 year was not very different from the peak concentration when the release from the tanks took 500 years)***		Accepted response (10/31/03)	Action will re-write the paragraph
BR-50.	Tier 2, Addend. C, Section 4.0 and 4.1, p. C1-36 and C1-37	Please make the parameters on lines 1-3 on p. C1-36 consistent with those on lines 28-32 on p. C1-37. It is difficult to tell which parameters were actually tested for sensitivity. ***Accept, will provide a better discussion on page C1-37***		Accepted response (10/31/03)	Action will provide better discussion sensitivity
BR-51.	Tier 2, Addend. C, Section 4.2.1, p. C1-39, lines 9-10	The solubility for sodium nitrate is given to be 72 g/L in the tank solution. It is given later in the document (Addendum C, p. C1-119) to be 1/5 of 360 g/L based on the literature. Please cross-reference the discussion in Addendum C here, or move that discussion to this section. ***Accept, however, although a solubility-release model was examined in this Risk Assessment, none of the results for the Risk Analysis used the solubility release model, since the waste in these tanks are sludge and not salt cake. A solubility release model was included to provide experience with this model before modeling salt cake***		Accepted response (10/31/03)	No action required
BR-52.	Tier 2, Addend. C, Figures 6 and 8	Please provide the nuclides that have been modeled in these figures. Which nuclide is the mobile one, and which is the immobile one? Do the mobile and immobile have the same specific activities? Is figure 8 based on the unit source inventory? ***Response. In section 4.2 unit inventory is discussed generically in terms of different***		Accepted response (10/31/03)	No action require

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		K_ds. Inventories for different source terms vary significantly and it becomes impossible to determine sensitivities, when the inventory is varies. The point to this section was to take out the impacts due to inventory by always leaving it at 1 curie or 1 kg. By doing this we can examine the impacts due to changing the release rate, the K_d, and the hydraulic conductivity of the aquifer. For example, in Figure 6 say the CoC is Tc-99, what is the relative impact if Tc-99 is modeled with a K_d of 0.1 mL/g instead of 0.0, from these figures, if Tc-99 had a K_d=0.1, the concentration would drop from 689 pCi/L to 103 pCi/L. For Figure 8, the impact to hydraulic conductivity was examined, in this case increasing the hydraulic conductivity from 4.8 m/d to 50.0 m/d, results in peak concentration drop from 689 to 83.9. These section was provided to show the sensitivity to different parameters			
BR-53.	Tier 2, Addend. C Section 4.3.1, p. C1-49, lines 4-16	It is explained that the larger the volume of solution used in retrieval the more dilute the contaminants in the leaking solution. However, the more solution used in retrieval the longer the retrieval will take and the longer the tank will be leaking. Therefore, the total volume leaked will likely be larger than in a lower-volume retrieval situation. The reader will not get this from the discussion in this section, and it is misleading to imply that using more solution in retrieval is more conservative than using less when it comes to leaks. For a larger volume of solution in retrieval you should consider larger leaks. *Accept, the methodology used to calculate the retrieval leak has been re-examined, and will be re-written. In the methodology presented here, a concentration is calculated based on the volume of retrieval fluid. Instead of using this methodology, the concentration of the retrieval fluid will be taken from the Hanford Tank Waste Operations simulator*		Accepted response (10/31/03)	Action, re-write retrieval leaks section in light of the new data
BR-54.	Tier 2, Addend. C, Figure 14, p. C1-57	Please change the symbols on this graph, since most people will only see a black and white version. The multi-directional triangles are hard to tell apart. *Accept, will change symbols on graph*		Accepted response (10/31/03)	Action, redo graph with better symbols
BR-55.	Tier 2, Addend. C, Section 4.3, Tables 12, 13;	Notice that plumes of I-129, nitrate, nitrite and Cr (VI) (and possibly other contaminants) from leaks, late in this century and into the beginning of next, are expected to become diluted by about a factor of 10 between the fenceline and core zone boundaries. Travel time looks to be about 20 to 30 y. The dilution/dispersion process is worth discussion. Either discuss it in close proximity to the tables (more detail in Section 4.3.3) or reference the place in the document where it has been discussed. *Accept, dispersive spreading within and transverse to the main direction of flow causes the gradual dilution of the contaminant plume.*		Accepted response (10/31/03)	Action, provide discussion of dispersive spreading from fenceline out to river
BR-56.	Tier 2,	Please provide a figure for uranium similar to Figures 17 and 18. The time scale can be		Accepted response	Action, add figure for

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	Addend. C, Section 4.3.2, p. C1-65	different if necessary, but its behavior over the next 100 y is worth showing because U is an important COC throughout the site. Additional figures showing its behavior with a Kd of 0 would be helpful, because this Kd is being used in other areas of the site (300 area, for instance). ***Accept and discussion point, will provide a figure for uranium, but in light of the recent PNL document (June, 2003), changing the K_d for uranium is in appropriate***		(10/31/03)	uranium
BR-57.	Tier 2, Addend. C, Section 9.0, p. C1-119 and C1-120	This section is very qualitative and brief and not very helpful. It would be good to highlight the parameters for which you considered several possible values and give a quantitative summary of how those changes influenced the peak concentrations. It would be helpful if the parameters that were not considered quantitatively could be addressed at the end of the section. So, the section could be divided into quantitative evaluations, and qualitative evaluations. This section is not a good place to introduce new information. ***Accept, this section will be moved to just before the Risk Assessment results and the information and organization requested will be proved***		Accepted response (10/31/03)	Action, re-write limitations and uncertainty section. Section will also be move to just before the section 7.0
BR-58.	Tier 2, Addend. C-2, General	Because this document has no index it would be very helpful if each of the tables in this section had a footnote to direct the reader to where the corresponding discussion in the text can be found for each table. ***Accept, will key tables to page numbers***		Accepted response (10/31/03)	Action, will key tables to text page numbers
BR-59.	Tier 2, Addend. C, Table 2-4, p. C2-16	The risk values for the Columbia River population are very large and orders of magnitude beyond 1E-05. Addendum C has minimal discussion about this. To prevent various panic attacks it would be helpful to discuss this scenario at length. ***Response. Tables with Columbia River population should not have been included. Two factors were not taken into account when these stables are dividing the risk by the population (5,000,000) and dividing the risk by a dilution factor (dilution factor would be large, total estimated recharge of all of Hanford going into the Columbia River is 50 ft^3 while the Columbia river flows at 120,000 ft^3)***		Accepted response (10/31/03)	Action will remove tables with Columbia River Populations
BR-60.	Tier 2, Addend. C, Table 2-5, p. C2-17	It looks like Native Americans will be at a relatively high risk level (1E-05 is exceeded in many places and at many times), and this appears to be only groundwater and only Tc-99 – they may actually be at higher risk when all other pathways and contaminants are considered. And this is just one WMA. In this case there may also be panic attacks, so discussion is warranted. ***Response, the risk framework HAB consensus advice #132, although it does not***		Accepted response (10/31/03)	Action will provide discussion on which risk scenarios were chosen and why

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		directly apply to tank retrieval decisions, states the core zone will have an industrial scenario for the foreseeable future, and that other scenarios may be used for decision making. In this spirit, the risk assessment provides discussions of industrial, residential, and all-pathways farmer in the main discussion and provides additional exposure scenarios in Addendum C2.			
DD-100	Tier 2, Add. C1, p. C1-127, para 2, bullet 5 (Conclusions)	Re pCi/L groundwater data cited, please reference Figure 10. Contrary to what the text indicates, the 3030 pCi/L peak concentration is without retrieval for the diffusion-dominated release model (see Figure 10). *Accept, you are right will modify text*		Accepted Response (11/04/03)	Action, fix text
DD-101	Tier 2, Add. C1, p. C1-128, para 3, bullet 2	Radiological EDE did not exceed dose targets at any location for residual waste, past leaks, nor retrieval leaks for all of the scenarios presented (Tables 22, 25, and 28). *Accept, you are right will modify text*		Accepted Response (11/04/03)	Action fix text
DD-102	Tier 2, Add. C1, p. C1-128, para 3, bullet 3	ILCR exceeded the 1E-5 target for the residential scenario for all sources at the fenceline (and several other downgradient points for past leaks) but not the industrial scenario for any source (Tables 23, 26, and 29). III did not exceed the target for residual waste, past leaks, nor retrieval leaks for any of the scenarios presented (Tables 24, 27, and 30). *Accept, you are right will modify text*		Accepted Response (11/04/03)	Action fix text
DD-103	Tier 2, Add. C1, p. C1-130, Conclusions	Please cite the relevant data tables to support each of these conclusions, because most of these conclusions are not readily apparent. *Accept, will cite relevant data tables.*		Accepted Response (11/04/03)	Action, cite relevant tables
DD-26	Tier 2, App. C, p. C5-1, para 3	In the first sentence, "submissions" may be more appropriate than "agreements." *Response, on December 13, 2002, a seminar was held with Ecology in which the iterative nature of risk assessments for tank farms was recognized. During this meeting, it was determined that risk assessments would be done at different stages of tank closure. Seminar notes were transmitted to all participants on January 29, 2003. From those seminar notes, RPP-14284 was written to reflect what was expected for each risk assessment along the closure path.*		Accepted Response (11/04/03)	No Action necessary
DD-27	Tier 2, App. C, p. C5-1, para 4	Table C5-7 shows that dose for "past tank leaks and UPRs" is 1.15E-1 mrem/y at the 200 Area Core Zone boundary (not 0.01 mrem/y, as stated in the text here). Is this because 0.01 mrem/y is for UPRs only, excluding past tank leaks? Please clarify. *Accept, this is a typo, the 0.01 mrem/yr given for the past leaks and UPRs should be*		Accepted Response (11/04/03)	Action, fix typo

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		0.1 Re Table C5-7, what proportion of the total radiological dose is due solely to Tc-99 and I-129? Re the same pattern in ILCR results, please show these data. *Accept, a table will be prepared showing the relative contribution of the top 2 or 3 CoC to the performance metric.*		Accepted Response (11/04/03)	Action, prepare table showing relative contribution of CoC to performance metrice
DD-28	Tier 2, App. C, p. C5-1, para 5	Re the first sentence, I cannot locate Section 5.10 in Addendum C1. Table C5-1 appears to be part of a sensitivity analysis. *Accept, this is a typo. For the analysis, a definitive number for the data was not available, therefore we made assumptions on values for those parameters or methodology. This table lists the assumptions, the assumptions and how we addressed them in the model.*		Accepted Response (11/04/03)	Action, fix typo
DD-29	Tier 2, App. C, p. C5-2, Table C5-1, Assumption #2	Re release rates, please provide the rationale for using stabilized (grouted) tank waste, as opposed to an unstabilized waste form. *Response, the analysis also included unstablized waste form and shows a difference of approximately 3 between stabilized and unstablized waste. At the time of the analysis, it was assumed that a grout would be placed in the tanks. Please note, the diffusion coefficient for the grout is extremely high for a grout.*		Accepted Response (11/04/03)	Action, address unstabilized waste form in uncertainty section
DD-30	Tier 2, App. C, p. C5-2, Table C5-1, Assumption #3	Why are retrieval leaks considered only for tanks C-106 and C-107? *Response, at the time of the analysis on tanks C-106 and C-107 were schedule for wet retrieval methods, all other tanks were scheduled for dry retrieval methods. However, since then the retrieval methods for other tanks within the WMA C have changed and the risk assessment will be updated to reflect those changes.*		Accepted Response (11/04/03)	Action, re-write retrieval leak section
DD-31	Tier 2, App. C, p. C5-4, para 4	Re contaminants, specify the criteria employed to select and retain COPCs. *Accept, the criteria employed to select and retain COPCs is given in section 3.5 of Addendum C1. Additional a table will be made to show the relative contribution of the top 2 or 3 COPCs to the performance metric.*		Accepted Response (11/04/03)	Action, refer the reader to the appropriate section in the addendum and prepare table showing the ranking of COPCs to risk metric.
DD-32	Tier 2, App. C, p. C5-	Why are retrieval leaks specified only for tanks C-106 and C-107? Is it not possible to have leaks even with "dry" retrieval methods?		Accepted Response (11/04/03)	Action, re-write retrieval leak section

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	6, Table C5-2	*Accept, at the time of the analysis on tanks C-106 and C-107 were schedule for wet retrieval methods, all other tanks were scheduled for dry retrieval methods. However, since then the retrieval methods for other tanks within the WMA C have changed and the risk assessment will be updated to reflect those changes.* Clarify references to Tables 5-6, 5-7, 5-8b, 5-8c, and 5-9. Are these Tables 6, 7, 8b, 8c, and 9 in Addendum C1? *Accept, will clarify references*		Accepted Response (11/04/03)	Action, clarify references
DD-33	Tier 2, App. C, p. C5-7, para 1	Please provide the basis for the statement, "Tc-99 and I-129 account for 95% of the total dose and ILCR," while Cr is the primary HI driver." Is this for WMA C, as a whole? *Accept, this is for the WMA C, and will provide an additional table that shows these metrics.*		Accepted Response (11/04/03)	Action, refer the reader to the appropriate section in the addendum and prepare table showing the ranking of COPCs to risk metric.
DD-34	Tier 2, App. C, p. C5-10, bullet #1	In the last sentence, the reference to "(Figure C1-2)" should be to "(Figure C5-2)." *Accept, will change text.*		Accepted Response (11/04/03)	Action, change text
DD-35	Tier 2, App. C, p. C5-11, bullet #3	Re cumulative impacts (i.e., Base Case) , it might be stated that the principal source driver for Tc-99 peak concentration is from past ancillary equipment leaks (Table C5-3). *Accept, will add statement*		Accepted Response (11/04/03)	Action, add statement
		Excluding advection dominated release of residuals, the base case sum in Table C5-3 is about 682 pCi/L for Tc-99, whereas here and in Figure C5-2, the base case sum is 588 pCi/L. Why the discrepancy? *Response, there is no discrepancy, you cannot add the peaks in the table to come up with the cumulative, the peaks occur at different times, therefore you cannot just add the peaks. The cumulative is calculated by adding each complete curve*		Accepted Response (11/04/03)	No action, although a statement might be added about why it is not appropriate to sum the values in the table.
DD-36	Tier 2,	This should be "Figure C5-3," not "Figure 5-3."		Accepted Response	Action, correct text

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	App. C, p. C5-13, Figure C5-3	*Accept, will correct*		(11/04/03)	
DD-37	Tier 2, App. C, p. C5-13, para 1	The federal (EPA) MCL for total Cr is 0.1 mg/L (not 0.05 mg/L). There is no MCL for Cr+6. *Accept, will correct*		Accepted Response (11/04/03)	Action, correct text
DD-38	Tier 2, App. C, p. C5-14, Table C5-5	The title of Table C5-5 specifies Cr+6. Is this correct? Please clarify the distinction between total Cr vs. Cr+6. *Accept, for conservative purposes we assumed all chromium was chromium+6.*		Accepted Response (11/04/03)	Action, will clarify the difference between Chromium (VI) and Chromium(III) and why Chromium(VI) was used
DD-39	Tier 2, App. C, p. C5-17, para 1	Where are assumed retrieval leaks (as an input variable)? In RPP-16525 (Rev. 1), it was shown that "ex-tank" risk coefficients (i.e., ILCR/Ci) for leaks were approximately 100 fold greater than "in-tank" risk coefficients for residual waste. Ex-tank risk coefficients included both past leaks and retrieval leaks. Aside from an assumed 8000 gallon leak vs. 2500 gallon residual and the 500-1000 y hold-up period for residual waste, why is it that ex-tank risk coefficients (leaks) are so much larger than in-tank risk coefficients (residuals) for a given exposure scenario? *Response, ex-tank leak coefficients are larger because they have already occurred when the recharge rate is 100 mm/y. The large recharge rate drives the risks associated with ex-tank releases. In-tank releases occur after a barrier has been placed over the site, once the barrier fails, the recharge rate only increases to 3.5 mm/y*		Accepted Response (11/04/03)	No action required
DD-40	Tier 2, App. C, p. C5-19, para 1	Why are all long-term risk metrics related to the groundwater pathway? For example, the intruder scenario (RPP-14283, Rev. 0) is typically modeled somewhere between 150 y post-closure (i.e., USDOE institutional control) and 500 y post-closure (i.e., NRC institutional control). If 150-500 y after closure is considered "long-term," then soil and air pathways should also be evaluated for risk (in addition to groundwater). *Response, a RCRA enhanced barrier will be placed over the site at closure. The barrier will be minimum of 15 ft thick with a design life of 500 years (DOE/RL-93-033). The design of the barrier incorporates provisions for bio-intrusion and human intrusion control. The barrier would eliminates soil pathways, and past performance assessments (200 East and 200 West burial grounds) have shown, that with a barrier in place, the air pathway is negligible contributor compared to the groundwater pathway*		Accepted Response (11/04/03)	Action, add clarifying text

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DD-41	Tier 2, App. C, p. C5-20, bullet 1#	Kd has units like L/kg or mL/g (not mg/L). *Accept, typo will be corrected*		Accepted Response (11/04/03)	Action, correct text
DD-42	Tier 2, App. C, p. C5-21, para 5	The residential drinking water scenario assumes 2 L/d (not 1 L/d). *Accept, typo will be corrected*		Accepted Response (11/04/03)	Action, correct text
DD-43	Tier 2, App. C, p. C5-22, para 1	It is stated that the dose for the industrial drinking water scenario (1 L/d) is "reduced by 50%, as compared to the residential scenario" (2 L/d). Besides intake rate, this would assume that other exposure factors (e.g., exposure duration, exposure frequency) are the same for both scenarios which seems incorrect. Please explain. *Accept, you are right, the industrial worker is only on site for 250 days vs 365 days and the industrial workers dose should be further reduced by 30 %. The total amount of drinking water consumed by a resident is 730 L, while for the industrial worker it is 250.*		Accepted Response (11/04/03)	Action, correct table
DD-44	Tier 2, App. C, p. C5-22, Table C5-7	Please explain the distinction between "Columbia River (groundwater)" vs. "Columbia River (surface)." *Response, The difference between Columbia River (groundwater) and the Columbia River (Surface Water) results is based on a difference in exposure routes included in each of the respective exposure scenarios evaluated. The groundwater dose/risk presented in Tables C5-7 and C5-9 are representative of groundwater concentrations modeled from the tank farm fenceline to the Columbia River (exposure point). The Columbia River (groundwater) results reflect that the receptor uses the groundwater as a drinking water source, whereas the Columbia River (surface water) results reflect that the receptor is swimming in the Columbia River ; routes of exposure includes ingestion, vapor inhalation, and dermal contact. The Columbia River (surface water) results reflect that groundwater is not used as a drinking water source, rather it representative of concentrations of groundwater contaminants discharging in the Columbia River. The surface water scenarios conservatively assume that no dilution or mixing effects that occur once the groundwater is discharged.*		Accepted Response (11/04/03)	Action, add clarifying text
DD-45	Tier 2, App. C, p. C5-25, para 3	Re WMA C closure, please explain why the less conservative (i.e., allows higher risk) EDE method (USDOE) was selected over the more conservative target organ or dose equivalent method (EPA) for calculating drinking water concentrations, corresponding to 4 mrem/y. *Response, both methods are discussed and a comparison is made between them. Additionally the 4 mrem/y applies to drinking water systems, the groundwater at*		Accepted Response (11/04/03)	No Action, however it should be noted in WDoH Guidance on Radionuclides, they use TEDE

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		Hanford is not used for drinking water, however we must comply with DOE O 5400.5 (II) (d). Additionally, the impacts to the MCL Derived Constituent Concentrations for the radionuclides are provided throughout the results section. The MCL Derived Constituent Concentrations for a constituent are based on the target organ dose calculation.			
DD-46	Tier 2, App. C, p. C5-26, para 2, bullet #4	Please discuss cumulative risk for the HSRAM residential scenario (in addition to the HSRAM industrial scenario). ***Response, following HAB advice #132, within core zone boundary the industrial work scenario should be used, however additional scenarios may be used to support decision making. Additional exposure scenarios have been provided, however, the ones for cumulative risk that we discuss are the DOE All pathways farmer and the industrial scenarios.*** Reference to Figure C5-8 should be to Figure C5-7. ***Accept, will change figure number***		Accepted Response (11/04/03)	Action, provide explanatory text on why different scenarios were chosen
DD-47	Tier 2, App. C, p. C5-27 to C5-28, Table C5-9	Note that several of the rad risks for the HSRAM Residential scenario at the Fenceline and Exclusion Zone exceed the 1E-5 risk target. ***Response, yes they do, however the model we used was biased toward calculating high values because of uncertainty with model parameters (the model parameters were biased to give results that are on the high side) and conceptualization. The values should come down as better estimates for these parameter become available. This process is shown in figure 4-2 of the closure plan on page 4-12.*** Please explain the distinction between Columbia River groundwater vs. surface water. Are risks larger for surface water than groundwater for rads due to fish intake? ***Accept see response to comment App. C, p. C5-22, Table C5-7*** An air unit risk value (and calculated slope factor) for Cr+6 is available from IRIS only for inhalation. Assuming the slope factor for ingestion was set to zero (see Table C1 in HNF-SD-WM-TI-707, Rev. 3), are tabulated Cr+6 cancer risks solely due to inhalation, and is this inhalation of groundwater during showering? ***Response, Cr+6 is inhaled through the showers, sprinklers, and/or dust contaminated with it. This is another area in which we erred on the high side. We assume all***		Accepted Response (11/04/03) Accepted Response (11/04/03) Accepted Response (11/04/03)	Action, provide better uncertainty section Action, provide clarifying text. Action, provide

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		chromium is chromium (IV), not chromium (III) Re hypothetical retrieval leaks for the HSRAM Residential scenario, risks from Cr+6 at the Exclusion Zone and Columbia River are 2.54E-8 and 8.46E-9, respectively, while total non-rad risk is listed as 1.59E-7. So, what are the other non-rad carcinogens? Same question applies to the HSRAM Industrial scenario for past leaks from Cr+6 at the Columbia River. *Response, that is a typo, the totals were copied wrong, will fix, chromium is the only ILCR* Please see comment for App. C, p. C5-22, Table C5-7. Response, see response for comment		Accepted Response (11/04/03) Accepted Response (11/04/03)	clarifying text. Action, fix table Action add clarifying text
DD-48	Tier 2, App. C, p. C5-28, Figure C5-7	Although all risks are below 1E-5 for the Industrial Worker, this is not the case for the Residential scenario. Please acknowledge this. *Accept, will acknowledge this in the text.*		Accepted Response (11/04/03)	Action add clarifying text
DD-49	Tier 2, App. C, p. C5-29, para 1, bullet #2	According to Table C5-7, dose resulting from any of the three sources (i.e., residuals, past leaks, retrieval leaks) did not exceed target dose at any location. *Accept, the bullet will be changed to reflect the table.*		Accepted Response (11/04/03)	Action, fix bullet
DD-50	Tier 2, App. C, p. C5-29, para 1, bullet #3	ILCR also exceeded the target risk at the Exclusion Zone for the resident due to past leaks, largely due to Tc-99. *Accept, will add a 4th bullet to acknowledge this fact.*		Accepted Response (11/04/03)	Action, fix bullet
DD-51	Tier 2, App. C, p. C5-	When will a "safety analysis that identifies accident scenarios for closure activities" be completed?		Accepted Response (11/04/03)	No action

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	29, para 2	*Response, Safety analysis has not been done to date that identifies accident scenarios for closure activities. The best estimate of one being done would be for the Tank Closure EIS in December 2003 or January 2004*			
DD-52	Tier 2, App. C, p. C5-30, para 1, bullet #6	The dose commitment is calculated for 50 y, rather than 70 y (see Table A22 in HNF-SD-WM-TI-707, Rev. 3). *Accept, text will be changed to 50 years.*		Accepted Response (11/04/03)	Action, fix text
DD-53	Tier 2, App. C, p. C5-30, para 2	The first sentence refers to "probability of the accident." This should be "number of accidents." *Accept, text will be changed*		Accepted Response (11/04/03)	Action, fix text
DD-54	Tier 2, App. C, p. C5-31, para 1, bullet #2	Re an accident, what are the consequences of exceeding the 5 rem acute exposure limit for onsite workers? *Accept, The consequences would be a lethal dose and has been included in the text.*		Accepted Response (11/04/03)	Action, text will be reworded
DD-55	Tier 2, App. C, p. C5-31, para 5	Reference to "Figure C5-9" should be to "Figure C5-8." An obvious point is that this figure considers only risk due to a groundwater pathway and does not consider atmospheric or soil pathways that may be operative for an intruder scenario or for exposures to ecological receptors. *Response, a RCRA enhanced barrier will be placed over the site at closure. The barrier will be minimum of 15 ft thick with a design life of 500 years (DOE/RL-93-033). The design of the barrier incorporates provisions for bio-intrusion and human intrusion control. The barrier would eliminates soil pathways, and past performance assessments (200 East and 200 West burial grounds) have shown, that with a barrier in place, the air pathway is negligible contributor compared to the groundwater pathway. Air and Soil pathways are considered as part of the groundwater pathway due to using contaminated water for irrigation*		Accepted Response (11/04/03)	Action, fix figure, add text as to why only GW pathway was included
DD-56	Tier 2, App. C, p. C5-34, para 1	It is stated, "the hazards associated with these activities include potential occupational hazards resulting in physical trauma and radiological exposure resulting in LCFs." Why are nonradionuclide chemical exposures not considered, as well (e.g., VOCs)? *Response, the short-term worker exposure analysis will address nonradionuclides (i.e., chemicals) on new data from the waste retrieval of tank C-106.*		Accepted Response (11/04/03)	Action, look at NOC for air permit and use that to include non-radionuclide exposures
DD-57	Tier 2, App. C, p. C5-34, para 3	Re closure of a TSD facility, it is stated, "no further active site management is required." Is this consistent with activities related to post-closure care?		Accepted Response (11/04/03)	Action, remove sentence

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		Response, yes, this is consistent. The sentence was deleted, so as not to be confusing.			
DD-58	Tier 2, App. C, p. C5-35, para 1	In addition to uncertainties listed for inventory and environmental fate/transport of COPCs, it should be acknowledged that uncertainties exist in exposure scenarios. For example, exposure factors (e.g., intake rate) and toxicity factors (e.g., risk coefficients) contribute uncertainty to risk estimates. Also, it should be acknowledged that only a groundwater pathway is evaluated here. *Response, will add additional text will be provided to address this. However, it should be noted that neither uncertainty nor sensitivity was presented in detail in HNF-SD-WM-TI-707. While many of the parameters in HNF-SD-WM-TI-707 have large uncertainties (some were imputed), the scenarios themselves are not well determined. The Post-intrusion and All Pathways Farmer (labels from prior performance assessments) are representative (average) individuals. The Native American represents a bounding individual. Numerous variations of these basic exposure scenarios are possible. Thus, the numeric uncertainty associated with particular variables is a minor issue compared to the potential range of individual lifestyles.*		Accepted Response (11/04/03)	Action, uncertainty section will be re-written
DD-59	Tier 2, Add. C1, p. C1-2, para 1	If the risk assessment presented in this closure plan is considered "preliminary post-retrieval," is it actually part of the "post-retrieval tank risk assessment" described in Table 1? *Response, yes it is. Modeling was set up for analyzing the risk following retrieval. We have taken steps to incorporate the inventories following retrieval into this model.*		Accepted Response (11/04/03)	No action
DD-60	Tier 2, Add. C1, p. C1-7, para 1	Note that protection of the environment (i.e., ecological risk) is not addressed until later stages of the closure process, namely as part of the tank farm feasibility study and tank farm closure risk assessment (Table 1). *Response, as agreed to in the December 13, 2002 workshop on risk assessments, an ecological risk assessment will be completed as part of the Tank Farm Feasibility Study, and WMA Closure. Presently, the tank farms are managed in a manner intended to eliminate, to the extent possible, the intrusion of plants and wildlife into the facilities. Furthermore, Ecological impacts will be much more impacted by the engineered features (for example, surface barriers, fill materials) and until these engineered features are better known.*		Accepted Response (11/04/03)	No action
DD-61	Tier 2, Add. C1, p. C1-7, para 5	Please note that, re a tank farm closure risk assessment (see Table 1), additional receptors (e.g., farmers, Native Americans, ecological receptors) and additional environmental exposure media (e.g., soil and air pathways) would need to be included. *Response, additional receptors were included.*		Accepted Response (11/04/03)	Add receptors and exposure media
DD-62	Tier 2,	Re footnote "a," note that the EPA drinking water standard (i.e., 4 mrem/y) is organ dose		Accepted Response	No action

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	Add. C1, p. C1-8, Table 2	or "dose equivalent" (distinct from USDOE's "effective dose equivalent"). *See response to App. C, p. C5-25, para 3* Re the 1 mrem/y standard for beta and photon emitters listed for surface water, I cannot find this in WAC 173-201A. According to WAC 173-201A-250 and WAC 246-221-290, it appears that the surface water standard should be 4 mrem/y. Please check this. *Response, will check this. Further checking into WAC 173-201A-50 1(a) Deletorious concentrations of radioactive materials for all classes shall be as determined by the lowest practicable concentration attainable and in no case shall exceed 1/12.5 of the values listed in WAC-246-221-290 (Column 2 Table II). That table was evaluated and a dose calculated from that*		(11/04/03) Accepted Response (11/04/03)	No action
DD-63	Tier 2, Add. C1, p. C1-10, para 2	I think the acute exposure limit for the intruder should be 500 mrem, rather than 500 mrem/y (see Table 2). *Response, you are right, the text will be changed*		Accepted Response (11/04/03)	Action, change text
DD-65	Tier 2, Add. C1, p. C1-75, para 4	ILCR should be computed and presented separately for radionuclides vs. nonradionuclide carcinogens, due to differences in underlying methodology (e.g., see EPA's 1996 RERAM document: EPA 402-R-96-016). Re radionuclides, slope factors are based on epidemiological data and expressed as a central estimate of the mean, ionizing radiation damages the cell via free radical formation, external gamma exposure is unique to radiation, natural background is high, and radionuclides exhibit decay and ingrowth of progeny. In contrast, re nonradionuclide carcinogens, slope factors are based on animal studies and expressed as a 95% UCL on the mean, nonradionuclide carcinogens can damage the cell via both genotoxic (including fee radical formation) and epigenetic (e.g., endocrine modifying activity, immunosuppression, cytotoxicity, peroxisome proliferation) mechanisms, dermal absorption can be significant for organic nonradionuclide carcinogens, natural background is typically low, and degradation products of nonradionuclide carcinogens may include other carcinogens. *Response, ILCR is computed and presented separately for radionuclides and non-radionuclides*		Accepted Response (11/04/03)	No Action required
DD-66	Tier 2, Add. C1, p. C1-77, Table 19	Add the "All Pathways Farmer" to the list under "Offsite Receptor." *Response, a farmer is listed in the table under Offsite Receptor*		Accepted Response (11/04/03)	Action, add All-Pathways farmer
DD-67	Tier 2,	Why is "sleeping on soil contaminated by irrigation" broken out from "irrigating a		Accepted Response	Action, update table

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	Add. C1, p. C1-79, Table 21	garden?" ***Response, this table come from an older version of the HNF-SD-WM-TI-707, and will be updated to reflect the latest revision of HNF-SD-WM-TI-707.***		(11/04/03)	
DD-68	Tier 2, Add. C1, p. C1-81, bullet 5	Note this "summary box" appears to have several errors (based on data presented in Tables in this section) flagged in the following comments. Radiological EDE did not exceed dose targets for residual waste, past leaks, nor retrieval leaks for all of the scenarios presented (Tables 22, 25, and 28). ***Accept, bullet will be corrected***		Accepted Response (11/04/03)	Action fix bullet
DD-69	Tier 2, Add. C1, p. C1-81, bullet 6	ILCR exceeded the 1E-5 target for the residential scenario for all sources at the fenceline (and several other downgradient points for past leaks) but not the industrial scenario for any source (Tables 23, 26, and 29). ***Accept, bullet will be corrected***		Accepted Response (11/04/03)	Action fix bullet
DD-70	Tier 2, Add. C1, p. C1-81, bullet 7	HI did not exceed the target for residual waste, past leaks, nor retrieval leaks for any of the scenarios presented (Tables 24, 27, and 30). ***Accept, bullet will be corrected***		Accepted Response (11/04/03)	Action fix bullet
DD-71	Tier 2, Add. C1, p. C1-81, bullet 8	For the analytes shown, MCL is exceeded only for I-129 at the WMA fenceline, largely due to the past leak contribution (Table 31). ***Accept, bullet will be corrected***		Accepted Response (11/04/03)	Action fix bullet
DD-72	Tier 2, Add. C1, p. C1-82, para 5	Although groundwater under WMA C is not presently a source of drinking water, it may be in the future. ***Response, it is unlikely that groundwater would be a source of drinking water in the future. In December of 2003, the EPA has set MCLG of 0 for radionuclides, it is unlikely that water that does not meet that goal could become a source of drinking water.***		Accepted Response (11/04/03)	Action modify sentence
DD-73	Tier 2, Add. C1, p. C1-83, para 3	Does "Chromium" refer to Total Cr or Cr+6? ***Response, this is another area in which we erred on the high side. We assume all chromium is chromium (IV), not chromium (III)***		Accepted Response (11/04/03)	Action, include in uncertainty section
DD-74	Tier 2, Add. C1, p. C1-84, para 2	What is the basis of selecting only two of the eight exposure scenarios, described on p. C1-76? ***Response, HAB advice #132 recommends the industrial scenario for the 200 Areas Core Zone Boundary, but other scenarios maybe used for comparison purposes. We***		Accepted Response (11/04/03)	Action, provide rationale for choosing scenarios

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		have discussed the industrial scenario based on this advice and provided results on five other scenarios, All-Pathways Farmer, HSRAM Recreational, HSRAM Farmer, HSRAM Residential, and Native American			
DD-75	Tier 2, Add. C1, p. C1-84, para 5	Supplement C2 appears incomplete at this point in time. When will it be available? *Response, this is a wording problem it should stated addendum C2*		Accepted Response (11/04/03)	Action, fix text
DD-76	Tier 2, Add. C1, p. C1-86, Table 22	Please define Columbia River groundwater vs. surface water. Are risks typically larger for surface water due to fish ingestion? *Response, The difference between Columbia River (groundwater) and the Columbia River (Surface Water) results is based on a difference in exposure routes included in each of the respective exposure scenarios evaluated. The groundwater dose/risk presented in Tables C5-7 and C5-9 are representative of groundwater concentrations modeled from the tank farm fenceline to the Columbia River (exposure point). The Columbia River (groundwater) results reflect that the receptor uses the groundwater as a drinking water source, whereas the Columbia River (surface water) results reflect that the receptor is swimming in the Columbia River ; routes of exposure includes ingestion, vapor inhalation, and dermal contact. The Columbia River (surface water) results reflect that groundwater is not used as a drinking water source, rather it representative of concentrations of groundwater contaminants discharging in the Columbia River. The surface water scenarios conservatively assume that no dilution or mixing effects that occur once the groundwater is discharged.*		Accepted Response (11/04/03)	Action add text on location
DD-77	Tier 2, Add. C1, p. C1-87, Table 23	An air unit risk value (and calculated slope factor) for Cr+6 is available from IRIS only for inhalation. Assuming the slope factor for ingestion was set to zero (see Table C1 in HNF-SD-WM-TI-707, Rev. 3), are tabulated Cr+6 cancer risks solely due to inhalation, and is this inhalation of groundwater during showering? *Response, Cr+6 is inhaled through the showers, sprinklers, and/or dust contaminated with it. This is another area in which we erred on the high side. We assume all chromium is chromium (IV), not chromium (III)* Note that Tc-99 and total rad risks exceed the 1E-5 ILCR target for the residential scenario at the WMA fenceline. *Response, Response, yes they do, however the model we used was biased toward calculating high values because of uncertainty with model parameters (the model parameters were biased to give results that are on the high side) and conceptualization.*		Accepted Response (11/04/03) Accepted Response (11/04/03)	Action add discussion on chromium Action, add discussion to uncertainty section

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		The values should come down as better estimates for these parameter become available. This process is shown in figure 4-2 of the closure plan on page 4-12.			
DD-78	Tier 2, Add. C1, p. C1-90, para 2, bullet 2	Contrary to what the text indicates, Table 26 shows that the 1E-5 ILCR target is exceeded for Tc-99 and total rad risk at the core zone boundary and at the Columbia River (surface water) for the residential scenario. Please revise. ***Accept, will revise text. However it should be noted for the Columbia river surface water is not diluted and it should be. See response to Add. C1, p. C1-86, Table 22*** Why are Cr+6 and total nonrad risk markedly higher (i.e., 6E-5 vs. 2.46E-7 or 3.89E-8) for the Columbia River (groundwater) than for upgradient points for the residential scenario? This seems reversed. ***Response, there is a mistake in the table, the number should be 1.39E-8***		Accepted Response (11/04/03) Accepted Response (11/04/03)	Action, revise text Action, revise text
DD-79	Tier 2, Add. C1, p. C1-90, para 2, bullet 3	According to Table 27, nitrite is a larger contributor than nitrate to HI. Please revise. ***Accept, you are correct, text will be changed***		Accepted Response (11/04/03)	Action revise text
DD-80	Tier 2, Add. C1, p. C1-90, para 3	Note that retrieval leaks were assumed in all WMA C tanks in RPP-16525, Rev. 1 (C-200 Series Tanks Retrieval F&R). ***Accept, the time of the document, all tanks except C-106 and C-107 were going to be dry retrieved, that has change the risk assessment will be updated to reflect that.***		Accepted Response (11/04/03)	Action revise retrieval leak text
DD-81	Tier 2, Add. C1, p. C1-91, Table 25	Are "Drinking Water Dose" dose estimates for an industrial or a residential scenario? ***Response, this is for a residential drinking water***		Accepted Response (11/04/03)	Action, revise text
DD-82	Tier 2, Add. C1, p. C1-98, para 4	Re cumulative effects, why present the least conservative scenario (i.e., industrial) for ILCR and HI and a more conservative scenario (i.e., all pathways farmer) for EDE dose? Mixing scenarios makes relative comparisons more difficult. And why is the most conservative scenario (i.e., Native American) not presented for cumulative effects, since this would reveal a more bounding conservative result? ***Response, HAB advice #132 recommends the industrial scenario for the 200 Areas Core Zone Boundary, but other scenarios maybe used for comparison purposes. We have discussed the industrial scenario based on this advice and provided results on five other scenarios in Addendum C2. All-Pathways farmer is DOE derived scenario for***		Accepted Response (11/04/03)	Action, provide rationale for scenarios chosen

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		DOE O 435.1			
DD-83	Tier 2, Add. C1, p. C1-100, Figure 24	Re HI, the y-axis numbering appears mislabeled with ILCR values rather than HI values. It looks like this is the same trace as for ILCR (Figure 23). ***Response, figures were mixed up and will be fixed***		Accepted Response (11/04/03)	Action fix graph
DD-84	Tier 2, Add. C1, p. C1-102, Table 31	Note that the MCL listed for Cr+6 (0.10 mg/L) is for total Cr (not Cr+6). ***Accept, will fix*** Why are groundwater concentrations in the "Baseline Closure Conditions" column not an exact sum of concentrations in the four columns to the left (i.e., residuals, past leaks, retrieval leaks, ancillary equipment leaks)? Does this relate to the temporal aspect of peak arrival at the WMA fenceline? Please explain. ***Response, you are correct, timing of peaks do not allow you to sum the columns, however, if you do sum, the cumulative total will always be less than the sum.*** Re footnote on MCL, MCL=maximum contaminant level. ***Response, you are right***		Accepted Response (11/04/03) Accepted Response (11/04/03) Accepted Response (11/04/03)	Action, fix table No Action Action fix text
DD-85	Tier 2, Add. C1, p. C1-103, para 2	**Although physical trauma and LCFs are considered as short-term human risks, there is no mention of nonradionuclide chemical risks. Nonradionuclide risks should be included, as well.** ***Response, The short-term worker exposure analysis will address nonradionuclides (i.e., chemicals) on new data from the waste retrieval of tank C-106.***		Accepted Response (11/04/03)	Action, get inventory information from air permit to address non-radionuclides
DD-86	Tier 2,	It is stated that short-term human risks need not be considered after final closure.		Accepted Response	Action, add statement

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	Add. C1, p. C1-103, para 4	However, an intruder scenario has an acute dose limit of 500 mrem, and an acute exposure is considered short-term. Please clarify. *Response Intruder scenario is not analyzed as a part of short-term worker human risks.*		(11/04/03)	that intruder is not a part of short term risk
DD-87	Tier 2, Add. C1, p. C1-105, para 3 (step 7)	Re the last sentence, inhalation rate (m3/s) is also used to calculate inhalation dose. *Response, Text was inserted to include breathing rates.*		Accepted Response (11/04/03)	Action, revise text
DD-88	Tier 2, Add. C1, p. C1-107, para 2	In addition to inhalation and ingestion pathways, GENII also evaluates external exposure. Please include external dose pathway too. *Response, For accident scenario, only the accident with the bounding case was analyzed, i.e., ventilation failure, therefore the direct contact was not included.*		Accepted Response (11/04/03)	Action, revise text to reflect this
DD-89	Tier 2, Add. C1, p. C1-112, para 3	Equation 8.2 needs a concentration term (pCi/L) on the RHS of the equation. *Response, IQ is the respirable inventory.*		Needs additional information (11/04/03)	Action, Duwayne will check and verify units
DD-90	Tier 2, Add. C1, p. C1-113, para 1	There is no Cf term in Equation 8.2. Response, Removed Cf line from explanation.		Accepted Response (11/04/03)	Action, revise text
DD-91	Tier 2, Add. C1, p. C1-113, para 2	Equation 8.3 has an incorrect term (i.e., DF) on the RHS of the equation. The units are correct (rem/L), but this is not a dose conversion factor. This should be a "unit liter dose" (ULD) term (see WHC-SD-WM-SARR-037, Rev. 0). In addition to inhalation, there is a contribution to dose (and LCF) via ingestion which employs an ingestion ULD. *Response, Equation was changed to show ULD vs. DF* Please specify the source for values of the atmospheric dispersion coefficient (χ/Q).		Accepted Response (11/04/03)	Action, revise text
DD-92	Tier 2, Add. C1, p. C1-114, Table 34	What is the source of the MEI regulatory limit (2.0E-3 LCF)? *Response Deleted column for regulatory limit.*		Accepted Response (11/04/03)	Action, delete column
DD-93	Tier 2, Add. C1, p. C1-114, Table 35	Does this indicate that the LCF risk to the MEI involved worker from a ventilation failure accident for tank C-106 is certainty (i.e., 1.51E1>1)? *Response, Yes.*		Accepted Response (11/04/03)	No action

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		Again, what is the source of the MEI regulatory limit (2.0E-3 LCF)? ***Response Deleted column for regulatory limit.***		Accepted Response (11/04/03)	Action delete column
DD-94	Tier 2, Add. C1, p. C1-115, para 2	I think this equation should be numbered 8.4 (not 5.4). ***Response, Equation will be changed to 8.4.***		Accepted Response (11/04/03)	Action, fix number
DD-95	Tier 2, Add. C1, p. C1-116, para 1	Why do these GENII atmospheric dispersion coefficients differ from those presented on p. C1-113? ***Response, GENII are chronic and calculated from extensive meteorological data. The values on p. C1-113 is acute for accident evaluation.***		Accepted Response (11/04/03)	No action
DD-96	Tier 2, Add. C1, p. C1-117, Table 37	Dose to populations should be expressed as "person-rem." ***Response, Dose has been changed to reflect population dose being expressed as "person-rem". Regulatory limits have been changed to reflect MEI only. And 5 rem for workers and .1 rem for public.*** Please note the source of the regulatory limit (5000 mrem/y). The EDE limit for the public is 100 mrem/y (ICRP Pub. 60). Also, these limits are for MEI, not populations.		Accepted Response (11/04/03) Accepted Response (11/04/03)	Action fix text Action add footnote
DD-97	Tier 2, Add. C1, p. C1-117, Table 38	Please specify that 0.5 rem was used as the dose for IW MEI and 14.81 person-rem was used for IW Pop. Are LCF risks in this table expressed as "per year," since doses in Table 37 are mrem/y? There appears to be some errors in LCF risks in the table. For example, for NIW MEI, the computation would be (9.4E-5 mrem/y)(4E-4 LCF/rem)(rem/1E3 mrem)=3.76E-11 LCF/y (not 3.76E-8 LCF/y). ***Accepted. Table now reflects comment.***		Accepted Response (11/04/03)	Action, fix table
DD-98	Tier 2, Add. C1, p. C1-119, para 1	This section on limitations and uncertainties appears inadequate. In addition to inventory, release models, and environmental fate/transport models, there are other uncertainties embedded in risk models (e.g., food chain models, exposure factors, toxicodynamics, toxicokinetics, dose factors, risk factors, risk additivity). Please acknowledge these additional sources of uncertainty. In general, three main categories of uncertainty are the various models, parameters employed in these models, and exposure scenarios employed in the risk assessment. ***Accept, this section will be beefed up and re-written***		Accepted Response (11/04/03)	Action, re-write uncertainty and limitations section
DD-99	Tier 2,	Re mrem/y groundwater data cited, please reference Tables 22, 25, and 28.		Accepted Response	Action, modify tables

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	Add. C1, p. C1-119, para 1	*Accept, will reference tables*		(11/04/03)	
JC-10	Tier 2, General Comment	While it is assumed that SST WMAs will be closed as landfills, an evaluation of the clean closure alternative is required. A Tier 1 Risk Assessment that addresses worker safety as well as environmental threats should be conducted, with the resultant conclusion applicable to all tank farms and WMAs. Such an activity would also streamline the process so that this decision does not have to be made for each and every tank farm and component thereof. (JC) *Response, the risk assessment for the Clean Closure option is being conducted as part of the Tank Farm EIS this also includes worker safety*		Accepted Response 11/20/03	Action Item: See action item for comment 4-1 line 1
MB-3	Tier 2, Sec. C.5.1.1, p. C5-7	Note e on Table C5-2 Features of the WMA C Base Case states that after the modeling of the 241-C-106 tank inventory after retrieval was completed, the USDOE decided to change the method of retrieval to acid dissolution. The modeling is therefore suspect and the environmental impacts may be affected. Ecology requests that the USDOE provide added information about the risk of retrieval inherent in retrieval of acid waste. Ecology cannot evaluate the impacts on the environment of releases during retrieval, lacking that information. *Response, Oxalic acid will be neutralized by the carbonate minerals naturally present in the soil and, given the amount and concentration of acid in an 8,000 gallon leak of 1M oxalic acid and the percent level of carbonate minerals in the soil, it is likely that the soil will neutralize the acid a short vertical distance (tens of feet or less) below the leak. The neutralized pH will likely be in the range of 7 to 8. Oxalic acid is fully deprotonated at a pH of about 4; therefore, above this pH all of the oxalate will be present in solution as the oxalate anion ($C_2O_4^{-2}$). This anion will complex with uranium, although no where near as strongly as with other organic complexes such as EDTA. PNNL found that the formation of the uranium oxalate complex did not reduce the adsorption of uranium onto Hanford soils compared to an oxalate-free solution. However, PNNL, was not using 1M oxalate solutions so the results are not directly compareable; however, it is possible that the presence of oxalate will not significantly increase the mobility of uranium through the vadose zone.* *Additionally, no specific contaminants were used in the fate and transport model. Instead specific contaminants are modeled by assigning it to a sorption coefficient (K_d) bin. Contaminants like I-129 and Tc-99 were assigned a K_d of 0.0 ml/g, while uranium was assigned a K_d of 0.6 ml/g. If appropriate, the K_d could be adjusted.*		Accepted Modified Response 11/20/03	Action Item: run sensitivity to Uranium K_d in the interim data report. Strike 2nd paragraph from response.

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MB-4	Tier 2, Sec. C5.2.2.3, p. C5-25	Text in the section states that the USDOE used the effective dose equivalent method in calculating WMA C closure risk evaluation, although the USEPA chose to use the Target Organ Method. Compliance with a DOE Order 5400.5, applicable to the Hanford Site, does not appear to be protective of public health, even if concentrations of the I-129 are less than currently estimated. Please provide comparisons of risk using both methods to allow Ecology to evaluate the impacts on public health. *Response, both methods of calculating total dose from radionuclides is discussed and a comparison is made between them. Additionally, the MCL derived concentrations for the COCs are provided throughout the results section. The MCL Derived Constituent Concentration are based on target organ dose. Furthermore, the 4 mrem in a year applies to drinking water systems, the groundwater at Hanford is not used for drinking water for the foreseeable future, however, we must comply with DOE O 5400.5 (II) (d).*		Accepted Modified Response 11/20/03	Action Item: provide both MCL derived constituent concentration and dose (EDE) in report. Strike last paragraph from response
MB-5	Tier 2, Sec. 5.0, ¶ 1, p. C1-76	Sentence 4 states that Native Americans are assumed to use contaminated water at the fence line or the Columbia River. It is not clear what assumptions were made about the consumption/use of plants sacred to their culture. Please explain. *Response, the Native American Scenario uses the scenario presented in Columbia River Comprehensive Impact Assessment CRCIA (DOE/RL-96-16 Section 5.1.4.1)*		Accepted Response 11/20/03	No action required.
SD-1	Tier 2, Page C5-1, Line 22:	Please give in concentration not just dose. *Response: will provide in concentration, not just dose. However, concentration is given in other sections of the Risk Assessment*		Accepted Response 11/20/03	Action Item: provide both MCL derived constituent concentration (target organ) and dose (EDE) in report.
SD-2	Tier 2, Page 5-12, Line 6:	This issue of composite iodine over the MCL is an issue. It seems to be glossed over and buried in the text *Response, it is mentioned in the text that we are over the 1 pCi/L MCL Derived Constituent Concentration on page 5-11, and it is shown on the figure 5-3. It should be noted that we are pushed over the limit because of the hypothetical retrieval leak and past practices. Residuals in the tank and ancillary equipment are well under the 1 pCi/L MCL Derived Constituent Concentration. Additionally, aquifer testing on completed on a well just outside the WMA Fenceline, indicates the hydraulic conductivity in the vicinity of WMA C is approximately 20 to 100 times higher. The lower hydraulic conductivity results in a lower peak concentration. We are in the process of running a case with the new hydraulic conductivity to provide additional information on it's net affect.*		Accepted Response 11/20/03	Action Item: provide additional discussion about when I-129 will be below the MCL derived constituent concentration (target organ)

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SD-3	Tier 2, Page 5-20, Line 23-25:	This issue needs to be elevated in the document. It needs to result in an NOD for establishing the release mechanism. *Response, at the present time we are modeling 3 release mechanisms (diffusion, which would be appropriate for a grout; advection, which is appropriate for a sand and gravel fill or a failed grout, and solubility release model, which is appropriate for salt cake tanks). At the same time, we are having PNNL analyze residual waste for each retrieved tank to develop a release rate model. Over this past year, PNNL has analyzed sludge from Tank AY-102, which is a surrogate to C-106. They have found that the principal risk driving COC, (Tc-99), is only 25% soluble in water, and are in the processing of further testing to develop a release rate model for this tank. We are schedule to send PNNL post-retrieval C-106 samples, for them to validate their results from AY-102. It should also be noted that the diffusion coefficient used for the residual waste 6E-7 cm²/s is extremely high.*		Accepted Response 11/20/03	No Action
SD-4	Tier 2, Page 5-20, Line 13-15:	This shows the need for retrieving at least down to the 1% goal and beyond. *Response, comment noted*		Accepted Response 11/20/03	No Action
SD-5	Tier 2, Page C1-8:	Don't you need to add the class C requirements for Cs etc. This section needs to talk about how the tank residuals and soil will meet class C or other intruder scenario. *Response, when the decision is made that it is greater than Class C waste, the performance objectives will be modified to reflect the decisions concerning Class C waste.*		Accepted Response 11/20/03	No Action
SD-6	Tier 2, Page C1-8:	Should include MCL for the COC also *Response, this table is a summary table taken from the Performance Objectives document; a complete listing of MCLs for the COC is given in the Performance Objective Document.*		Accepted Response 11/20/03	Action Item: modify the performance objectives to include MCL derived constituent concentration
SD-7	Tier 2, Page C1-9	A bullet should be added for meeting drinking water standard *Response, clarification is needed, where and when should it meet the drinking water standard? At the present time, the existing groundwater conditions preclude the use of the groundwater for drinking water. The peaks in groundwater contamination from residuals left in Tank and ancillary equipment do meet the drinking water standard, however, past a composite of the hypothetical retrieval leaks and past leaks do not meet*		Accepted Response 11/20/03	Action Item: Add discussion on approximate time frame on when the aquifer could be used for drinking water (i.e. when the existing

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		the drinking water standard and will not for the next 200 years			groundwater plumes or either remediated or have naturally attenuated
DD-104	Tier 3, Att., p. C-1-4-2, para 1	Please clarify that this risk assessment for C-106 is focused on long-term impacts to groundwater and does not evaluate soil nor air pathways, as might be required in an intruder scenario or with short-term risks, respectively. *Response, a RCRA enhanced barrier will be placed over the site at closure. The barrier will be minimum of 15 ft thick with a design life of 500 years (DOE/RL-93-033). The design of the barrier incorporates provisions for bio-intrusion and human intrusion control. The barrier would eliminates soil pathways, and past performance assessments (200 East and 200 West burial grounds) have shown, that with a barrier in place, the air pathway is negligible contributor compared to the groundwater pathway. Air and Soil pathways are considered as part of the groundwater pathway due to using contaminated water for irrigation*		Accepted Response (11/04/03)	Action, refer reader to barrier section
DD-105	Tier 3, Att., p. C-1-4-2, Table 4-1	It might be stated that "base case" retrieval for C-106 results in about one order of magnitude reduction in ILCR, HI, and EDE. *Response, it is almost 2 orders of magnitude*		Accepted Response (11/04/03)	Action, add text
DD-106	Tier 3, Att., p. C-1-4-5, para 2	Reference to "Section 3.4" should be to "Section 4.4." *Response, will correct*		Accepted Response (11/04/03)	Action, fix text
DD-107	Tier 3, Att., p. C-1-4-5, Table 4-2	Why does the pre-retrieval HI (5.68E-3) for the industrial worker differ from the corresponding HI in Table 4-1 (3.68E-3)? *Response, this is a typo and will correct*		Accepted Response (11/04/03)	Action, fix text
DD-108	Tier 3, Att., p. C-1-4-7, Table 4-3	It might be stated that ILCR, HI and EDE results for the industrial worker are the same as those presented in Table 4-1 for the C-106 closure condition, demonstrating that retrieval leaks drive long-term risk for C-106. *Response, retrieval leaks will drive the long term risk.*		Accepted Response (11/04/03)	Action add text on retrieval leaks
DD-109	Tier 3, Att., p. C-1-4-8, para 1	It may be worthwhile to evaluate similar results for the residential scenario (in addition to the industrial worker) and also for peak fenceline concentrations (in addition to average fenceline concentrations). *Response, we can provide the results for the residential scenario. A 3-dimensional model is being developed for the S/SX WMA, this model will provide insight on how to*		Accepted Response (11/04/03)	Add residential results

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		scale the results from 2-D to 3-D to get true peak fenceline peaks and will be report in the WMA S/SX risk assessment.			
DD-110	Tier 3, Att., p. C-1-4-12, para 1	Although inventory, waste release mechanisms, and environmental fate/transport modeling are identified as sensitive and uncertain inputs (Table 4-5), it should be acknowledged that other inputs for overall risk prediction are also uncertain and potentially sensitive. These inputs are applied after prediction of groundwater concentrations and are not trivial. These other inputs might include various models (e.g., food chain model, toxicokinetic model) and model parameters (e.g., food chain transfer factors, exposure factors, dose factors, risk factors). Although these models and parameters in this tank waste analysis have typically been reduced to a single risk or dose coefficient for a defined exposure scenario (e.g., ILCR per pCi/L for an all pathways farmer, mrem/y per pCi/L for the Native American), these coefficients incorporate all of the uncertainties in many underlying variables (see HNF-SD-WM-TI-707, Rev. 3). Please acknowledge this. *Response, will refer reader to new uncertainty section in Tier II.*		Accepted Response (11/04/03)	Action, uncertainty section will be changed to show this
DD-111	Tier 3, Att., p. C-1-4-14, para 1	Why was the less conservative EDE method (USDOE) selected over the more conservative target organ or dose equivalent method (EPA) for calculating drinking water concentrations, corresponding to 4 mrem/y? For example, for I-129, the concentration corresponding to 4 mrem/y EDE is 21 times higher than the MCL corresponding to 4 mrem/y (see Table C5-8). *Response, both methods are discussed and a comparison is made between them. Additionally the 4 mrem/y applies to drinking water systems, the groundwater at Hanford is not used for drinking water, however we must comply with DOE O 5400.5 (II) (d). Additionally, the impacts to the MCL Derived Constituent Concentrations for the radionuclides are provided throughout the results section. The MCL Derived Constituent Concentrations for a constituent are based on the target organ dose calculation.*		Accepted Response (11/04/03)	No Action

RPP-13774, Rev. 2

04-TPD-010

ATTACHMENT 4

State Environmental Policy Act Environmental Checklist

Consisting of 31 pages,
including the coversheet

RPP-13774, Rev. 2

STATE ENVIRONMENTAL POLICY ACT
ENVIRONMENTAL CHECKLIST

FOR THE
ACCELERATED TANK CLOSURE DEMONSTRATION PROJECT
TANK 241-C-106

MODIFICATION OF HANFORD FACILITY RCRA PERMIT
THROUGH ADDITION OF THE SST SYSTEM CLOSURE PLAN

JANUARY 2004

WASHINGTON ADMINISTRATIVE CODE
ENVIRONMENTAL CHECKLIST
[WAC 197-11-960]

A. BACKGROUND

1. Name of proposed project, if applicable:

Accelerated Tank Closure Demonstration (ATCD) project for single-shell tank (SST) 241-C-106 (C-106).

This *Washington State Environmental Policy Act* (SEPA) environmental checklist is being submitted concurrently with the application to modify the Hanford facility *Resource Conservation and Recovery Act* (RCRA) permit (WA7890008967) by adding the SST system closure plan in support of the ATCD project.

2. Name of applicant:

U.S. Department of Energy (DOE)

3. Address and phone number of applicant and contact person:

Roy Schepens, Manager
Office of River Protection
U.S. Department of Energy
P.O. Box 450
Richland, WA 99352
(509) 376-6677

4. Date checklist prepared:

January 2004

5. Agency requesting checklist:

Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600

6. Proposed timing or schedule (including phasing, if applicable):

The ATCD project, which involves component closure of tank 241-C-106, is scheduled to be completed by December 2004.

7. **Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.**

   The ATCD project will collect information on 1) the ability to dissolve and retrieve residual tank waste utilizing an acid wash, 2) the physical response and behavior of a Phase I grout fill in an actual tank, 3) field deployment of grout production equipment and 4) the conduct of component closure activities of 241-C-106. This information will be used in determining future closure actions of the remaining SSTs and tank farms at the Hanford Site.

8. **List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.**

   This SEPA Checklist is being submitted to the Washington State Department of Ecology (Ecology) concurrently with the application to modify the Hanford Facility RCRA permit. An ATCD component closure activity plan will provide the basis for regulatory approval and modification of the RCRA permit. An environmental assessment has been prepared for the ATCD project in accordance with the *National Environmental Policy Act* (NEPA) and DOE implementing regulations and DOE has issued a Finding of No Significant Impact (FONSI).

   General information concerning the Hanford Facility environment can be found in the *Hanford Site National Environmental Policy Act (NEPA) Characterization* report (PNNL-6415). This document is updated annually by the Pacific Northwest National Laboratory (PNNL) and provides current information concerning climate and meteorology, ecology, history and archaeology, socioeconomics, land use, noise levels, geology and hydrology. These baseline data for the Hanford Site and past activities are useful for evaluating proposed activities and their potential environmental impacts.

   The following information has been developed that is related to this demonstration project:

   - *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* (DOE/EIS-0189)
   - *Supplement Analysis for the Tank Waste Remediation System* (DOE/EIS-0189-SA3)
   - *Environmental Assessment for the Accelerated Tank Closure Demonstration Project* (DOE/EA-1462)
   - *Waste Retrieval and Storage Data Package* (RPP-14147) and
   - *Tank System Closure and Facility D&D Data Package* (RPP-14148).

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

No other applications are pending for approvals of other proposals affecting the property covered by this proposal.

10. List any government approvals or permits that will be needed for your proposal, if known.

Ecology is the lead regulatory agency authorized to approve the application for modification of the Hanford Facility RCRA permit and for toxic air emissions. The following air permits have been obtained for this project: WSDOE Approval Order 97NM-001 Rev. 2, 2/24/03 and Rad Air Approval AIR031102, 11/10/03. In addition, DOE has compliance requirements under DOE Order 435.1 as described in more detail in the SST System Closure Plan which will also be addressed as part of this project. No other permits are known to be required at this time.

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The ATCD project will identify the technical and regulatory framework under which SST closures will be conducted. DOE and Ecology recognize that this initial demonstration in and of itself does not constitute final closure. This demonstration of a component closure action of SST 241-C-106 is one of the phases that will contribute to the closure of the WMA C tank farm. The project will not "remove or decontaminate all waste residues, contaminated containment system components (liners, etc.), contaminated soils, and structures and equipment contaminated with waste, and manage them as dangerous waste", as required by WAC 173-303-640(8) for closure of a tank system.

The ATCD project is a component closure action of C-106. The majority of the waste in 241-C-106 has been removed in previous sluicing/retrieval efforts. This has resulted in residual sludge remaining in the tank that consists of three or four piles of waste. These piles are up to 5 ft high and are widely spaced. This demonstration project involves the dissolution of approximately 9,000 gallons of waste. The demonstration project will evaluate the efficiency of using a chemical wash of oxalic acid to dissolve this waste. Past sluicing efforts have utilized supernate from AY-102. Use of oxalic acid is a variation of the past sluicing efforts with the added purpose of dissolving all or a significant portion of these waste piles.

The chemical wash with oxalic acid will involve the following steps:

- The remaining supernate in the tank will be pumped out.
- The piles will be leveled using water and the existing sluice nozzles.
- The water will be pumped out.
- Acid will be added to the tank to react with the residual sludge. The acid will be added into the tank in a series of batch loadings.
- Following appropriate reaction times, each acid batch containing dissolved waste will be pumped out.

Between 38 kL (10 kgal) and 132 kL (35 kgal) of 1 M oxalic acid at a time will be introduced directly into C-106. These batches will be allowed to react with the residual sludge piles from one to seven days after which the acid and dissolved waste will be pumped to a receiving tank. Up to 200 kgal of acid could be used during the course of this campaign. The transfers will take place in a hose-in-hose transfer line. All transfers will be through a dedicated, fully encased line thus eliminating possibilities of misrouting or cross-connections. A waste compatibility study was conducted during the planning of this project. Excess caustic was added to the receiving double-shell tank prior to the acid transfer to maintain the contents of the DST within specified concentration limits. A mixer pump is operated in the DST during and following the transfer to facilitate neutralization of the acid.

Oxalic acid was chosen because many sludge species readily form complexes with the oxalate to provide solubility. The other benefit of oxalic acid is a low corrosion rate for black iron. This means that the primary tank will not be subjected to any significant degradation.

The demonstration of acid dissolution of C-106 residual waste sludge piles is expected to achieve improved waste removal and provide advantages over supernatant sluicing for the following reasons:

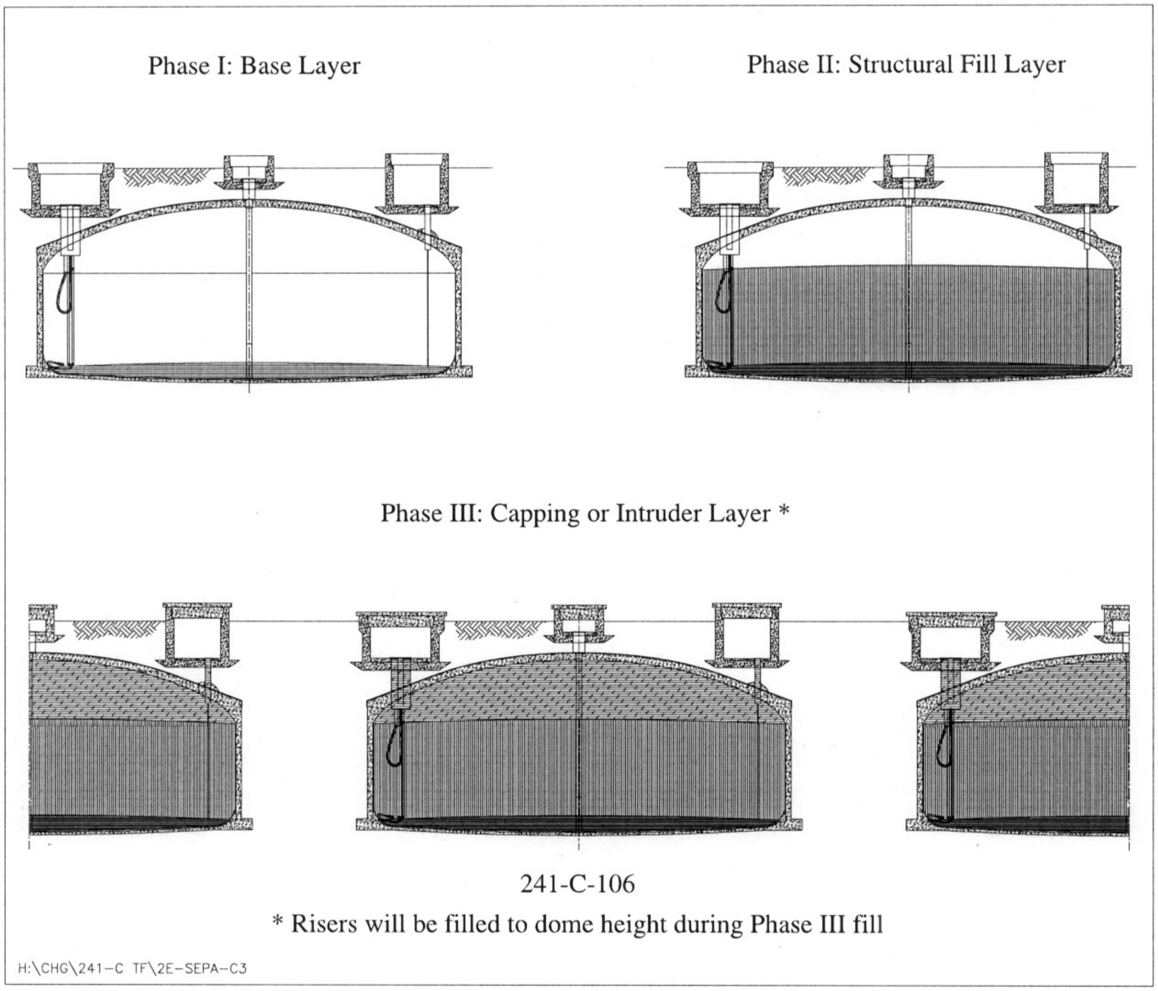
- There is a smaller waste inventory in C-106 since the acid is a reagent – not a waste.
- The acid is not highly corrosive to black iron.
- There is a dedicated route with a fully contained hose-in-hose transfer line.
- This will not involve recycling of the acid, as is the practice in sluicing with supernate.
- The concentration of the waste being transferred will be lower than during sluicing. Sluicing transferred up to 8% solids. Acid dissolution is expected to result in 3 to 5 % dissolved waste in the acid, with no significant transfer of solids.
- 1 M oxalic acid would be used; this is not considered a strong acid. Insignificant heats of dilution, neutralization, or reactions are expected.
- The acid reacts with the oxides, hydroxides, and carbonates that are common in sludges. This tends to neutralize the acid so that the transferred solution will have a lower acid strength than the starting acid.

- Acid will be brought to the site in a tank truck and will not be mixed or stored on site.

The retrieval of waste from C-106 will be completed prior to initiating this interim closure action. Retrieval will be completed following the criteria in the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et. al. 1989) M-45 series and Appendix H.

Following waste retrieval, Ecology and DOE will review the success of the acid wash retrieval campaign. If it is determined that sufficient waste has been removed to proceed with the demonstration project, a phased approach will be used to achieve component closure of C-106. Phase I will involve placement of an initial layer of grout fill material. Between 30-cm (12-in.) and 90-cm (36-in.) of grout would be placed in the Phase I placement (~126 to 380 m^3 or ~160 to 500 yd^3). The remaining phases leading to tank closure are not part of this demonstration. Figure 1 displays the proposed multi-phased approach to component tank closure.

Figure 1. Conceptual Component Closure



Phase I: Base Layer
The initial conditions of the tank following retrieval and prior to the addition of a base layer assumes that the liquid and solid wastes have been reduced to such a volume that HFFACO requirements are satisfied. A cementitious grout will be placed in the tank and flow over any remaining residual waste and around any in-tank equipment or miscellaneous debris. The purpose of placing this base layer is to evaluate the ability to place a foundation layer in a tank that would support future structural fill layers.

Cementitious Grout Production. Cementitious grout for this demonstration will be produced off site and transported by truck to the C Tank Farm.

Grout Performance Objectives. Phase I will place a layer of cementitious grout in C-106. The specific grout mix design constituency is under development and is intended to meet the following performance objectives.

- Provide sufficient compressive strength to support a bulk tank fill layer.
- Create a cover of grout that will minimize liquid infiltration, which restricts waste residuals from being re-mobilized.
- Reduce the leachability of the contaminants of concern (CoCs).

In addition to these performance objectives, the current engineering design (RPP-12331) identifies additional attributes of the grout to support emplacement within the tank:

- Exhibit a relatively low heat of hydration
- Be free-flowing and self-leveling

The grout will be formulated to be free-flowing and of sufficient volume so as to cover the residual waste at the bottom of the tank and form a base grout layer. The grout may be placed in approximately 30-cm (12-in.) lifts of 126 m^3 (165 yd^3) through an existing riser (RPP-12331). Up to three lifts may be placed in the tank. Although an uneven residual waste surface is expected, sufficient grout will be placed in the tank to cover the residual waste volume at the bottom of the tank and hence substantially reduce in-tank dose rates. Some of the liquid remaining in the tank may be less dense than the grout and displaced upwards. This may require the additional of a dry grout to absorb this liquid. This bound liquid would be covered with the next layer of grout to immobilize the contaminants in the liquid. Additives/getters that reduce the mobility or leachability of various CoCs may be added to create a more robust grout mixture. The performance of any additives or getters will be demonstrated in the laboratory; not as part of this field demonstration. Grout placement (flowability) may be affected by the addition of getters. If additives or getters are incorporated into the grout, any effects on flowability will be evaluated. An in-tank video system will be used to document and provide information to confirm the placement and lift thickness.

Some debris may not be encapsulated by Phase I grouting (e.g., discarded equipment may protrude above the stabilization layer, and/or residual waste attached to the walls above the grout level). The only direct tank penetrations are the cascade pipeline and nozzles high on the tank wall/side and the risers in the top. The plan for the cascade lines, which are sloped, is to fill up to them. Then fill only enough to cover the inlet and let the grout set for a short period of time to form a solid cap in the end. This would isolate the line. The risers will have external caps/flanges on top and be filled in the tank up to the dome top level as a part of filling the tank. Transfer lines and drain lines coming into the pits above the tank will be capped to prevent accidental waste addition. Some lines will be cut and capped. The ventilation riser will be filled as well during the tank fill process. Water infiltration controls will continue to be maintained following placement of the base layer until the WMA closure action is completed. The base layer provides additional assurance against potential contaminant release, by covering waste residuals left in the tank. Contaminated equipment

removed from the tank would be disposed as solid waste, and that fill equipment may be cleaned using water, which will then be disposed. The contaminated equipment is considered listed waste. It is treated per the Alternative Treatment. Standard (40CFR268.45) and disposed of on the Hanford Site.
Active ventilation with a high-efficiency particulate air filtration system will be used during grouting activities to control potential emissions to the environment. The following air permits have been obtained for this project to control radiological and toxic emissions, WSDOE Approval Order 97NM-001 Rev. 2, 2/24/03 and Rad Air Approval AIR031102, 11/10/03. Existing passive ventilation will be used following grout placement until further action is required. Information will be obtained during the placement of the Phase I layer of grout on how operations are affected, such as impact on HEPA filter change-out.

The impacts associated with alternatives for the retrieval, treatment, and disposal of tank waste from the SSTs were evaluated in the Tank Waste Remediation System Environmental Impact Statement (TWRS EIS). This document was co-authored by DOE and Ecology and satisfied NEPA and SEPA requirements for the evaluation and public disclosure of the impacts from retrieval, treatment and disposal of tank waste. DOE, in its Record of Decision (ROD) for the TWRS EIS, selected the Phased Implementation alternative as its preferred alternative. The impacts of retrieval have been previously evaluated and disclosed.

Several retrieval technologies were identified in the TWRS EIS that could be used including hydraulic sluicing (past practice sluicing), a robotic arm using sluicing liquids (including alkali and acid solutions instead of water), mechanical retrieval, robotic crawler, and pneumatic retrieval. From among these technologies, DOE selected hydraulic sluicing and robotic arm-based retrieval for detailed analysis in the TWRS EIS. However, as indicated in the TWRS EIS, the other retrieval technologies could "be used to retrieve tank waste during any of the ex situ alternatives." The *Supplement Analysis for the Tank Waste Remediation System* (DOE/EIS-0189-SA3) determined that program changes including the use of alternative retrieval technologies (e.g., a crawler based system) for retrieving waste did not require further analysis. The impacts of retrieving waste from C-106 are bounded by the analysis in the TWRS EIS and are not subject to decisions associated with the request for a RCRA Permit modification or this SEPA checklist. DOE has and continues to conduct retrieval activities at C-106 in preparation for the ATCD project.

Compliance with NEPA requires that DOE actions taken during the demonstration project will be reversible. NEPA requires that research, testing, and demonstration projects do not result in a commitment on the part of the agency that would foreclose the consideration of future alternatives. The reversible action associated with the ATCD project is the placement of Phase I fill material in the tank. The potential exists that the closure action of the WMA C tank farm would not be consistent with this demonstration of component closure of tank C-106 and would require removing the Phase I fill material placed in the tank to meet regulatory requirements for WMA closure.

The tank closure EIS (TC-EIS) will evaluate landfill and clean closure alternatives of the single-shell tank farm systems. The basic landfill closure alternative consists of adding

grout in layers into retrieved tanks. The first layer (Phase I) would be composed of a grout with possible addition of getters for one or more CoCs. The second layer (Phase II) would be composed of a higher compressive strength grout than the first layer, but without getters. This layer would provide structural stability and fill the majority of the tank volume. The third layer (Phase III) would be composed of the highest compressive strength grout that could add a benefit of protection to an inadvertent intruder by providing an obvious layer that would resist drilling activities to the extent that the inadvertent driller would likely move away from the tank area

This demonstration project cannot foreclosure future options concerning the closure of C-106. As stated above, following retrieval, Ecology and DOE will review the success of the retrieval efforts. If it is determined that sufficient waste has been removed from the tank then DOE would proceed with the placement of the Phase I fill portion of the demonstration. If it is determined that sufficient waste has not been removed to proceed with the demonstration then DOE would not place any fill material in the tank and would suspend component closure activities for C-106 pending the completion of the TC-EIS and issuance of the ROD. The TC-EIS is evaluating alternatives for closure of WMAs and the SST system. These alternatives include landfill closure, modified clean closure and clean closure. This approach to the ATCD Project does not foreclose implementation of any of these alternatives. This demonstration preserves all future options for final closure of C-106.

12. **Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.**

The ATCD project site is located in section 2, Township 12 N, Range 26 E on the eastern edge of the 200 East Area in the Hanford 241-C tank farm (C farm). The C farm is north of the PUREX Plant and East of B Plant. The 244-CR process vault, an inactive facility used as a lag storage and waste transfer station for various waste streams, is located near the south corner of C farm (Figures 2 and 3).

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. **General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other**

Flat.

b. **What is the steepest slope on the site (approximate percent slope)?**

The approximate slope of the land is less than 2 percent.

c. **What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.**

The surface and near-surface soils in the 200 Areas generally are not well developed and consist of a number of soil types such as Rupert sand, Burbank loamy sand, and Ephrata sandy loam.

- Rupert sand consists of coarse sand and covers the majority of the 200 West Area and approximately one-half of the 200 East Area.
- Burbank loamy sand is coarse-textured and covers approximately one-third of the 200 West Area, a small portion of the 200 East Area, and the majority of the area between the 200 Areas.
- Ephrata sandy loam is a medium-textured soil that covers the northern portion of the 200 East Area.

Soil at C farm has been previously disturbed extensively during the construction and installation of the buried SST in the C farm. There would be only a small amount of soil disturbance during the ATCD project. At the ATCD project site, there would be temporary soil disturbance outside the tank footprint, primarily in the trample zone around work areas, heavy equipment traffic areas, and material lay down areas. Temporary impacts would include soil compaction. None of the soils that would be disturbed have been designated as prime or unique farmlands.

Figure 2. Location Map of WMA C and Surrounding Facilities in the 200 East Area.

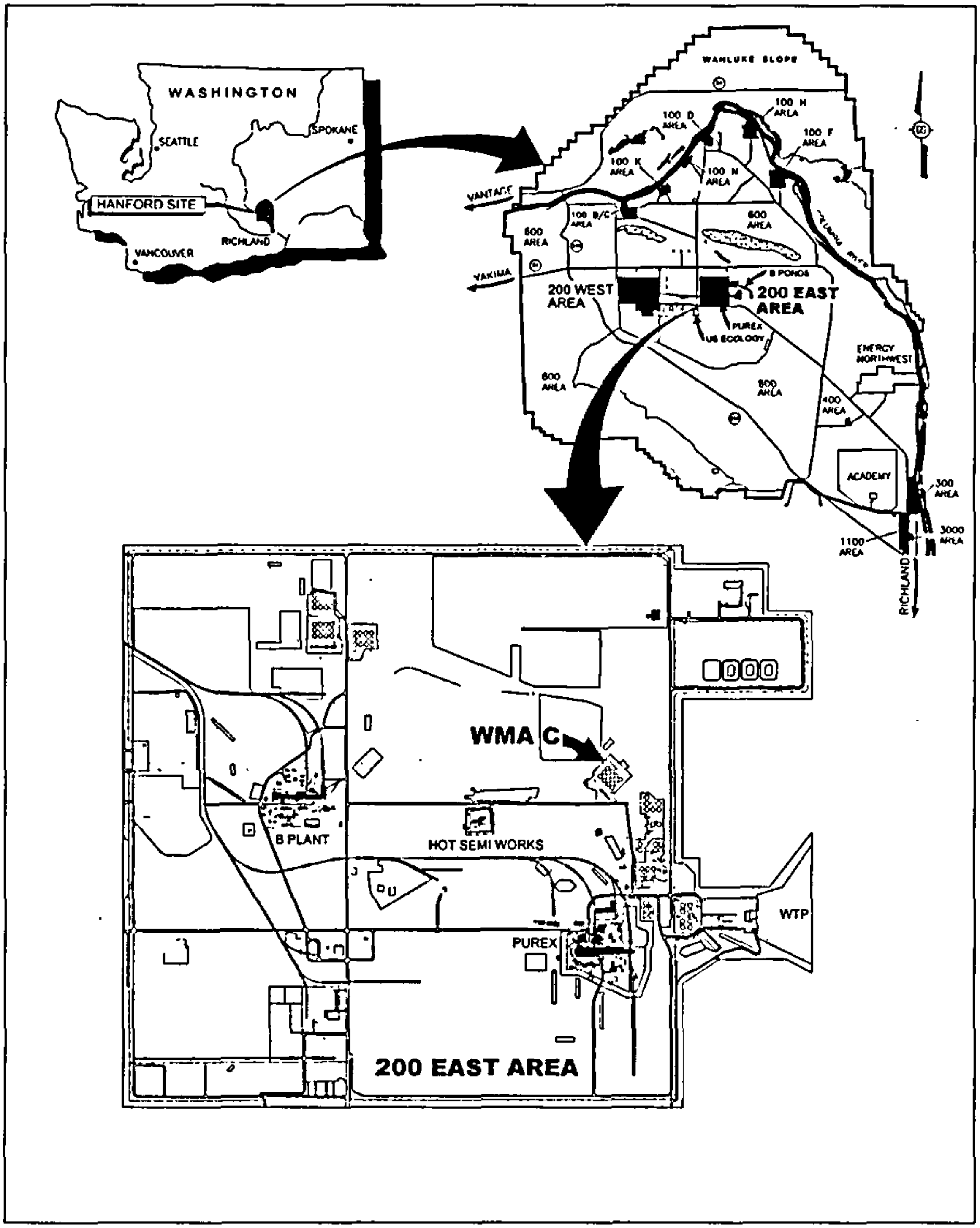


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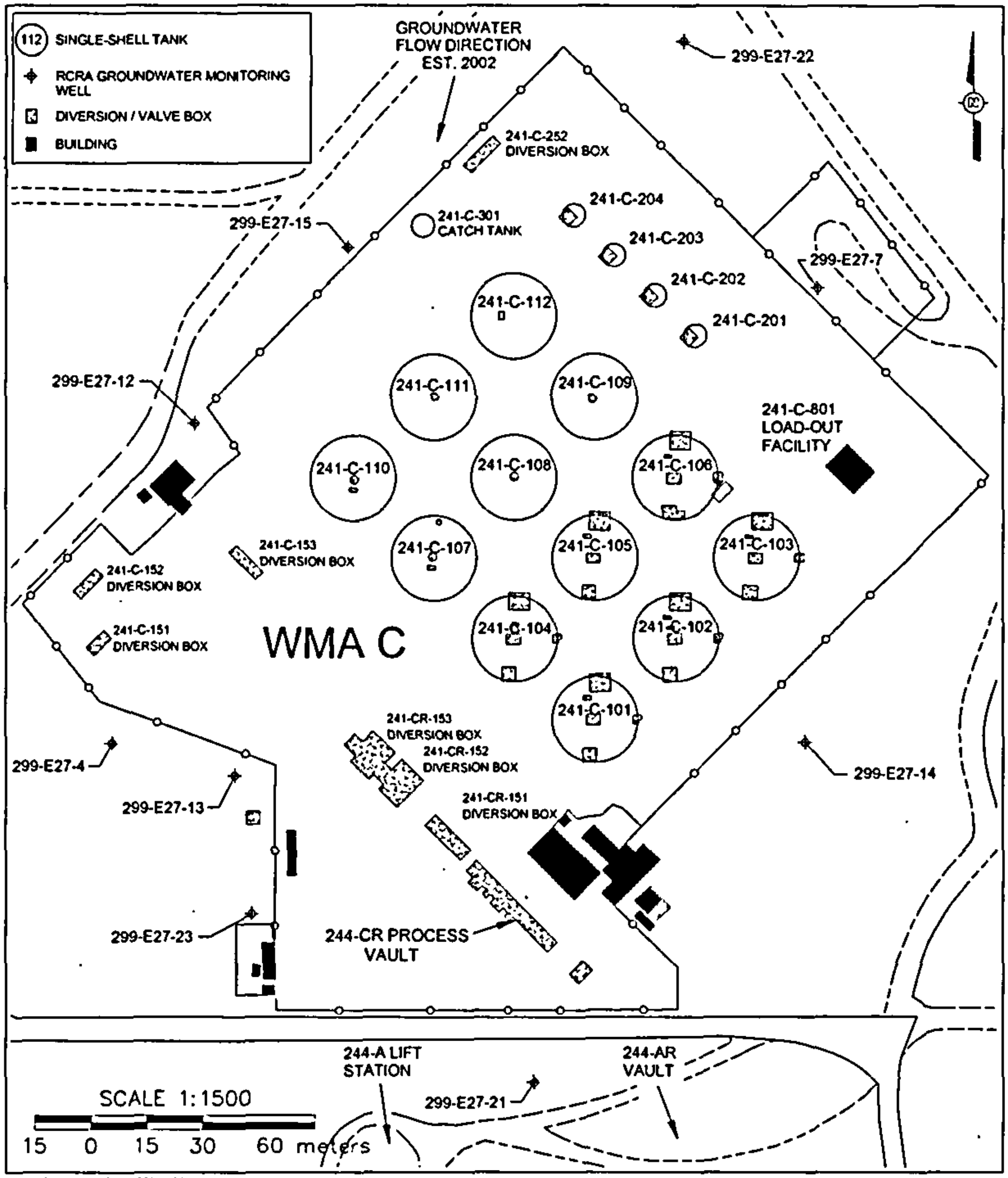
Figure 3. Location of WMA C (241-C Tank Farm) and Surrounding Facilities.



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d. **Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.**

No unstable soils have been identified.

e. **Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.**

It is estimated that between 30-cm (12-in.) and 90-cm (36-in.) of grout would be placed in the Phase I placement (~126 to 380 m^3 or ~160 to 500 yd^3). There would be no filling or grading outside of the tank.

f. **Could erosion occur as a result of clearing, construction, or use? If so, generally describe.**

There is not expected to be any increase in erosion as a result of the ATCD project.

g. **About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?**

It is not anticipated that there will be a need to place impervious surfaces following completion of the demonstration project. Weather-tight seal systems currently in place will be established above the tank after the Phase I fill has been placed into C-106. The tank will be monitored and inspected until final closure.

h. **Proposed measures to reduce or control erosion, or other impacts to the earth, if any:**

Standard construction practices for erosion and sediment control will be used at equipment staging locations and around C-106. Standard erosion/sediment control techniques may include sediment fences, straw bales, or other similar sediment catchments.

2. **Air**

a. **What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.**

Routine construction traffic and activities in and around the tank farms could generate some fugitive dust. The atmosphere in C-106 is influenced by the presence of radioactive and hazardous material that is stored in the tank. Accessing the interior of the tank provides a release pathway into the atmosphere. There would be no releases as part of the site preparation. During grouting operations active ventilation with high-efficiency particulate air filtration will be used to control potential release of contaminants to the environment. Appropriate air permits will be obtained which will provide appropriate mitigating

controls. Following grout placement, existing passive ventilation will be used until further action is required.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

There are no off-site sources of emissions or odors that would affect the conduct of the ATCD project.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

No substantial additional emissions would occur as result of the ATCD project. Construction traffic could generate some fugitive dust.

Active ventilation with high-efficiency particulate air filtration will be used during grouting operations to control potential release of contaminants to the environment. Appropriate air permits will be obtained which will provide appropriate mitigating controls.

3. Water

a. Surface:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

The Columbia River is 5.6 miles north of the Central Plateau (200 Areas). There are no naturally occurring water bodies near the Hanford tank farms. The SSTs are land-based facilities as defined in WAC 173-303-282(3)(h). WAC 173-303-282(6)(c)(i)(B)(II) requires that land-based facilities be located at least 402 m (1,319 ft) from any perennial water body. WAC 173-303-282(6)(d)(ii) requires that land-based facilities be located at least 402 m (1,319 ft) from any wetlands, designated critical habitats, habitats designated by the Washington State Department of Wildlife as essential to the maintenance or recovery of any state listed threatened or endangered wildlife species, natural areas that are acquired or voluntarily registered or dedicated by the owner, or state or federally designated wildlife refuges, preserves, or bald eagle protection areas.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

The ATCD project will not require any work over, in, or adjacent to any surface water.

3) **Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.**

There will be no fill or dredge material placed in or removed from surface water or wetlands.

4) **Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.**

All water for the 200 East Area is supplied from the Hanford Site water system. Water is distributed throughout the area by the following separate systems:

- Raw water system – Raw water is untreated, non-chlorinated water used primarily for cooling, flushing, and dilution.
- Sanitary water system – Sanitary water is treated (filtered, purified) and used for drinking and sanitary facilities.

Raw water is available from an existing 30.5 cm (12 in.) fire water line through a 5 cm (2 in.) supply line into the 241-C-73 air and water service building located outside and to the east of the C farm fence. The water requirements for the ATCD project will rely on existing developed water supply capabilities and would not require new surface water withdrawals or diversions. All pressurized raw and potable water lines feeding C Farm were leak tested in July 2002. No leaks were detected; two abandoned water lines of uncertain status were cut and capped. Active pressurized water lines serving C Farm have backflow preventers.

5) **Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.**

No, the ATCD project does not occur within a 100-year floodplain.

6) **Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.**

There will be no discharge of waste material to surface waters.

b. **Ground:**

1) **Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.**

There would be no groundwater withdrawals or discharge of water to the groundwater as part of the ATCD project. No surface, ground, or run-off water impacts are expected. All pressurized raw and potable water lines feeding C Farm were leak tested in July 2002. No leaks were detected; two abandoned water lines of uncertain status were cut and capped.

Active pressurized water lines serving C Farm have backflow preventers. Surface runoff and storm water would be directed to natural drainage areas and/or depressions. Work areas, roadways, and parking lots would be crowned or sloped to drain to localized drainage areas such as ditches or swales for evaporation or percolation into the ground.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals, agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

The question is not applicable to the ATCD project.

c. Water runoff (including stormwater):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

The Hanford Site receives 15 to 18 cm (6 to 7 in) of annual precipitation. Precipitation runs off the existing buildings and seeps into the soil on and near the buildings. The ATCD project will not increase the runoff volume in the 200 Area.

2) Could waste materials enter ground or surface waters? If so, generally describe.

There is no potential for waste material to enter groundwater or surface waters from the ATCD project actions.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

No surface, ground, or run-off water impacts are expected. All pressurized raw and potable water lines feeding C Farm were leak tested in July 2002. No leaks were detected; two abandoned water lines of uncertain status were cut and capped. Active pressurized water lines serving C Farm have backflow preventers. Surface runoff and storm water would be directed to natural drainage areas and/or depressions. Work areas, roadways, and parking lots would be crowned or sloped to drain to localized drainage areas such as ditches or swales for evaporation or percolation into the ground. As previously noted, standard construction practices for sediment/erosion control will be used as appropriate.

During retrieval water would be supplied using a hose from AY Farm to provide the water used in sluicing and not the C-farm infrastructure that was tested. The AY water supply hose would be above ground allowing for immediate identification of any potential leaks which could be immediately corrected. Only minor leakage in C-Farm from the water hose line connections has been observed. These were immediately corrected.

4. Plants

a. Check or circle types of vegetation found on the site:

deciduous trees: alder, maple, aspen, other

evergreen trees: fir, cedar, pine, other

X shrubs

X grass

pasture

crop or grain

wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other

water plants: water lily, eelgrass, milfoil, other

other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

The area around C farm has limited vegetation consisting of grasses and shrubs. The area has been disturbed extensively by past activities. The amount of vegetation that may be removed or altered would be less than one acre. This area is under a continuous vegetation management plan that includes the use of herbicides to prevent the encroachment of vegetation into the tank farm.

c. List threatened or endangered species known to be on or near the site.

There are no endangered or threatened species of plants in the C farm.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

Not applicable.

5. Animals

a. Circle any birds and animals which have been observed on or near the site or are known to be on or near the site: birds: hawk, heron, eagle, songbirds, other; mammals: deer, bear, elk, beaver, other; fish: bass, salmon, trout, herring, shellfish, other.

Information on animals can be found in PNNL-6415.

b. List any threatened or endangered species known to be on or near the site.

There are no endangered or threatened species or their habitats in the area of the ATCD project nor are there any known nesting areas in the vicinity of the ATCD project, therefore, there would be no impacts to this resource or habitat. Two federal and state listed threatened or endangered species have been identified on the 1,517 km^2 (586 mi^2) Hanford Site along the Columbia River, the bald eagle and the peregrine falcon. In addition, the state listed white pelican, sandhill crane, and ferruginous hawk also occur on or migrate through the Hanford Site. The Columbia River is about 9.3 km (5.6 mi) from the 200 East Area.

c. Is the site part of a migration route? If so, explain.

The Hanford Site is a part of the Pacific Flyway. The Hanford tank farms are not utilized by waterfowl.

d. Proposed measures to preserve or enhance wildlife, if any:

This project contains no specific measures to preserve or enhance wildlife.

6. Energy and natural resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Equipment will use diesel fuel, gasoline, and electricity during ATCD activities.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No, the ATCD project would not impact the potential use of solar energy by adjacent properties.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Energy consumption is not anticipated to be substantial, and energy conservation features are not applicable to the ATCD project.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste that could occur as a result of this proposal? If so, describe.

The ATCD project consists of short-term activities involving the retrieval of tank waste, transport of grout and the placement of the Phase I grout layer. Waste retrieval from the

tank farm system was evaluated in the TWRS EIS. Therefore, any human health risks associated with retrieval of the initial tank fill material from C-106 are bounded by the risk assessment of the TWRS EIS. To evaluate human health and safety issues, the ATCD project only requires consideration of short-term effects. Long-term health and safety and risk issues would be evaluated when final closure plans for C farm are developed.

The short-term human health risks include routine (non-accident) and accident conditions resulting from activities associated with the ATCD project. Operators would not come into physical contact with chemicals because they will be required to wear protective clothing. In addition, air monitoring and filtration will be used to identify and control any air emissions from C-106 during the period it is open. All personnel working in the tank farm will receive health and safety training appropriate for working in this environment.

The following describes the three categories of short-term risks associated with conducting the closure demonstration activities. As stated in the response to A.11 and above, the impacts of retrieving waste, from C-106 are bounded by the analysis in the TWRS EIS and are not subject to decisions associated with the request for a RCRA Permit modification or this SEPA checklist. DOE has and continues to conduct retrieval activities at C-106 in preparation for the ATCD project.

Occupational Accident Risk

The potential exists for accidents (e.g., cuts and falls) resulting from transportation and fill placement activities associated with the ATCD project. The bounding occupational accidents for the demonstration would be within the estimates presented in Appendix E of the TWRS EIS. Based upon the analysis in Appendix E, occupational accident risks are not considered to be significant.

Routine Radiological Exposure Risk Results

People have always been exposed to radiation from natural sources. The average resident of the United States receives an annual radiation dose from natural sources of about 300 mrem (0.3 rem). Exposure to large amounts of radiation (50,000 to 600,000 mrem [50 to 600 rem]) can cause serious illness or death. Exposure to small doses of radiation, such as in medical x-rays, may cause no biological damage to humans, although the probability of cancer may be slightly increased. At the Hanford Site, DOE activities have involved manmade radiation sources from nuclear processing. The DOE annual radiation dose limit for a member of the public is 100 mrem (0.1 rem).

To estimate health effects for radiation protection purposes, it usually is assumed that a collective dose of 2,000 person-rem in the general population will cause one extra latent cancer fatality (ICRP 1991). It does not matter whether 20,000 people each receive an average of 0.1 rem or 2 million people each receive an average of 0.001 rem. In either case the collective dose would equal 2,000 person-rems, and thus one additional latent cancer fatality would be expected.

Demonstration activities require work in radiation zones during the installation of

equipment, and during operations. Due to the nature of the work in a radiation zone, the workers could be exposed to and receive an occupational radiological dose from ionizing radiation. Atmospheric emissions also may result from demonstration activities. Every effort is made to eliminate exposures to the workers from air emissions. Risk from these exposures is measured in terms of latent cancer fatalities.

The bounding latent cancer fatality risks from the demonstration activities would be within the estimates presented in the TWRS EIS, Appendix D and Appendix E. Based upon the analyses in Appendices D and E, there would be no significant risks due to latent cancer fatalities as a result of conducting the ATCD project.

Radiological Accident Risk Results

Radiological accidents are unplanned events or a sequence of events that result in undesirable consequences. The potential exists for radiological accidents resulting from the closure demonstration activities. Radiological accidents could result in the unmitigated release of radiological constituents to the atmosphere, exposing the involved worker, noninvolved worker, and general public resulting in a latent cancer fatality risk. The probability of the accident occurring is taken into consideration. When the consequences of the accident or latent cancer fatality risk is evaluated with the probability of the accident occurring, the product of the two is referred to as the point-estimate latent cancer fatality risk.

The bounding latent cancer fatality risks for the demonstration activities would be within the estimates presented in Appendix E of the TWRS EIS. Personnel will receive safety training and be outfitted with appropriate protective clothing that will minimize any exposure from a release. These steps will significantly reduce the risks from postulated releases.

1) Describe special emergency services that might be required.

Hanford Site security, fire response, and ambulance services are on call at all times in the event of an emergency. Hanford Site emergency services personnel are specially trained to manage a variety of circumstances involving chemical and/or mixed waste constituents and situations.

2) Proposed measures to reduce or control environmental health hazards, if any:

All personnel are trained to follow proper procedures during disposal operations to minimize potential exposure. Chemical and radiological safety hazards would be mitigated by preventing direct contact with the residual chemical constituents, wearing protective clothing, providing appropriate training of project personnel, controlling ingress and egress to the ATCD project site, and using respiratory protection by on-site personnel as necessary.

b. Noise

1) **What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?**

The Hanford Site is an industrial complex and generates noise at levels that are consistent with the various activities conducted within the complex boundaries. Noise levels are maintained within prescribed limits. The ATCD project would use industrial equipment that would generate noise; the noise levels generated would be within levels currently generated and would not constitute an increase in noise levels. Because of the size of the Hanford Site, its scattered facilities, and its largely undeveloped nature, activities generally have no off-site noise impacts. The noise levels from the ATCD project would be short term, limited to the duration of project activities, and would not be permanent or long term.

2) **What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.**

Noise impacts associated with the project are described above. There would be no substantial change in noise levels due to the ATCD project.

3) **Proposed measures to reduce or control noise impacts, if any:**

In the unlikely event that Occupational Safety and Health Administration noise standards would be exceeded (*Noise Control Act of 1972*), appropriate measures to protect personnel would be employed (ear muffs, ear plugs, etc.).

8. Land and shoreline use

a. What is the current use of the site and adjacent properties?

The Hanford Site is a single RCRA facility identified by the U.S. Environmental Protection Agency (EPA)/State Identification Number WA7890008967 that consists of over 60 treatment, storage, and disposal units conducting dangerous waste management activities. These treatment, storage, and disposal units are included in the *Hanford Facility Dangerous Waste Part A Permit Application* (DOE/RL-88-21). The Hanford Site consists of all contiguous land, structures, other appurtenances, and improvements on the land used for recycling, reusing, reclaiming, transferring, storing, treating, or disposing of dangerous waste, which, for the purposes of RCRA, are owned by the U.S. Government and operated by DOE (excluding lands north and east of the Columbia River, river islands, lands owned or used by the Bonneville Power Administration, lands leased to Energy Northwest, and lands owned by or leased to Washington State).

The current use of the Hanford Site includes a series of tank farms that are used to store hazardous and radioactive wastes including liquids and sludges.

b. Has the site been used for agriculture? If so, describe.

The Hanford Site has not been used for agriculture since 1943. Prior to 1943 portions of the Hanford Site, particularly near the abandoned Hanford town site, supported fruit orchards. Based upon review of available documents, the ATCD project site was not used for agriculture.

c. Describe any structures on the site.

There is a substantial amount of ancillary equipment (i.e., pits, transfer lines, ventilation equipment, vaults, diversion boxes) in C farm that will require disposition at or before closure of the entire tank farm. The cesium load-out facility (241-C-801) is located in C farm and was operated until 1976 as a transfer facility for cesium-rich waste. The cesium load-out facility is located near the east corner of the tank farm and would not interfere with component closure activities for C-106. Support facilities were installed in the vicinity of C-106 to support the C-106 waste retrieval campaign in the late 1990s (project W-320). The ancillary equipment is not part of the ATCD component closure action.

d. Will any structures be demolished? If so, what?

There will be no structures demolished as part of the ATCD project.

e. What is the current zoning classification of the site?

The Hanford Site is zoned as an unclassified use district by Benton County.

f. What is the current comprehensive plan designation of the site?

The 1985 *Benton County Comprehensive Land Use Plan* designates the Hanford Site as the "Hanford Reservation" (BCBCC 1985). Under this designation, land on the Hanford Site can be used for "activities nuclear in nature." Nonnuclear activities are authorized "if and when DOE approval for such activities is obtained." The Hanford Comprehensive Land-Use Plan Environmental Impact Statement Record of Decision (64 FR 61615) stated that the Central Plateau (200 Areas) geographic area is designated industrial-exclusive.

g. If applicable, what is the current shoreline master program designation of the site?

Not applicable to the ATCD project site.

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

No.

i. Approximately how many people would reside or work in the completed project?

The ATCD project does not produce opportunities for habitation or new employment.

j. Approximately how many people would the completed project displace?

The ATCD project would not displace any people.

k. Proposed measures to avoid or reduce displacement impacts, if any:

Does not apply.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

Does not apply (refer to Section 8f).

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

Not applicable. No housing units would be provided.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

Not applicable. No housing units would be eliminated.

c. Proposed measures to reduce or control housing impacts, if any:

Not applicable. There are no housing impacts associated with the ATCD project.

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The visual features of the tanks farms and surrounding area will not be affected by the ATCD project. All features and equipment associated with the project can be considered to be at ground level.

b. What views in the immediate vicinity would be altered or obstructed?

There will be no views altered or obstructed as a result of the ATCD project.

c. Proposed measures to reduce or control aesthetic impacts, if any:

Not applicable.

11. Light and glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Not applicable.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No, there will be no new light sources or glare created from the ATCD project.

c. What existing off-site sources of light or glare may affect your proposal?

There are no off-site sources of light that would affect the ATCD project.

d. Proposed measures to reduce or control light and glare impacts, if any:

Not applicable, there are no impacts associated with lighting or glare created by the ATCD project.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

There are no designated or informal recreational opportunities in the immediate vicinity of the ATCD project.

b. Would the proposed project displace any existing recreational uses? If so, describe.

No, the ATCD project would not displace any existing recreational uses.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

Not applicable, there are no impacts on recreation or recreation opportunities created by the ATCD project.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

The waste storage tanks could be considered of potential historical significance because they are an element that contributes to activities that were associated with World War II and Cold War periods of United States history. The ATCD project might require making modifications to the existing tank structures. Typically, contaminated structures of historical value would have their history and use documented but would not be preserved intact. DOE has received an exemption that would allow documenting only one SST, one DST, and one inactive miscellaneous underground storage tank rather than documenting each tank individually (DOE/RL-96-77). The ATCD project would not affect the ability for this documentation to occur.

The tank farms underwent extensive excavation when the tanks were installed underground. It is unlikely that any archaeologically significant resources would be encountered during the ATCD project, and any that were encountered would likely not be in their original cultural context. Notwithstanding this situation, in the event cultural resources were encountered during the ATCD project, work would be halted and the NEPA compliance officer and State Historic Preservation Officer would be notified to determine the appropriate disposition of the resource and any mitigative actions that would be required prior to continuing with the project.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

Consideration of impacts to cultural resources is mandated under Section 106 of the *National Historic Preservation Act* implemented by 36 CFR 800. Requirements identifying significant historic properties that may be impacted by the proposed action or alternatives within the project's area of potential effect. Historic properties are defined as archaeological sites, standing structures, or other historic resources listed in or determined eligible for listing in the *National Historic Preservation Act*. If adverse effects on historic, archaeological, or cultural properties are identified, agencies must attempt to avoid, minimize, or mitigate the impacts to these resources.

The Hanford Site as a whole contains extensive prehistoric and historic archaeological sites. However, the 200 Areas contain very few known prehistoric or historic archaeological sites. A comprehensive archaeological resources review for the fenced portions of the 200 Areas was conducted in 1987 and 1988 (PNNL-6415). Two historic archaeological sites, four isolated historic artifacts, one isolated cryptocrystalline flake, and an extensive linear feature (White Bluffs Road) were the only material greater than 50 years old discovered during the field survey. Only the White Bluffs Road was determined eligible for listing on the National Register of Historic Places. This road, which passes

diagonally southwest to northeast through the 200 West Area, originated as a Native American trail. Segments of the White Bluffs Road that are located in the 200 West Area have been determined to be non-contributing. Such non-contributing segments of the White Bluffs Road are those that do not add to the historic significance of the road but retain evidence of its contiguous bearing.

c. Proposed measures to reduce or control impacts, if any:

The ATCD project activities might require making modifications to the existing tank structures. During the ATCD project, C-106 would be filled with between 30-cm (12-in.) and 90-cm (36-in.) of grout (~126 to 380 m^3 or ~160 to 500 yd^3) that would alter the integrity of the tanks' historical context. Typically, contaminated structures of historical value would have their history and use documented but would not be preserved intact. DOE-Richland Operations Office, the Advisory Council on Historic Preservation, and the Washington State Historic Preservation Office entered into a programmatic agreement for the maintenance, deactivation, alteration, and demolition of the built environment on the Hanford Site in August 1996. Through this agreement, DOE received an exemption allowing them to document only one SST, one DST, and one inactive miscellaneous underground storage tank rather than individually documenting each tank. No further consultation or action is required concerning historic preservation issues related to the tanks.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on-site plans, if any.

Does not apply.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

The Central Plateau is not accessible to the public and is not served by public transit.

c. How many parking spaces would the completed project have? How many would the project eliminate?

Does not apply.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

There would be no new permanent roads, streets, or improvement to the road network.

e. **Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.**

No.

f. **How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.**

The traffic volume to and from the Hanford Site as well as in the vicinity of the C farm will not change from current volumes. There will be no increase in labor force to conduct the ATCD project.

g. **Proposed measures to reduce or control transportation impacts, if any:**

Not applicable.

15. **Public Services**

a. **Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.**

No.

b. **Proposed measures to reduce or control direct impacts on public services, if any.**

Not applicable.

16. **Utilities**

a. **Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other.**

Electricity, potable water, refuse service, telephone, and a sanitary sewer system are available in the 200 East Area.

b. **Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.**

The following utilities are currently available at the C farm and would be used temporarily during the ATCD project.

- SST electrical power system – The electrical power capacity available to the C farm will be 1,000 kVA of 3-phase power at 13.8 kV and 60 Hz.

- SST raw water – The raw water available in the C farm flows through a 5 cm (2-in) line to the 241-C-73 air and water service building at 1,000 kPa (145 lb/in^2 gauge).

- SST service air system – The service air available to the C farm is 25 ft^3/min of dry compressed air with a dew point of -40 °C at 690 kPa (100 lb/in^2 gauge).

Staging would occur in previously disturbed areas within the 200 East Area near C farm. Equipment for materials storage, mixing, and delivery of fill materials would be trucked to the ATCD site and set up in designated fenced areas of less than one acre, near C farm. Trailers for contractor personnel also would be provided. Grout production would occur off-site and be delivered to the C farm. All contractor equipment and facilities would be located in previously disturbed areas.

The staging area would require limited preparation because of the relatively level topography in the 200 East Area around C farm. Fencing would be provided around the contractor facilities. Water and power would be provided from existing on-site sources and temporary connections would be made to these services.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Roy J. Schepens [signature] Date 1/19/04

Roy Schepens

U.S. Department of Energy

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